7 PUBLIC TRANSPORT SYSTEM

7.1 Planning Approach

The Mission of the Urban Transport Master Plan for Phnom Penh is 1) to shift from a private-oriented urban transport system to a well-balanced system of public and private transport and a combination of road, public transport and traffic management for improving the mobility of citizens and 2) to materialize the urban potential of Phnom Penh Capital City (PPCC). In general, the urban transport policy aims at securing people's mobility need and rationalizing urban transport systems. To secure people's mobility need is implemented by providing both accessibility and mobility to urban facilities necessary for their daily life. This mobility should be guaranteed as much as possible for all people. The trip area of people becomes much wider today than that of previous times when walking was the only means of transport because of the popularity of motor vehicles such as motorcycles and cars. However, cars might not be available for all the people and occasionally even car drivers are unable to use their own cars due to specific reasons. This is the first reason why public transport is needed.
From the viewpoint of rationalization of urban transport systems, cars are a system which broadly occupies urban roads that are most precious urban spaces, emits exhaust gas and noise to surrounding area and mostly is not energy-efficient.
Above all, cars might be an important transport means in the urban area, but its performance is very limited under a high-density urban environment. For PPCC, which is a medium-sized city with its historically developed structure, it is necessary to decrease car trip demand coming into its center due to the low road capacity and difficulty in eliminating spatial constraints in the center district. Thus, an efficient public transport system is necessary to promote the modal shift and encourage the shift from car trips.

7.1.1 Focal Points of Public Transport Plan

(1) Focusing on Multi-Modal Transport Aspect in Urban Mobility

Needless to say, a significant feature of the current urban transport situation in Phnom Penh is that it lacks a formal public transport system such as a bus system, although the motodop and the motorumok are substantially served as public transport. Basically, people's transport needs are served by individual transport modes, and this implies that people lacking own transport /driving skill might not be guaranteed to have good mobility. There are many kinds of stakeholders expected for this urban transport project. Obviously, there are those who either own or do not own individual transport means. The transport plan should be arranged for such groups. This analogy is also adaptable for outside residents who may occasionally visit Phnom Penh with no available transport means. Convenient and smooth urban mobility should be secured for all of the people including aged / disabled persons, and smooth intermodal connection between different transport modes should also be secured under the present urban transport plan. These concepts, so called multi-modal transport principle, would be applied to the formulation of the public transport plan.

(2) Introduction of Trunk Public Transport System

Introducing a public transport system will contribute to the increase of urban mobility and the effective use of limited urban roads in the dense Phnom Penh city center. It will also have positive impacts on urban development as activities are directed along the public transport corridor and transit-oriented development in the center of mode interchange areas such as stations and terminals.

(3) Broad Integration of Public Transport Means and Related Countermeasures

To achieve the above objectives, it is mentioned that the public transport system should be integrated

between trunk transport and feeder transport, and smooth connection between public transport and individual private transport means should be established as well. In this connection, it is also mentioned that related soft policy measures like Traffic Demand Management (TDM), parking control and building control measures along major arterial roads should be closely coordinated with implementation of the public transport plan.

(4) Integrating with Landuse Plan

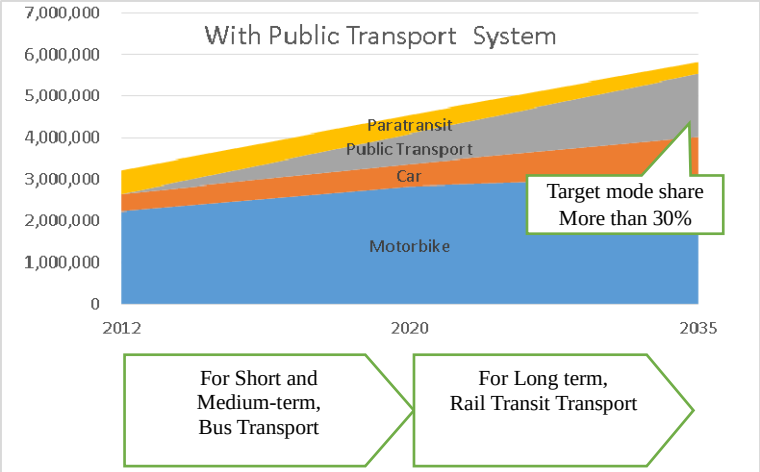
As indicated by past urban transport projects, there is a strong interaction between urban transport development and landuse changes. For example, a combination of mass transit route and linear development of high-density residential areas in the suburbs, so called Transit Oriented Development (TOD), is recognized to be a strategy in which urban development side expects location advantage by high quality service of mass transit, and simultaneously mass transit side expects sufficient transport demand by high-density residential development. In downtown area with mixed land use by dense business zone/commercial district/ amusement center, it is preferable to provide people with comfortable pedestrian spaces coupled with a convenient public transport system.
Likewise, it is desirable that the urban transport network and facilities are formulated by area so as to meet the urban mobility expected from respective land use plans designated to each area.

(5) Close Linkage with Tourism Development

Phnom Penh is one of the tourist destinations in Cambodia and tourism is an important industry contributing to the Gross Regional Domestic Product (GRDP) of Phnom Penh. As for the future development of tourism, it is very important to provide convenient rapid access transport from/to regional transport connecting points such as the Phnom Penh international airport, long distance Bus terminals and the central railway station if available. In addition, several sightseeing transit services connecting between popular touring spots and major hotels are necessary in order to upgrade tourism activities, particularly for foreign tourists. A public transport system can provide a solution to some extent for the requirement above, and it is important to make necessary coordination with tourism development plans.

7.1.2 Basic Policy of Public Transport System Development

Needless to say, there is presently no formal public transport system existing in Phnom Penh except for such para-transit modes as the motodop and the motorumok modern (tuk-tuk) that are popularity used as public transport. In this master plan, final output of this public transport proposal is the formulation of mass transit system in the long term. However, taking into account the specific preparation period in developing a trunk public transport system and transport alternatives for the transition process, it is necessary to make an intermediate public transport plan focusing on the short and medium terms as shown in Figure 7.1-1.



Source: PPUTMP Project Team

Figure 7.1-1 Image of Public Transport System Development

Corresponding with this concept, a bus network development plan is discussed as a short and medium-term transport plan and then a mass transit transport plan is discussed as a long-term transport plan.
The 2035 public transport system needs to meet 10% (of total trips excluding walk trips is about 450 thousand trips) of the public transport demand in 2020 considering the expected 2035 public transport demand (30% of total trips excluding walk trips is about 1,750 thousand trips).
Assuming that the number of buses in 2020 is about 200, based on the result of the 2nd public experiment and the 2020 bus route length, to be discussed in 7.1.2, the number of bus passengers/bus/day is 2,250. This figure is the possible daily bus ridership.

7.2 Bus Transport Plan

7.2.1 Basic Considerations for the Bus Transportation Plan

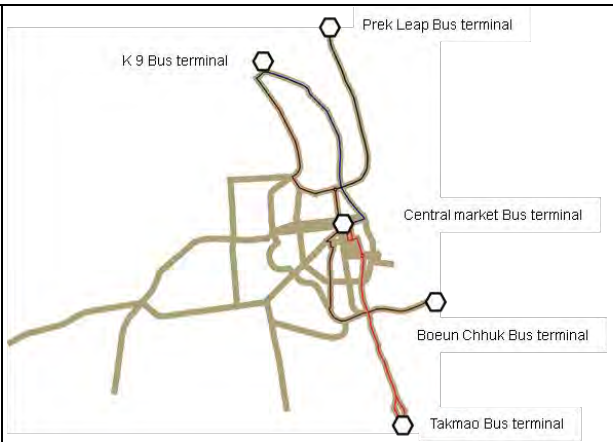
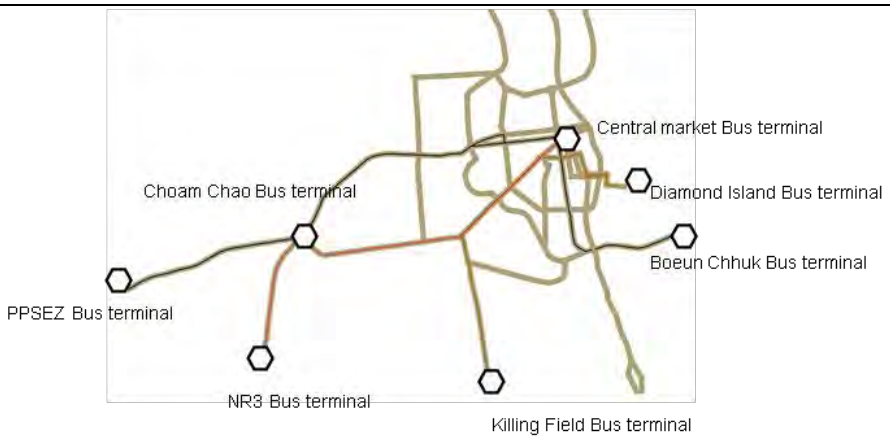
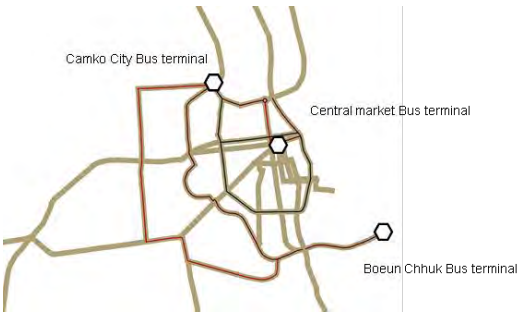
Bus system is the trunk public transport system for the short- to medium-term planning in PPCC. Basic considerations of the bus transport plan in short- to medium-term are as follows:

a) Starting point of the bus transport plan is the 2nd public experiment (city bus operation), which is one route along Monivong with 7.2 km and about 1,550 daily passengers;
b) The 2035 public transport demand (30% of total trips excluding walk):
c) The planning and facility criteria such as population/location of facilities and minimum road width of bus route (8 m)/interval of bus stops (300 m - 500 m);
d) Major transport corridors, future population and urban structure in 2020; and
e) Staging, basically, for short term, covering the north-south and east-west transport corridors and medium term, covering the urbanized area in 2020

7.2.2 Medium-term Bus Network Proposal before Introduction of Rail Transit System

Taking into consideration current public transport demand, the following 3 types of bus route groups are proposed, namely, 1) type 1= routes covering north-south corridor (radial bus lines connecting between CBD and suburbs in north-south direction), 2) type 2= routes covering east-west corridor (radial bus lines connecting between CBD and suburbs in east-west direction), and 3) type 3= ring routes covering city center and its peripheral area in 2020 (circular bus lines connecting the fringe area of CBD). Total number of routes is 10.
For intermodal service with long distance transport and private transport means, intermodal facilities such as bus terminals should be provided at starting points, terminating points and major intermediate points of bus lines.

Table 7.2-1 Proposed Medium-Term Bus Network

Type 1 : Bus lines for North-South radial traffic between CBD and suburban center	
Total route length: 43.4 km Related major transport nodes: 5	
Type 2 : Bus lines for East-West radial traffic between CBD and suburban center	
Total route length: 59.6 km Related major transport nodes: 7	
Type 3 : Bus lines for circular traffic in the surrounding area of CBD	
Total route length: 60.2 km Related major transport nodes: 3	

Source: PPUTMP Project Team

To examine the bus service availability by district, population coverage ratio by zone is calculated, assuming a bus service coverage area within 300 m from the bus route. Table 7.2-2 shows the result; the bus route proposed as an initial public transport plan can cover around 40% of the population in Phnom Penh area. Highest services are expected in CBD such as Doun Penh and Chamkar Mon, followed by Toul Kouk. A relatively high ratio is also expected in their neighboring zones such as Russey Keo, Meanchey and Saensokh; however, lower coverage rate is found in the suburbs such as Por Senchey and Dangkao. For these areas where fewer bus services are provided, specific countermeasures like utilization of secondary public transport modes like para-transit should be considered more.

Table 7.2-2 Population Coverage by Bus Services

Khan	Total Population (2012)	Population by bus services	Average bus service coverage
Chamkar Mon	184,200	151,572	0.82
Doun Penh	212,800	188,280	0.88
Toul Kouk	186,100	122,210	0.66
Dangkao	96,100	4,137	0.04
Por Senchey	269,200	37,214	0.14
Meanchey	443,200	133,673	0.30
Russey Keo	250,500	77,488	0.31
Saensokh	210,100	54,997	0.26
TOTAL	1,852,200	769,571	0.42

Source: PPUTMP Project Team

7.2.3 Bus Network Development Staging

Bus network development staging from 2014 to 2020 is performed according to the steps shown below.

Source: PPUTMP Project Team

Figure 7.2-1 Staging of Bus Route Network for Short to Medium Term

7.2.4 Medium- to long-term bus network after introduction of rail transit system

After the trunk public transport system like rail transit is introduced, bus transport will change its role from main public transport to mostly supplementary transport of the trunk system. Based on this notion, a network alteration/reorganization will be made on the bus network (refer to Figure 7.2-2).

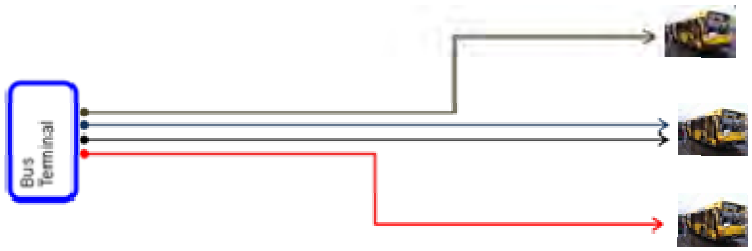
(1) Bus route before introduction of trunk transport system

In this stage, bus transport is a main player of the public transport system and should supply almost all the public transport capacity; in this regard, bus routes are deployed in major urban corridors along the arterial roads, and many bus lines are concentrated in the bus terminal of the route. The total transport capacity might reach nearly 10 thousand PPHPD at its largest, but traffic efficiency might drop drastically as well as passenger convenience.

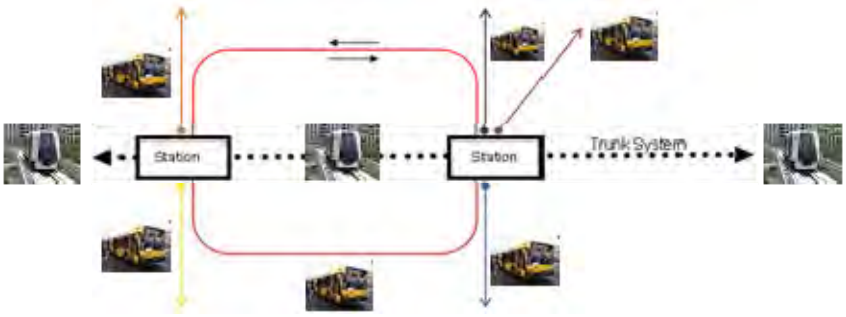
(2) Bus route after introduction of trunk transport system

When the trunk public transport such as rail transit is introduced, the public transport capacity in main urban corridors will increase together with upgrading of the transport service level. Meanwhile, public transport users in main corridors will change their transport mode from bus to the new trunk transport, and there will also be corresponding changes in bus routes depending on transport needs. One example of bus route reconfiguration is shown in the figure below. Along the main transport corridor, the bus route changes from mainline transportation to branch transport system / feeder transport system. This type of transport system can provide public transport users with efficient transport services and feed the trunk transport system with passengers beyond walking distance to stations.

[Before introduction of rail transit system]



[After introduction of rail transit system]



Source: PPUTMP Project Team

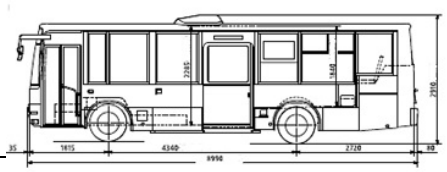
Figure 7.2-2 Concept of Bus Route Reconfiguration with the Introduction of Rail Transit System

7.2.5 Bus operation plan

(1) Bus vehicles

A general bus specification is provided below.

Table 7.2-3 General Bus Specification

Size			Lateral view
Medium type	Passengers	26 (seating) 30 (standing) 56 (Total)	
	Length (m)	9.0	
	Width (m)	2.3	
	Height (m)	2.9	
Mini type	Passengers	28 (seating) 0 (standing) 28 (Total)	
	Length (m)	7.0	
	Width (m)	2.0	
	Height (m)	2.8	

Source: PPUTMP Project Team

Both types shown in the table are applicable as public bus fleet. The medium type bus is used for serving the principal bus line running on arterial roads/ secondary arterial roads, expecting medium to large bus demand. Mini buses are used for local bus routes serving as secondary/feeder bus routes for the principal bus route, and can be operated on narrower streets.
For passengers' comfort, cabin accommodation is important. Air-conditioning is an inevitable cabin condition under fierce tropical climate. Fuel-efficient type of vehicle is also recommendable in view of ecology/energy efficiency.

(2) Bus stop

Bus stops are deployed at an interval of 0.5 km to 1 km on each bus line, depending on the level of transport demand. In principle, bus stops are placed near curb side of the sidewalk. Bus stops are furnished with a shelter, bus information board and some other equipment. A typical bus stop is shown in Figure 7.2-4 .

Source: PPUTMP Project Team

Figure 7. 2-3 Typical Image of Bus Stop

(3) Bus depot

To park the bus in operation and conduct maintenance / light repairing, each bus route accommodates bus depot facilities. A spacious flat area is generally selected as location for a bus depot, taking into account ease of accessibility to bus routes and convenience for bus operation and management. The bus depot is to be equipped with the following facilities:

- Functional space - Bus parking area, Maintenance yard, Parts stock yard
- Operation facilities - Mechanic repair facilities, Fuel supply facilities, Cleaning facilities
- Management - Operation management center, Administration division

7.3 Introduction of Trunk Public Transportation System

7.3.1 Candidate Trunk Public Transportation Systems

Classification of Mass Transit System

Regarding land transport systems available for urban transport, they are classified as shown in Table 7.3-1, solely focusing on physical/technical aspects.

Right of Way (R/W): Any transport system requires a specific running space (R/W) to operate its rolling stock. How R/W is provided strongly affects the introduction of mass transit. In general R/W is classified into the following 3 categories:

- Category A (a R/W which is used exclusively for a specific transport system, e.g., underground tunnel for Metro)
- Category C (a R/W on road in which a transport system operates with mixed traffic)
- Category B (a R/W considered to be between category A and C)

Vehicle Support mechanism: There are 2 kinds of systems: one in which vehicles have steel wheels and are operated on steel tracks and one in which vehicles have rubber wheels and is operating on specific exclusive tracks such as monorail systems.

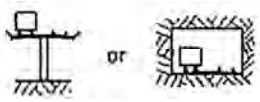
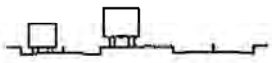
Guideway: There are specific facilities to control the steering of the transport system such as guide tracks in Automated Guideway Transit (AGT) system and rail tracks in railway. A transport system without guide way, e.g., bus system, is steered manually by a driver.

Propulsion mechanism: This refers to the power source which drives vehicles. There are two types: one is driven by diesel internal-combustion engine and the other is driven by electric motor.

Operation control: This is the technical factor to safely operate vehicles. There are three type of operation control, i.e., the manual operation based on driver's observation without mechanical support, manual operation supported by signals and other mechanical equipment, and driverless full-automated operation.

These conditions are related to each other. Considering the relationship, a practical classification is given in the table below.

Table 7.3-1 Classification of Urban Transport Systems

Support mechanism + Guiding type		Steered by driver on the road	Supported by rubber wheel + Guided by guide track	Supported by Steel wheel on the steel rail track
Propulsion		Internal-combustion engine	Electric motor	Electric motor
R/W	A: Fully controlled R/W without grade crossing 	BRT（bus way）	Metro(by rubber wheel), Monorail, AGT	LRT Metro
	B: Longitudinally separated but with grade crossing 	BRT	Guide Bus* *including case of ICE	LRT
	C: Surface streets with mixed traffic 	Bus（on St.）		Tram

Note: BRT= Bus Rapid Transit, LRT= Elevated Rail Transit
Source: Modified from Vukan R. Vuchic's Urban Transit: Operations, Planning and Economics

Table 7.3-2 Outline of Major Urban Transport Systems

	Exterior view	R/W	Capacity (PPHPD*)	Minimum curve radius(m)	Average Investment Cost (M$/km)
Standard Bus		Road at grade	2,000	50m	
BRT		Exclusive bus way at grade	4,000	50m	
Monorail		Exclusive guide way track on elevated structure	2,000 ~ 22,000	50m	100 ~ 190
AGT		Exclusive guide way track on elevated structure	1,000 ~ 13,000	50m	70 ~ 150
LRT		Exclusive rail track on elevated structure	6,000 ~ 20,000	50m	70 ~ 150
Tram		Exclusive rail track at grade	6,000 ~ 20,000	50m	15 ~ 20
LIM*1		Exclusive rail track in underground /elevated structure	30,000	50m	190 ~ 250
Metro		Exclusive rail track in underground structure	4,000 ~ 85,000	120m	250 ~ 300

Note: PPHPD= Passengers Per Hour Per Direction, *1 Linear Metro
Source: Modified from Ministry of Land, Infrastructure, Transport and Tourism website (Japan)

Among the major transport systems, actual transport situation in Japan is summarized in Table 7.3-3.

Table 7.3-3 Latest Urban Transport Indicators in Selected Regions in Japan

Name of Mass Transit	Location	Route Length (km)	Daily Passengers Volumes per route km	Mode Type	Train Composition	R/W
Oedo line	Tokyo	40.7	19,000	Light Metro	8@LIM	underground tunnel
Shinjuku line	Tokyo	23.5	28,000	Metro	10@Metro	underground tunnel
Tozai line	Tokyo	30.8	42,000	Metro	10@Metro	underground tunnel
Chiba city liner	Chiba city	15.2	2,000	Monorail (Suspension type)	2@L-mono	elevated exclusive guideway
Tokyo monorail	Tokyo	17.8	7,000	Monorail (Straddle type)	6@L-mono	elevated exclusive guideway
Tama monorail line	Tokyo	16	7,000	Monorail (Straddle type)	4@L-mono	elevated exclusive guideway
Okinawa yui rail	Naha city	12.9	2,000	Monorail (Straddle type)	2@M-mono	elevated exclusive guideway
Saitama new urban transport	Saitama city	12.7	3,000	AGT	6@AGT	elevated exclusive guideway
Yokohama sea side line	Yokohama city	10.6	4,000	AGT	5@AGT	elevated exclusive guideway
Yurikamome	Tokyo	14.7	6,000	AGT	6@AGT	elevated exclusive guideway
Toneri liner	Tokyo	9.7	6,000	AGT	5@AGT	elevated exclusive guideway
Waseda tramway	Tokyo	12.2	4,000	Tram	1@Tram	Road in mixed traffic
Hiroshima tram line	Hiroshima city	19.0	5,000	Tram	1@Tram	Road in mixed traffic

Source: Railway Statistics Yearbook (2011)

<Specifications of each model>

Rolling Stock Type	Car length(m)	Width (m)	Height (m)	Passenger capacity
L-mono (Large-sized monorail)	15.50	3.00	3.74	100
M-mono (Medium-sized monorail)	14.70	2.98	3.74	82
AGT (Automated Guideway Transit)	9.00	2.50	3.30	75
LIM (Linear Induction Metro)	16.50	2.50	3.15	100
Metro	20.00	2.85	4.14	150

7.3.2 Estimation of Public Transport Demand Potential in Phnom Penh

For the system selection of mass transit system, the most important factor is transport demand in the future. In this regard, potential public transportation demand level should be clarified so as to determine the required transport capacity in general. Using the future Origin-Destination (OD) trip matrix in 2035, which is tabulated by existing transport mode, trip aggregation is carried out based on the following assumptions.

Passenger trip catchment areas for mass transit is assumed to be within a radius of 500 m and passenger trip catchments areas for feeder bus is assumed to be a belt area of 200 m wide

Interzonal trips by mode are converted into ridership estimation of mass transit according to the following formula:

$${}_mP_{ab} = \Sigma_{i=1,n}\Sigma_{j=1,n}\, {}_mT_{ij} \times S_{ia}/A_i \times S_{ib}/A_j$$

Where,
${}_mP_{ab}$: Partial Passengers volume between station a and station b (trip mode m)
${}_mT_{ij}$: Trip from zone i to zone j (trip mode m)
S_{ia}: Partial catchment areas of station (a) included in area of zone i
A_i: Area of zone i

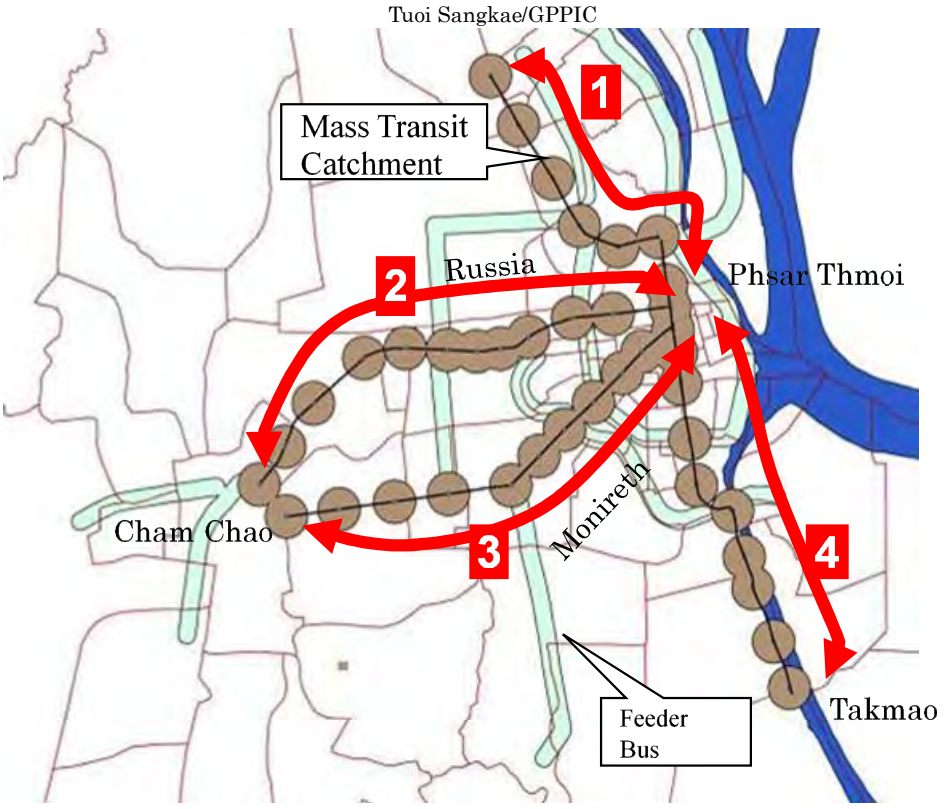
Potential public transport demand is calculated, assuming the following diversion rate by trip mode:

Potential public transport volume = walk trip x 0% + motorcycle trip x 30% + Car trip x 30% + Para-transit trip x 100%

In order to estimate demand flow by direction, aforementioned transport corridors are divided into route segments as shown in Figure 7.3-1, and potential public transport demand is aggregated by route segment, assuming stations of the mass transit route and feeder transport routes.

Each route segment is defined as follows:

- Segment 1: from Tuol Sangkae to Phsar Thmei
- Segment 2: from Chaom Chau to Phsar Thmei via Russia
- Segment 3: from Chaom Chau to Phsar Thmei via Monireth
- Segment 4: from Takmao to Phsar Thmei



Source: PPUTMP Project Team

Figure 7.3-1 Outline of Potential Public Transport Demand Estimation

Table 7.3-4 Estimation Result of Potential Mass Transit Demand in 2035

Segment	Route length(km)	Minimum estimation scenario *1		Maximum estimation scenario *2	
		Daily passengers volume	Average Volume per route km	Daily passengers volume	Average Volume per route km
1	7.6	28,000	3,000	46,000	6,000
2	11.5	55,000	5,000	82,000	7,000
3	10.5	55,000	5,000	95,000	9,000
4	10.0	55,000	6,000	93,000	9,000
Total	39.6	193,000	5,000	316,000	8,000

Note: *1: Only passengers within 500m catchments area are counted.
*2 Includes passengers using feeder transport means.
Source: PPUTMP Project Team

From the result above, necessity of mass transit introduction is seen to be in the following order:

- First priority line: Segment 2 / Segment 4 with demand level of 5,000 - 9,000 passengers /day/km
- Second priority line: Segment 1/ Segment 3 with demand level of 3,000 - 9,000 passengers /day/km

7.3.3 System Selection of Trunk Public Transport in 2035

(1) Adaptable Transport System by Demand Level

An adaptable transport system is selected, comparing with actual transport result (refer to Table 7.3-5). Except for the Metro and Tram the other systems are considered to be adaptable for each route segment.

Table 7.3-5 System Selection Based on Expected Demand Level

System type	Actual transport performance in Japan (passengers /day /km)	Adaptability	
Metro	20,000 to 40,000	Primary capacity is too large for expected demand level	▲
Linear Metro	7,000 to 19,000	Match to expected demand level	○
Monorail	2,000 to 7,000	Match to expected demand level	○
AGT	2,000 to 6,000	Match to expected demand level	○
LRT	Same as AGT, Monorail	Match to expected demand level	○
Tram	around 5,000	Demand level might be within affordable range	○

Source: PPUTMP Project Team

(2) Choice of R/W

To successfully introduce mass transit system, it is essential to divert trips from private transport users (car, motorbike) to public transport system. To realize this, it is important for mass transit system to be competitive with conventional road transport modes. Competitiveness of transport system can be

measured by several evaluation factors, i.e., required time for travel, cost, comfort and convenience. Among them the most notable factor is considered to be time factor. Since public transport entails that transit passengers go through various transition process such as access/egress, mode change and transit waiting, etc., it causes extra time accordingly. Depending on trip condition, trip diversion cannot be expected. To clarify this situation, a simple model comparison is examined as follows:

Table 7.3-6 Comparison of Required Travel Time by Transport Mode and Trip Length

Trip length	System	carriageway (R/W)	Speed (km/h)	reuired time (min.)				
				In vehicle time	Access/ Egress time	Transfer time	waiting time	Total
5km	Car	Road	15	20.0	0	0	0	20.0
	TRAM BRT	Exclusive at grade	25	12.0	5	8	3	28.0
	RT	Exclusive grade separation	30	10.0	5	8	3	26.0
10km	Car	Road	15	40.0	0	0	0	40.0
	TRAM BRT	Exclusive at grade	25	24.0	5	8	3	40.0
	RT	Exclusive grade separation	30	20.0	5	8	3	36.0
15km	Car	Road	15	60.0	0	0	0	60.0
	TRAM BRT	Exclusive at grade	25	36.0	5	8	3	52.0
	RT	Exclusive grade separation	30	30.0	5	8	3	46.0

Rating: Good | Fair | Bad

Assumptions:
Speed :average speed (car) commercial speed (TRAM)
Transfer time: from feeder bus stop to TRAM station

Note: RT (Rapid Transit) includes Metro, Monorail, AGT and LRT(Light Rail Transit)

Source: PPUTMP Project Team

- As suggested from the table, it is noted that applicable main line system requires exclusive grade separation in R/W category to secure better transport service quality, comparing with private car mode. In this regard, Tram and BRT are not recommended.
- On the contrary, selection of R/W type affects significant influence to the system introduction in terms of physical aspect and implementation cost.
- Table 7.3-7 shows the adaptability of each transit system from viewpoint of R/W characteristics.

Table 7.3-7 System Adaptability for R/W

R/W type		On Surface	Elevated viaduct	Underground tunnel
R/W feature	Spatial requirement	Basically, R/W is secured in mixed traffic. Can only be done with LRT.	Partial road capacity is lost due to the space for construction of viaduct column.	No interference with surface traffic.
	Infra cost	Requires small extra cost for track furnishing	Requires significant infra cost for viaduct structures	Requires huge infra cost for tunnel structures
Transit	Metro	▲	◎	◎
	LIM	▲	◎	◎
	Monorail	▲	◎	△
	AGT	▲	◎	○
	LRT	○*1	◎	◎

Note: Symbol: ◎=Desirable, ○=Applicable, △=Not desirable, ▲=Impossible
*1: In case of transit mall
Source: PPUTMP Project Team

- It is considered that R/W for mass rapid transit system should be secured by grade separation type (elevated / underground) because it enables to maintain high competitiveness of mass transit against private traffic mode such as cars except for special cases such as “Transit mall scheme”. Underground R/W is most desirable from viewpoints of possibility for coexisting with surface traffic; however, its huge infra cost gives hesitation to its application.
- In this project, it is assumed that elevated type is selected as basic R/W in urbanized areas and underground R/W is exceptionally applied in designated districts (Monivong, Russian, etc.) where renowned cityscape should be maintained.

(3) System Selection and Route Formation for Trunk Public Transport

From the viewpoint of transit operation, a transit route passing through an urban central station is better than a transit route terminating at the urban central station because of fewer off-duty trains during peak hour period. Therefore, the transit route should be made by combining several route segments. Regarding demand level by each segment, segment 3 and segment 4 show higher demands while segment 1 and segment 2 show lower demands. In this connection, combinations in which segment 3 or 4 are the main section and others are dependent sections are considered to be effective.

Case1: Line 1 connecting segments 1 and 4 + Line 2 connecting segments 2 and 3
Case2: Line 1 connecting segments 2 and 4 + Line 2 connecting segments 1 and 3
Case3: Line 1 connecting segments 1, 2 and 4 + Line 2 segment 3

Note. Combination of segments 2 and 3 is not applicable due to horizontal alignment.

Based on the above and required R/W, the trunk public transport system in 2035 is proposed as follows:

- Line 1: Connecting Segment 2 and segment 4, first section is located between Takmao to Phsar Thmei (Central Business District (CBD) station), of which R/W might be partially underground. From Phsar Thmei to Chaom Chau, second section is located on Russian. AGT / LRT /Linear Metro is considered to be eligible mode. As its R/W, an underground structure is adopted for the area within the Inner Ring Road (IRR) while elevated structure is used other than above section.

- Line 2: Connecting segment 1 and segment 3, the line is located from Grand Phnom Penh to CBD station (Phsar Thmei) and then stretches along Monireth to Chaom Chau via the south of airport. From there it proceeds to the northern part of Monivong. AGT / LRT / Linear Metro is considered to be eligible mode. The line is crossed with line 1 at CBD station (Phsar Thmei).

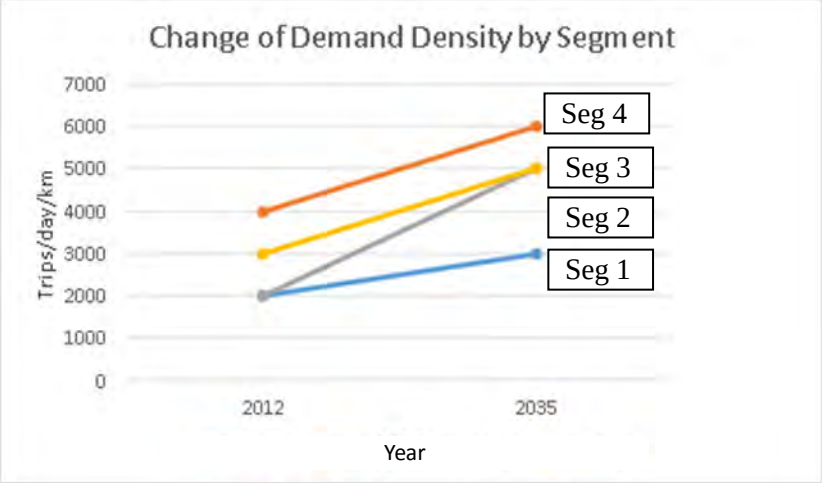
(4) Stage Development Plan for Trunk Public Transport System

The implementation of a mass transit system project requires a considerable period from planning, to conduct of feasibility study and construction. In addition, considering the project scale, in this case, a total route length of 39 km, budget constraints might become serious issues. Therefore, the development of the trunk public transport system should be done by stages, considering transport demand growth and investment balance.
As for the growth of potential demand, the baseline for demand at present is examined by using the present OD matrix in same methodology. Its result is shown in Table7.3-8 .and Figure 7.3-2

Table 7.3-8 Change of Potential Transit Demand

Route segment	Route Length(km)	Daily passengers volume		Average Volume per route km	
		2012	2035	2012	2035
1	7.6	18,000	28,000	2,000	3,000
2	11.5	24,000	55,000	2,000	5,000
3	10.5	41,000	55,000	3,000	5,000
4	10.0	42,000	55,000	4,000	6,000
Total	39.6	125,000	174,000	3,000	4,000

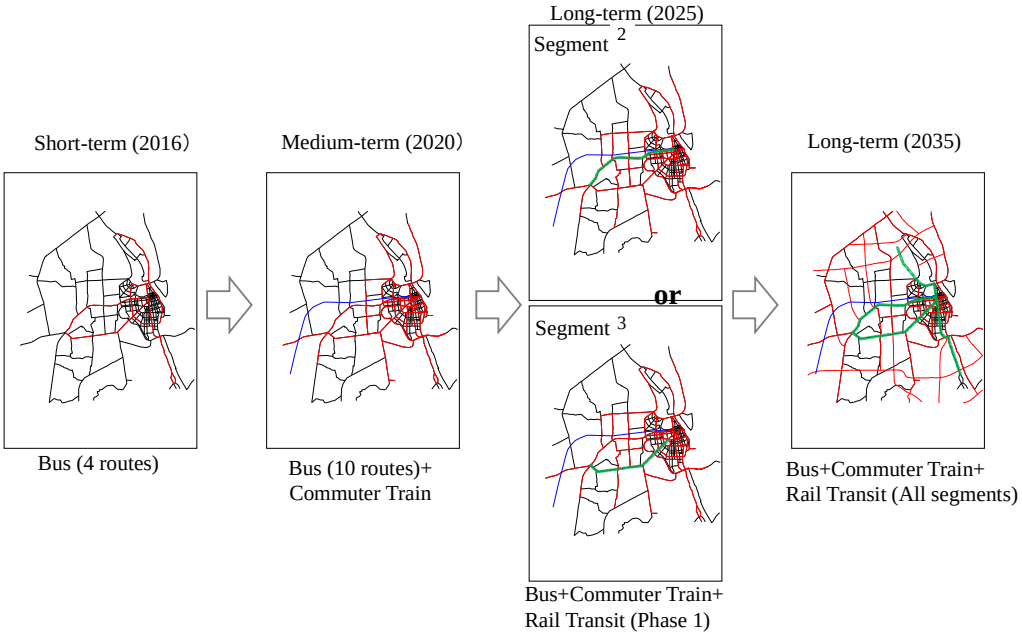
Note: Demand estimation is based on minimum estimation scenario
Source: PPUTMP Project Team



Source: PPUTMP Project Team

Figure 7.3-2 Change of Transport Demand by Route Segment

- From the viewpoint of demand intensity, the most critical is segment 4. In this segment, even the **current public transport demand potential seems to exceed bus transport capacity;** thus, mass transit introduction is desirable. However, since currently no formal public transport system exists, bus transport system development is necessary as a practical solution. The citywide bus network is to be completed up to 2020 (medium term).
- After that, in the long term, around 2025, the mass transit introduction for segment 2 or 3 is to be implemented. In accordance with mass transit introduction, the bus route network should be reorganized to support the feeder transport network of the mass transit route.
- During 2025 to 2035, other 3 segments will be implemented and the whole trunk public transport network will be completed.



Note: Segments 2 and 3 in the above figure refer to Figure 7.3-1
Source: PPUTMP Project Team

Figure 7.3-3 Staging for Public Transport Network Development

7.3.4 General Plan of Trunk Transport System

(1) Alignment of Trunk Transport in CBD Area

Regarding Line 1 and Line 2 crossing in CBD, an image of the alignment is shown in Figure 7.3-4.

Source: PPUTMP Project Team

Figure 7.3-4 Image of Alignment of Trunk Line in Central District

(2) Station Location and Planning Criteria

Station locations are determined from the following viewpoints:

- In general, station interval is considered to be approximately 1 km for mass rapid transit system in the urban area.
- They are near major cross points with orthogonal roads so as to collect transport demand effectively.
- They are near major urban facilities/establishments (collective public housing estate, office/shopping complex, public service facilities, etc.)
- In case of elevated type stations, physical / engineering issues might arise in terms of geometrical design of road or traffic flow.
- Securing smooth access route to stations is considered.

In the station planning, following station classification will be applied in accordance with the transit's operation features and demand characteristics.

- Major station: Stations with specific transit function such as Terminals (start /end station), Junction stations and stations with branch to car depot, and stations expecting large passenger volume
- Mode interchange station : Stations with mode change function, i.e., a station plaza, to connect with feeder transport systems (bus, taxi and other public transport)
- Other stations: Ordinary stations other than those in above classification.

Source: PPUTMP Project Team

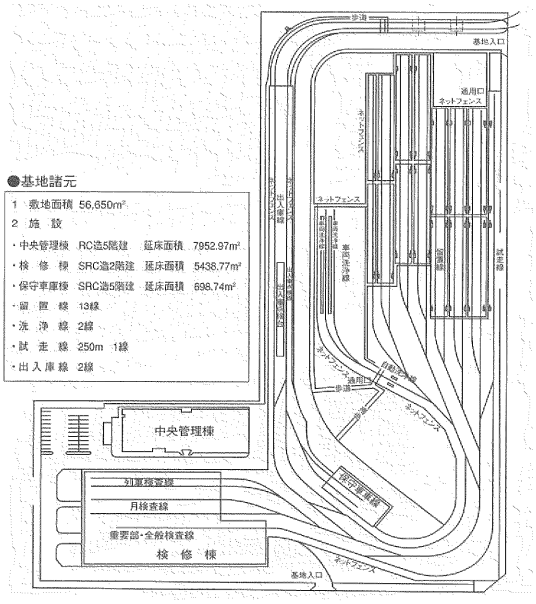
Figure 7. 3-5 Example of Station Type

(1) Depot

For mass transit operation, it is inevitable to maintain its infrastructure and rolling stock in proper condition. In addition, all or some train sets have to be parked during off-peak hours. To cope with these requirements, it is necessary to provide special car depot facilities in a designated area. Main functions of car depot are as follows:

- Car storage tracks
- Train inspection yard
- Car cleaning lines
- Maintenance workshop
- Sub-station facilities

An example of car depot of AGT is shown in Figure 7.3-6. The required area of car depot varies according to number of train sets; however, average area size is about 3 to 5 ha. The location of car depot is generally determined from the viewpoint of train operation and is located near terminal stations. However, since car depot has significant environmental impact, in many cases, it is located in a suburban or rural area.



Source: PPUTMP Project Team

Figure7.3-6 Example of Car Depot

For Phnom Penh, it is desirable to select some vacant space in the suburban area as car depot location.

7.4 Orientation for Reforming Para-Transit

Under current transport situation, para-transit modes such as the Motodop and the Motorumok modern (tuk-tuk) play a significant role as a quasi-public transport mode and they are popular urban transport among people. When formal public transport systems such as buses and mass rapid transit are introduced along with the future transport plan, current para-transit users will naturally shift to public transport; however, suppliers of para-transit services will face loss of market opportunity. Whether the para-transit mode will be excluded or co-exist in the future transport plan becomes a controversial issue. There are 2 different views (pros & cons) concerning the function and the status of para-transit in the future as shown below.

Table 7.4-1 Summary of Para-Transit Position in the Future

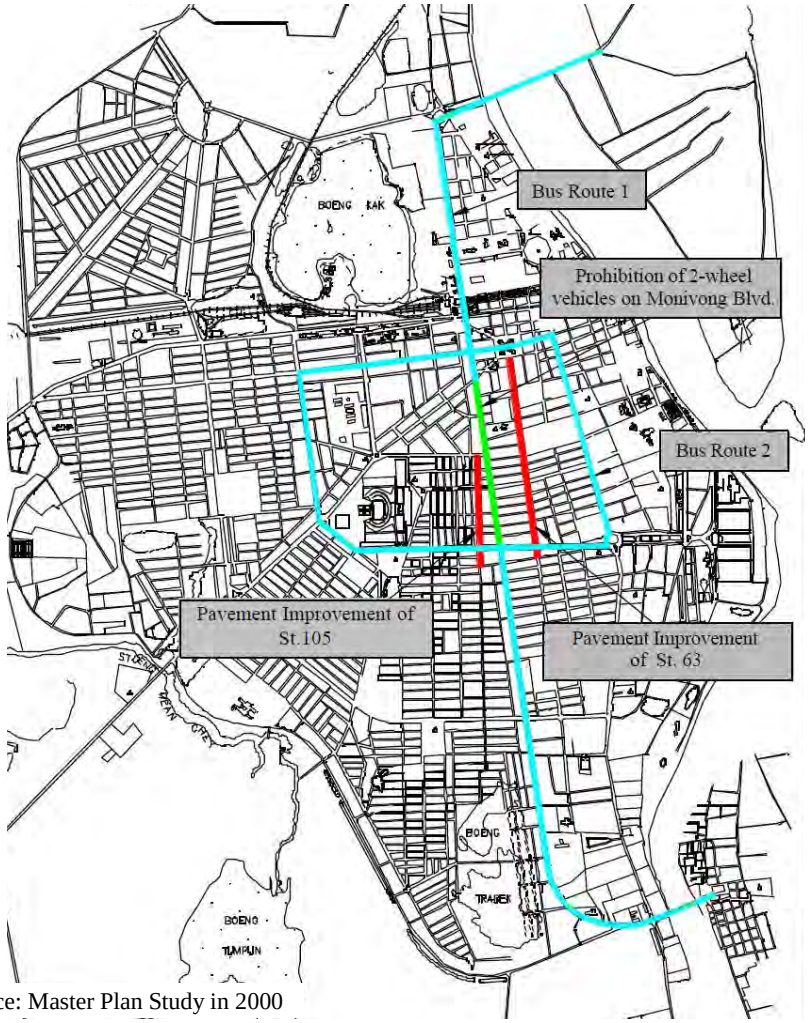
Viewpoint	Pros	Con
Function as transport means	As one of feeder level transport, para-transit still plays vital role integrated with future public transport system in Phnom Penh.	It becomes an annoying factor, making road traffic more congested on the scarce road space. As an obsolete transport, para-transit loses in severe competition with public transport and will be eliminated.
Social/ Economic policy	Forming a minor business sector in Phnom Penh, para-transit services are entitled to growing concern for its support of the informal economy.	By economic growth and personal income increase, para-transit business changes the way it operates accordingly.

Source: PPUTMP Project Team

It is recognized that the public transport system consists of not only a main transport line (generally mass transit system) but also a supplementary transport system which collects and distributes transport demand from/to individual traffic zones. Even if there were a mass transit system in Phnom Penh, it cannot serve the entire public transport need of the city without a feeder transport system. In this regard, para-transit system like the motodop can be adopted as a feeder transport for main public transport under certain regulation /license scheme on service area /business rule. In fact, such a concept is realized in the urban public sector, e.g., the bike-taxi system in Bangkok, which is applied for access /egress transport between trip origin points and urban railway (BTS) stations and operated under an official transport scheme.

As for Phnom Penh, the previous master plan study in 2000 had discussed about restrictions of 2-wheeled vehicles in the public experiment for bus transport service, as shown below:

> Vehicles other than motorized 4-wheel vehicles (motorcycles, bicycles, motorumok, cyclos, etc., referred to as "2-wheeled vehicles") are prohibited from entering the section of Monivong between Sihanouk and Charles De Gaulle during the period (June 1 to 30) and time period (5:00 to 19:30) of the Bus Operation Experiment. (This measure was not implemented)



Source: Master Plan Study in 2000

Figure 7.4-1 Restrictions on 2-Wheeled Vehicles During Public Experiment of Bus Transport

It seems that even restricting 2-wheeled vehicles within a designated area should have the support of most of bus users in order to make bus service effective. As a precondition for this challenge, there are several issues to be solved, i.e., consent from Motodop drivers, authorization process for Motodop services through establishing an association of Motodop drivers and issuing licenses for them, and arrangement of traffic regulation.
Regarding the para-transit other than the Motodop (2-wheeled vehicle), i.e., the Motorumok modern (tuk-tuk) and Cyclo, it might be irrelevant to include them as a component of formal public transport system due to their obsolete characteristic, i.e., lower travel speed comparing with average speed in traffic stream. In this regard, it is considered that catering to a specific transport service like tourism-related services will be left for them in the future transport market.
Apart from that, as the current commuting means for suburban factory employees, small-sized trucks are used without the necessary passenger amenities such as seats and a roof top. Therefore, it is urgent to address this situation in view of passenger safety and comfort issues. In this regard, a para transit system which is operated in the suburban area of Thailand, equipped with a roof top and benches, that evolved from a small truck called Songthaew seems to be a considerable model for its countermeasures.

7.5 Effective Use of Existing Public Transport (Railway and Water Transport)

In terms of transport facilities, there are railway and water transport facilities existing in Phnom Penh. However, as a part of urban transport system, their presence is hardly recognized by people.
Concerning railway transport, it is in the middle of restoration process as freight railway by concession scheme. However, it is proposed to introduce commuter rail services using existing rail tracks because a new station development is planned in the Phnom Penh Special Economic Zone (PPSEZ) in which employment for 20 thousand people is to be generated in the future after the completion of current rehabilitation project by ADB for southern railway section. In addition central railway station is recognized as an important historical heritage of Phnom Penh and has symbolic value as gateway of Phnom Penh. As described in the preceding section, crossing point of Monivong and Russian will become a hub of the trunk public transport network, and this situation can be an opportunity to activate existing railway facilities. If long distance passenger service could resume from Central station, it can provide a new perspective of comprehensive mode interchange area development integrating inter-city transport node with urban transport node.
River utilization as urban transport might be considered owing to Phnom Penh's peculiar location, i.e., historically PPCC has been developed in close relation with the Mekong and Sap Rivers. Although water transport has a restriction to operate only along river, it requires a relatively small infra-cost for network expansion and is environmentally friendly, comparing to other modes. This feature is considered to be an advantage in connecting with surrounding areas of Phnom Penh, taking into account that there are few cross-river points by bridge in the Mekong River basin.

7.6 Mode Interchange Area

7.6.1 Basic Planning Direction

A mode interchange area is a transfer point between several modes of transport. The transfer is the most serious weak point of public transport systems. Therefore, the key to the success of a public transport system is how to develop a convenient mode interchange area. Urban development with facilities allowing transfers within modes such as a rail transit station and rail transit/bus terminal, especially in the suburban area, can pave the way to a new type of urban development concept in Phnom Penh such as transit-oriented development (TOD).
Based on the above discussion and the proposed public transport system in this master plan such as

rail transit, commuter train, bus rapid transit and bus, the planning of a mode interchange area is discussed below.

Note: A transit-oriented development (TOD) is a mixed-use residential and commercial area designed to maximize access to public transport, and often incorporates features to encourage transit ridership. A TOD neighborhood typically has a center with a transit station or stop (train station or bus terminal/stop) surrounded by relatively high-density development with progressively lower-density development spreading outward from the center. TODs generally are located within a radius of one-quarter to one-half mile (400 to 800 m) from a transit stop, as this is considered to be an appropriate scale for pedestrians (from Wikipedia).

7.6.2 Functions and Facilities of Mode Interchange Area

Functions and facilities for a well-functioning mode interchange area are as follows:

■ Efficient and convenient space for mode of transport using the mode interchange area

A well-developed motorcycle and car parking, and taxi and para-transit pools should be provided to cope with the passenger demand.

These include park and ride parking, cycle and ride parking, taxi and para-transit pools.

■ Smooth transfer

This means short transfer distance, providing the most intelligible route and well-connecting the transfer between transport modes.

Aids to smooth transfer are sidewalks, barrier free if necessary, and elevators/escalators where necessary.

■ Comfortable clean and safe waiting spaces and other amenities

It is necessary to develop waiting spaces that are comfortable, has protection against sun and rain and are well-lighted to make waiting passengers feel safe especially at night. In addition, it is important to provide understandable information for all modes of transport using the mode interchange area.

Other passenger amenities include sheds, street furniture, information boards for public transport network, a bus location system and toilets.

▲ Regional/district center

There are spaces and facilities that can be developed where people can gather, do business or just spend time and where extensive information about regional/district daily life and transport is made available.

These are public facilities such as Khan branch offices and commercial/business facilities.

Note: ■ means necessary for all mode interchange areas; ▲ means consider to develop if necessary.

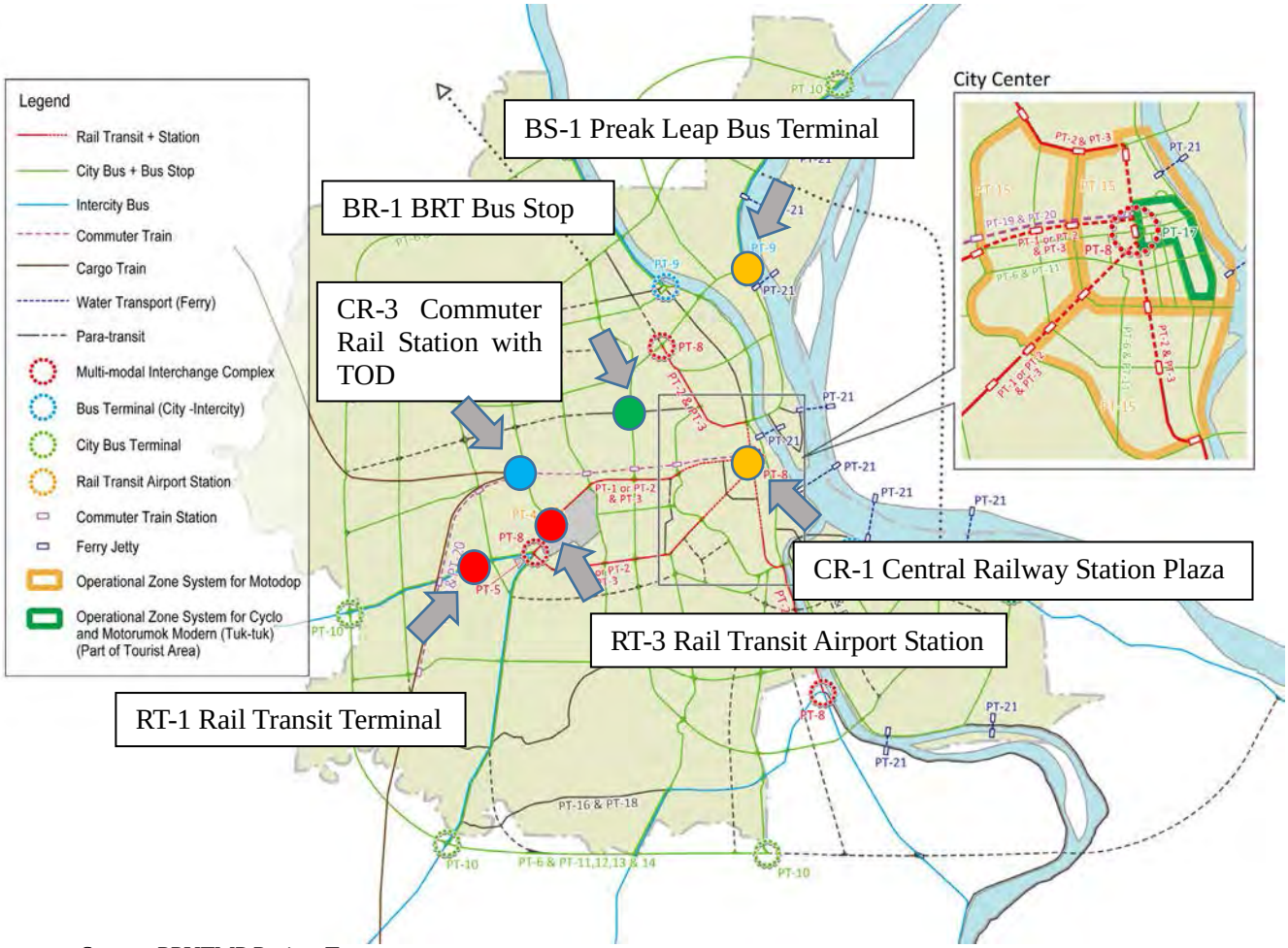
Based on the above directions, the interchange types for the public transport modes planning in the future Phnom Penh may be categorized into 10, and these are shown in Table 7.6-1. Among these types, six are typical ones with proposed locations shown in Figure 1 and their conceptual designs, illustrated in Figure 7.6-2, mainly showing the flow pattern of primary modes of transport including pedestrian flow. Obviously, the development of an efficient and comfortable mode interchange area will persuade people to shift from private mode to public transport, thus drastically reducing road traffic.

Table 7.6-1 Summary of Mode Interchange Area by Type

Number	Main Mode	Type of Mode Interchange Area	Name of Mode Interchange Area	Mode Interchange Pattern											Development Concept of Mode Interchange Area
				Rail Transit	Commuter Train	BRT	City Bus	Inter-city Bus	Para- transit (Motodop and Motorumok)	Taxi	Bicycle/ Motorcycle (Cycle & Ride)	Private Car (Park & Ride)	Airport	Ferry	
1	Rail Transit	RT-1	Rail Transit Terminal	○	–	–	○	○	○	○	○	○	–	–	Development of commercial complex with inter/city bus terminal, P&R parking, etc. as a regional/district center
2		RT-2	Elevated/ Underground Station	○	–	○/-	○	–	○/-	–	○/-	–	–	–	Safe transfer between rail transit, city bus and para-transit
3		RT-3	Airport Station	○	–	–	○	–	○	–	–	–	○	–	Direct connection by moving sidewalk to/from Airport Terminal
4	Commuter Rail	CR-1	Central Station	–	○	–	○	–	○	○	○	○	–	–	Redeveloped Central Railway Station with city bus terminal, taxi & para-transit stand and car parking as a multi-modal urban complex
5		CR-2	Railway Station	–	○	○/-	○/-	–	○	○	○	○	–	–	Convenient transfer between city bus, taxi and para-transit with P&R parking
6		CR-3	Railway Station with TOD	–	○	○/-	○	–	○	○	○	○	–	–	With Transit Oriented Development (TOD), which is a residential and commercial development located around a railway station with good walkability, P&R parking to encourage public transport use, mainly in the suburban area
7	Bus Rapid Transit (BRT)	BR-1	BRT Bus Stop	○/-	○/-	○	○	–	○	–	○/-	–	–	–	Busway stop intersected with ordinary bus routes along primary road
8	Bus	BS-1	Bus Terminal	–	–	–	○	○	○	○	○	○	–	–	Relocated intercity bus terminals from city center and mainly convenient transfer between intercity and city buses as a regional/district center
9		BS-2	Bus Stop	○/-	○/-	○/-	○	–	○/-	–	○/-	–	–	–	Walkable sidewalk space, bus shelter and well-managed para-transit waiting space
10		BS-3	Connecting with Ferry	–	–	–	○	–	○	–	○	–	–	○	Convenient transfer between city bus, ferry and para-transit at ferry jetty

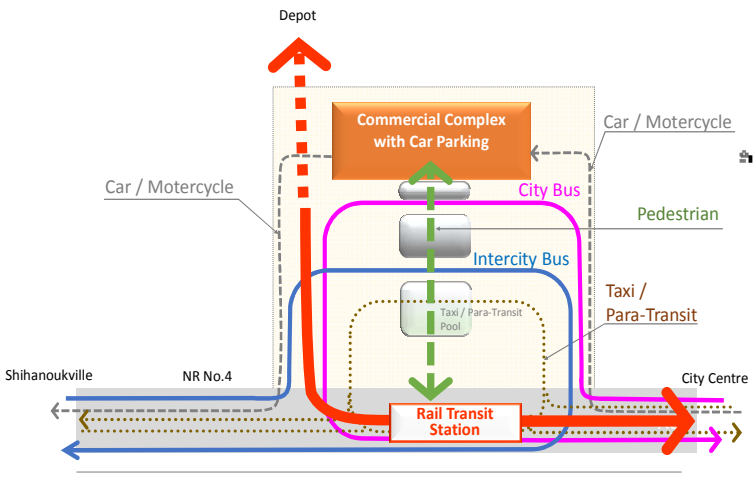
Note: ○ : Connecting
- : Not connecting
○/- : Not always connecting

Source: PPUTMP Project Team

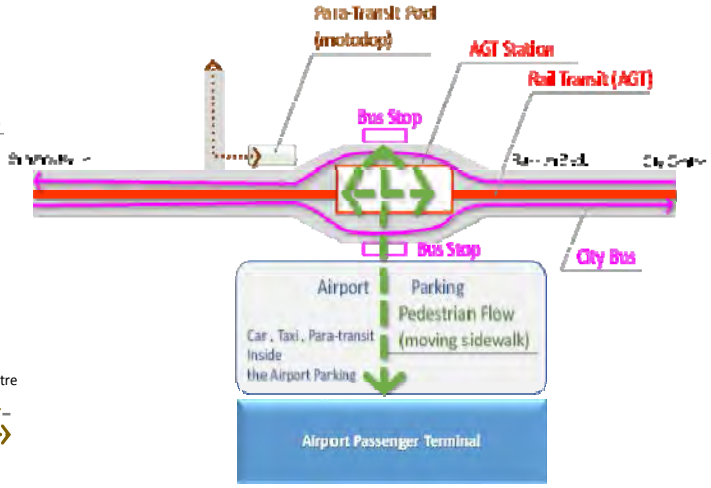


Source: PPUTMP Project Team

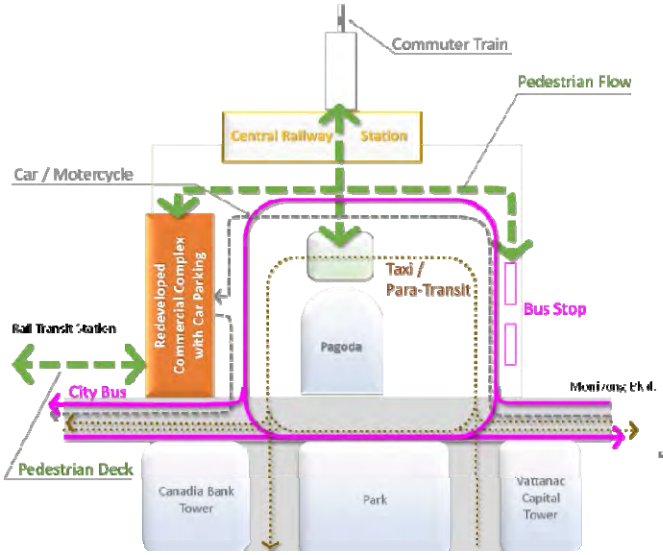
Figure7.6-1 Location of Six Mode Interchange Areas



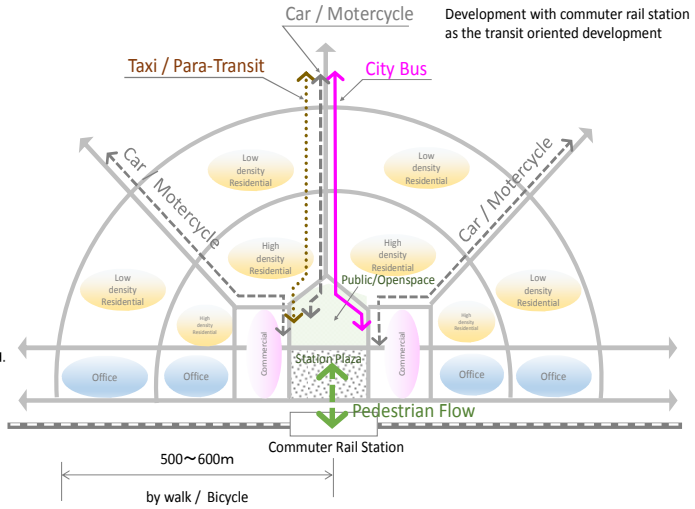
RT-1 Rail Transit Terminal



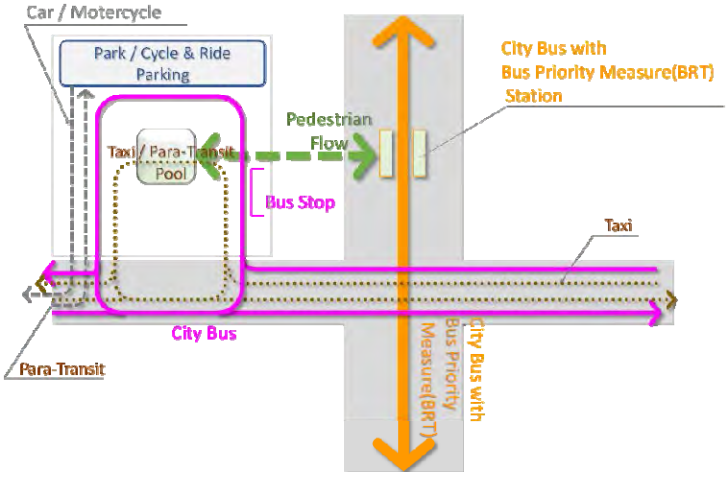
RT-3 Rail Transit Airport Station



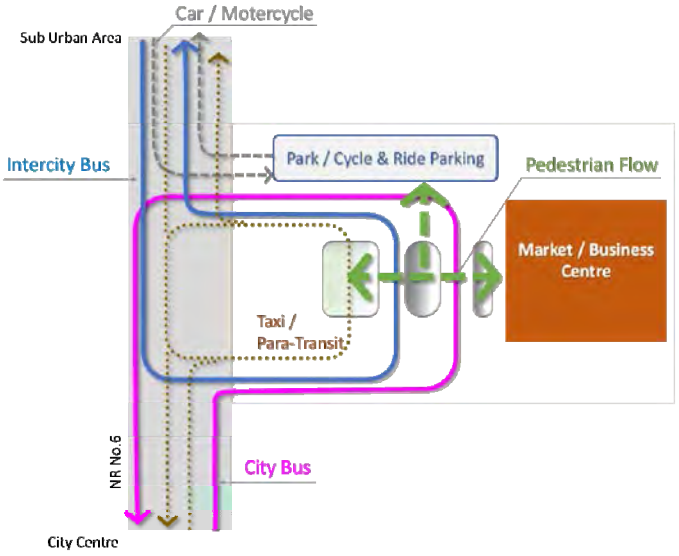
CR-1 Central Railway Station Plaza



CR-3 Commuter Rail Station with TOD



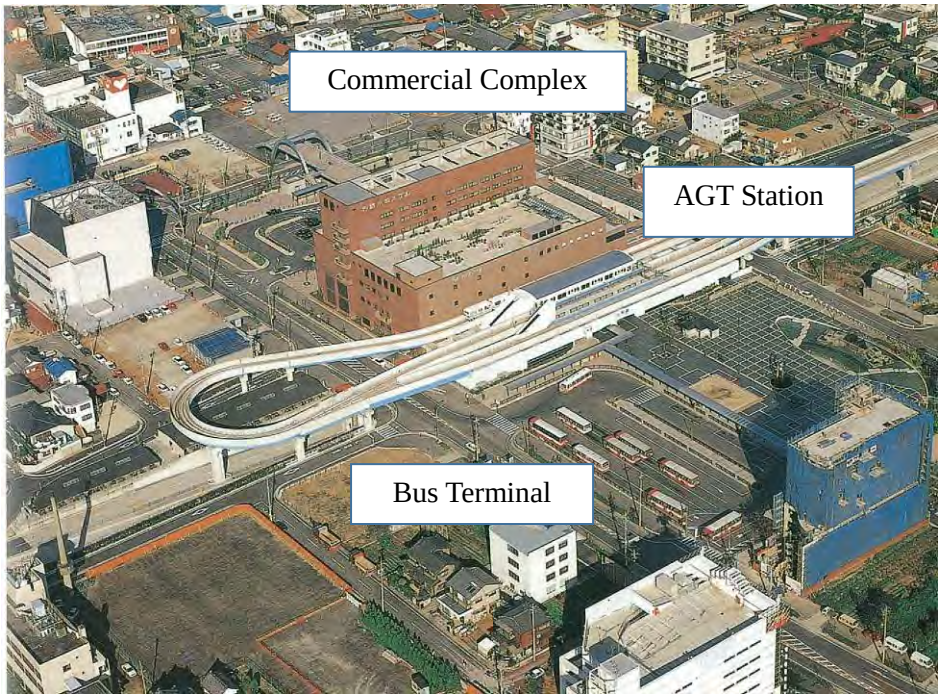
BR-1 BRT Bus Stop



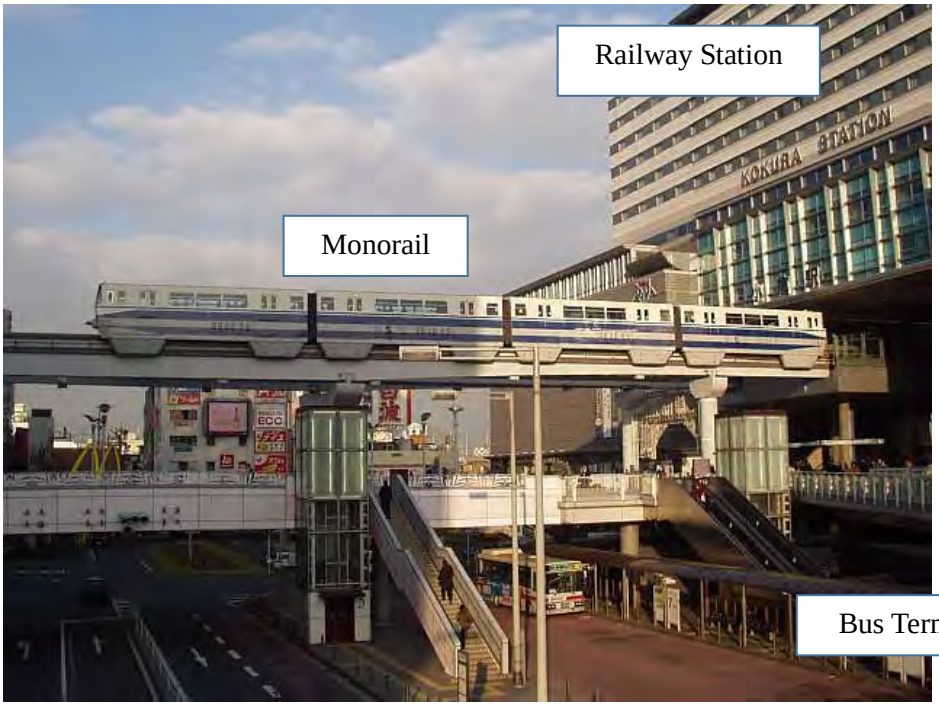
BS-1 Prek Leap Bus Terminal

Source: PPUTMP Project Team

Figure7.6-2 Conceptual Design of Six Mode Interchange Areas



Example of mode interchange facilities between AGT and bus terminal.



Example of mode interchange facilities between Monorail and bus terminal

Source: PPUTMP Project Team

Figure7.6-3 Japanese Examples of Mode Interchange Areas

8 ROAD SYSTEM

8.1 Network Planning Approach

8.1.1 Planning Policy

(1) Basic standpoint of PPUTMP Team on Road Network Planning

As this is a Master Plan Study, the network to be proposed will only include arterial and collector roads and exclude local roads. Generally the future road network 2035 in the Project area will be formulated based on the road network plan in 2020MP, which has been already approved by the City Council.
Since the 2020 MP was developed before the expansion of the city's boundary, several roads in the suburban area should be added in order to support the new urban development.

(2) Factors to be taken into account for the planning

The following are taken into account in the planning of the road network:

a) Existing and foreseeable problems
b) Some road projects already in the stage of construction
c) Ongoing urban development projects in various stages including the several road projects included
d) Two ring road plans (Middle Ring Road: RR-II, Outer Ring Road: RR-III), which have been generally approved, although some modification might be made.
e) Special attention will be paid to the large-scale development projects of housing and transport and industrial facilities such as a new port, a new airport, a new logistics center, PPSEZ, and a number of urban development projects in Phnom Penh.

(3) Factors relating to the road alignment

Factors that are taken into consideration in the planning of road alignments are as follows:

a) The alignment involving many building relocations should not be applied.
b) New bottleneck intersections should not be created; therefore, irregular intersections such as intersections with more than 5 legs will not be proposed as much as possible.
c) The arterial/collector roads are to be developed with the interval of approximately 300 m to 500 m in the densely populated area and 2 to 3 km in the suburban area, depending on the population density.

8.1.2 Definition of Road network

For the road network planning purpose, the following terms are defined.

(1) Present Network

The road network as of March 2013 is defined as the "Present Network" or "Do-nothing" case.

(2) Base Network

Base network is the present network added with the committed projects including those under

construction. The committed projects may include those by MPWT, DPWT and private companies. In case of the road plan involved in an urban development project, those not yet progressed to the implementation stage will be excluded from the Base Network, since plans for those projects might be changed and sometimes they are even cancelled.

The base network is used as the basis of planning and its component projects are not evaluated in this Project.

(3) Proposed Network for 2035

Proposed network for 2035 is the network including all the newly proposed projects added to the Base Network. Component projects of the network will be examined and evaluated from traffic, economic, financial or environmental points of view. After the above analysis, the network for 2035 will be modified to be the final proposed one.

8.1.3 Urban Structure in 2035

The urban structure elaborated in the previous chapter suggests a basic direction for formulating the future road network.
In 2035, the central area will remain as the most important focal area in terms of politics, commerce, business, manufacturing industry, education and other urban activities.
Several sub-centers are proposed at the surrounding area of the Central Area. Particularly the development of Chaom Chao, the logistics center in Samraong Kraom and the industrial area along NR4 in the west will require one of the main transport corridors, i.e., the enhancement of the E-W axis. It also requires the N-S axis for connecting sub-centers such as Camko, Grand Phnom Penh and Chrouy Chanva in the north, and Chabar Ampov, AZ satellite city and Takmau in the south. In addition, other sub-centers, Bak Khaeng industrial area along NR6 and the new centers, Krang Thnong in the Northwest, Cheng Aek in the south should be supported by expanding the road network system.

8.1.4 Network configuration

(1) Network pattern

The present road network pattern in the Project area shows a radial/ring road pattern by and large, while the network in the districts shows a grid pattern.
Accordingly, the future network plan will be developed in accordance with these patterns.

(2) Functional Hierarchy

For developing a functional road network, the road hierarchy is to be clarified in the future network as well.
Functional hierarchy is composed of expressways, arterial roads, collector roads and local roads. Among them, the local road will not be included in this project, since it should be discussed in the corresponding district plan.

a) Expressway
   An expressway is a limited-access road, and usually the intersections with other roads are grade-separated and will be interchanges or junctions so as to minimize the influences of traffic merging and other frictions from the other roads. At present, there is no expressway in the Project area.
b) Arterial Road
   The arterial road mainly serves inter-regional traffic and major portion of the traffic demand

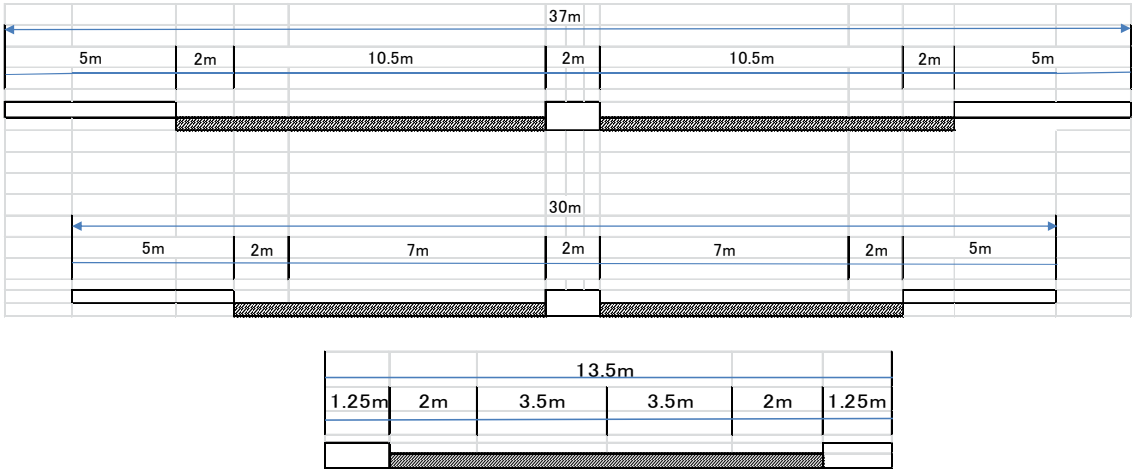
between the Central Area and surrounding sub-centers and among the sub-centers.

c) Collector road

The collector road interconnects each district and is also used as a connection road to arterial roads mentioned above.

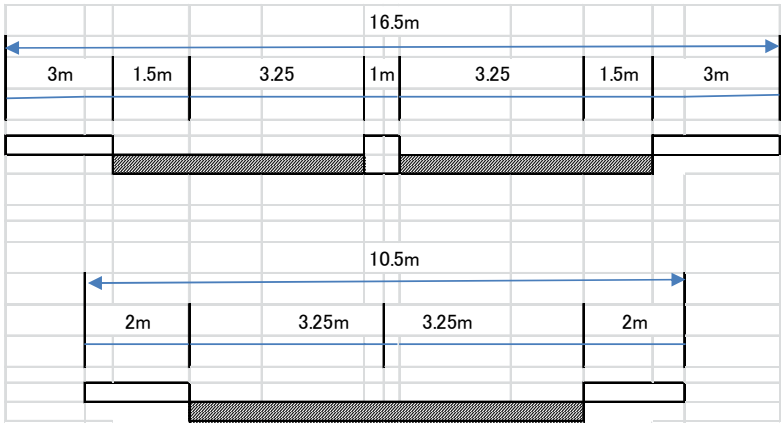
The following figure shows the typical cross sections based on the road design standard employed in Cambodia. These cross sections will be applied for the proposed roads if enough space is available.

Arterial roads



(Bridge section or 2-lane section)

Collector Roads



Source: PPUTMP Project Team

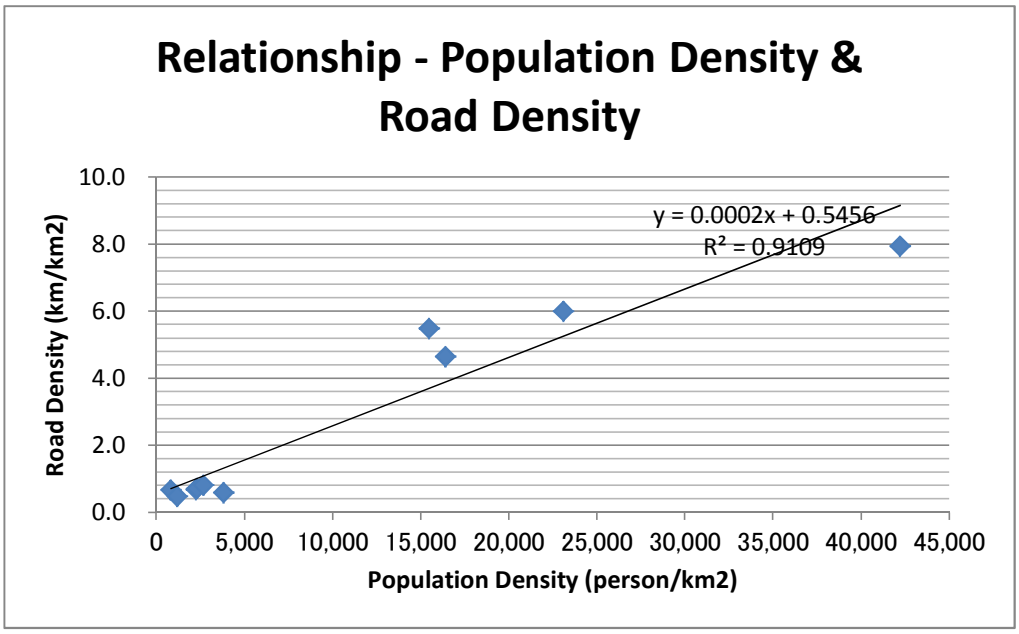
Figure 8.1-1 Typical Cross Section for Road Planning

(3) Road Density

As stated in the Progress Report, the road density in the central area inside IRR is sufficiently high when compared to the other cities, while that in the suburban area is still low.

The future population mainly grows in the suburban area, where more road developments will be required for enhancing mobility and sustaining the suburban life.

Figure 8.1-2 shows the relationship between the population density and the road density by using the district data in Phnom Penh in 2012.



Source: PPUTMP Project Team

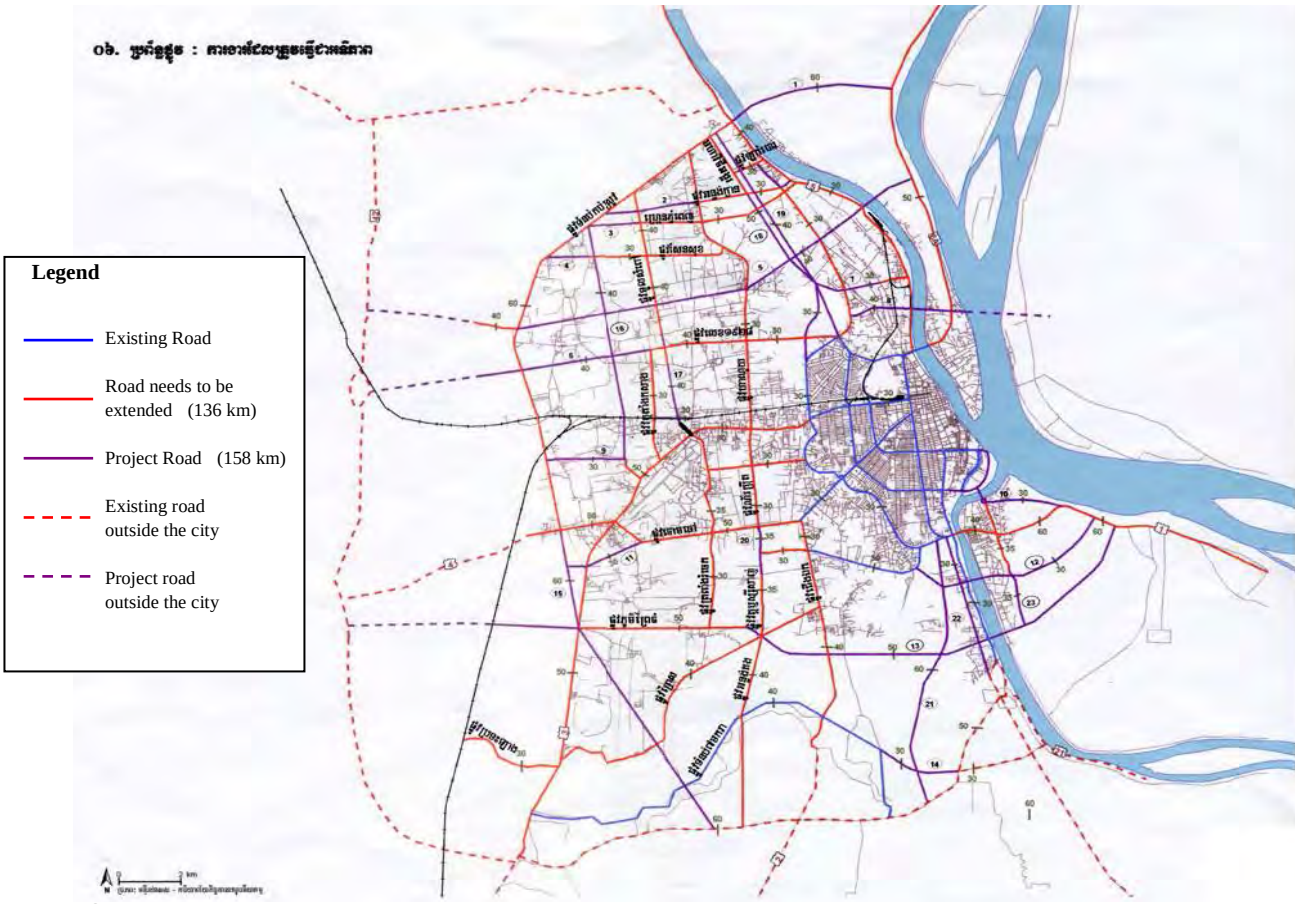
Figure 8.1-2 Population Density and Road Density

Based on the above relationship, the road density required by Kahn in 2035 is estimated as shown in Table 8.1-1. In general, the road density in the central area such as Doun Penh and Chamkar Mon is presently already reaching the required road density in 2035, while that in the suburban area is much less than the required density in 2035.
The future road network in 2035 will be planned by setting the density shown in the table as a roughly estimated target figure.

Table 8.1-1 Road Density Required by Khan in 2035

District Name	Road Length (2012) (km)	Area (km2)	Road Density (2012) (km/km2)	Pop. Density (2012) (person/km2)	Pop. Density (2035) (person/km2)	Required Road Density (2035) (km/km2)
1201 Chamkar Mon	52.0	11.2	4.6	16,437	21,452	4.8
1202 Doun Penh	42.3	7.7	5.5	15,481	17,904	4.1
1203 Prampir Meakkara	17.5	2.2	7.9	42,219	46,472	9.8
1204Toul Kouk	48.2	8.1	6.0	23,112	22,491	5.0
1205 Dang Kao	75.4	114.7	0.7	838	1,602	0.9
1205 Posen Chey	106.6	226.1	0.5	1,191	1,978	0.9
1206 Mean Chey	67.6	115.9	0.6	3,826	6,413	1.8
1207 Russey Kaev	75.2	110.8	0.7	2,262	3,875	1.3
1208 Sen Sok	64.8	91.1	0.7	2,307	4,427	1.4
Total	549.6	687.6	0.8	2,694	4,172	1.4

Source: 8.1.5 Road Network proposed in MP2020



Source: PPUTMP Project Team

Figure 8.1-3 Road Network Plan in Master Plan 2020

Figure 8.1-3 shows the road network plan proposed in the 2020MP, which has been already approved by the Governor of Phnom Penh. Accordingly this project follows the road network in the 2020MP as much as possible.
Some modification, however, will be made here because of the changes of the surrounding conditions after the completion of the 2020MP, such as expansion of the city boundary, new ring road project already under construction and new private sector's development projects.
It is also noted that some undesirable road sections in the above network will be re-aligned in this project, for instance, the irregular intersections with more than 5 legs, a road section cutting through the good agricultural area. etc.

8.2 Preliminary Analysis for Network Planning

8.2.1 Present road network problems

Current road network problems have been identified and explained in the Progress Report.
Their possible countermeasures are presented here in Table 8.2-1.

Table 8.2-1 Existing Problems and Countermeasures

Central Area	
Existing Problems	Possible measures
a) Although most of the streets have been improved, traffic congestion is getting serious on main streets in the central area, particularly the main intersections such as Russia/Monivong, Monivong/Charles De Gaulle, Nean Kong Hing, Sihanouk/Monivong and Russia/Toul Kok.	• Construction of Underpass/Flyover at bottleneck intersections • Package of Traffic Management measures such as improvement of traffic signal system and restriction of roadside parking, among other things.
b) There are some discontinuities in main roads: • Inner Ring Road at Steng Mean Chey • Discontinuousness of St. 608 • Missing Links between streets 430 and 261 • No extension of streets 253 and 261 northward from Russian Boulevard)	• Flyover project is being undertaken. • The extension of Street 608 to Street 273 will be planned. • The connection link between 430 and 261 will be planned. • Difficult for extending these streets because of the fully builtup area
c) There is a considerable amount of U-turn traffic: • Khbal Thnol Flyover and Monivong Bridge • Pet Lok San Flyover	• Improvement of the intersections will be proposed such as installation of a roundabout or construction of left turn ramps.
d) Sidewalks are usually occupied by parking vehicles and road crossings sometimes pose danger due to vehicles violating rules. Accordingly, pedestrian network is not functioning, particularly in the central area.	• More strict enforcement of traffic rules will be employed. • Pedestrian crossing facilities such as overpass or underpass will be installed.
Suburban Area (Outside Inner Ring Road)	
a) There are some areas where the road network is insufficient or has not been adequately developed. • Newly developed areas, for example, the northern part of Russian Blvd, the southern part of Chaom Chao Road, the western side of Kob Srob Dike Road, etc.	• Road network will be developed in those areas taking into account the future population density.
b) Alignments are not well designed like a zigzag or L-shaped road. • Krang Thnong road, Kouk Roka road, Toul Sambo road, Prey Vaeng Road, etc.	• Their functions will be replaced by the new road network consisting of E-W and N-S roads.
c) Missing Links • Missing link along the Ring Road (RR3) between Kob Srov road and NR-3 • Missing links in Boeng Tumpun District • Missing link of Solar Road between Russian and Airport Access	• Their connections will be proposed in the Master Plan.

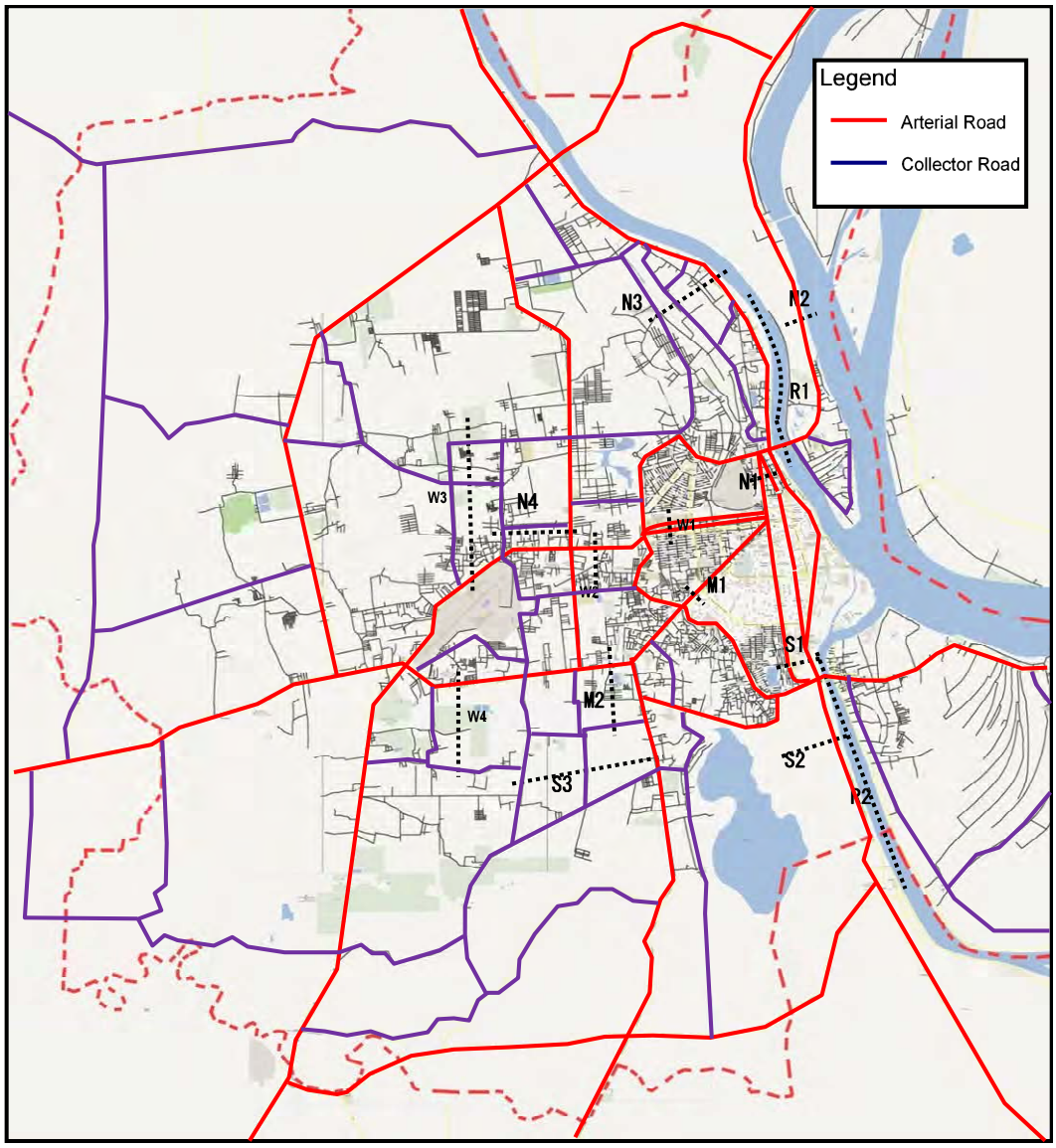
Source: PPUTMP Project Team

8.2.2 Traffic Demand and Capacity

In order to analyze the balance between traffic demand and capacity by direction, the traffic volume/capacity (v/c) ratios at present and in 2035 are calculated for the corridors as shown in Figure 8.2-1. The v/c ratios are shown in Table 8.2-2, which indicates the following points:

a) The traffic demand is already exceeding the traffic capacity on S1 (Monivong and Norodom), M1 (Monireth) and R2 (Monivong Bridge).
b) In 2035, the traffic demand is predicted to exceed the capacity at almost all the corridors.

c) Particularly the v/c ratio is high on M1 (Monireth), R1 (Chrouy Changva Bridge), S1 (Monivong & Norodom), R2 (Monivong Bridge), S2 (NR2) and W1 (Russia & Kampuchea Krom). Accordingly the traffic capacities for these corridors should be increased.



Source: PPUTMP Project Team

Figure 8.2-1 Corridors for Balance Check

Table 8.2-2 Traffic Demand and Capacity

Corridor	Present Network			Do Nothing Case		
	Capacity (pcu/day)	Traffic Volume in 2012 (pcu/day)	v/c Ratio	Capacity (pcu/day)	Traffic Volume in 2035 (pcu/day)	v/c Ratio
N1	119,700	103,403	0.86	119,700	207,344	1.73
N2	58,600	19,035	0.32	58,600	42,214	0.72
N3	42,400	17,965	0.42	42,400	39,588	0.93
N4	34,200	21,962	0.64	34,200	40,005	1.17
W1	91,800	84,292	0.92	91,800	166,453	1.81
W2	150,100	66,259	0.44	150,100	166,927	1.11
W3	95,400	60,539	0.63	95,400	117,982	1.24
W4	53,000	32,895	0.62	53,000	58,859	1.11
S1	103,300	108,040	1.05	103,300	227,553	2.20
S2	73,200	55,883	0.76	73,200	145,143	1.98
S3	49,800	26,762	0.54	49,800	67,504	1.36
M1	53,800	57,712	1.07	53,800	141,838	2.64
M2	58,500	43,845	0.75	58,500	75,318	1.29
R1	34,400	32,342	0.94	34,400	85,117	2.47
R2	70,300	74,952	1.07	70,300	149,487	2.13

Source: PPUTMP Project Team

8.3 Base Network

As a component project of the Base Network, the projects completed in 2014, those under construction and the committed projects will be identified in this section.

8.3.1 Road/Bridge Projects completed in 2014, under construction and committed projects

The following projects are either already completed (in 2014), currently under construction or committed projects, and therefore will be included in the Base Network. These are shown in Figure 8.3-1. (*Note*: The number after the project corresponds to the number in the figure.)

(1) 2nd Chruoy Changvar Bridge (no. 1)
This bridge is located north of the existing Chrouy Changvar Bridge and is under construction with a loan from China. After the completion, the two bridges will be used as a pair of one-way bridges, like the Monivong Bridges. The bridge width will be 11 m consisting of 2 lanes for vehicles and 2 motorcycle lanes and sidewalks.

(2) East River Bank Road in Chrouy Changva Commune (no. 2)
This road is constructed for supporting the urban development in the Chrouy Changva Commune promoted by Sokha Group.

(3) Toul Kork Flyover (no. 4)
This is the fourth flyover project to be constructed at the intersection of Russian Boulevard with Mao Tse Toung and Kim Il Soung Boulevard in order to ease the traffic congestion on both roads. It is expected to be completed sometime between 2015- 2016.

(4) Stung Meanchey Flyover (no. 3)
This is the third flyover project being constructed at the intersection of Inner Ring Road with Monireth Boulevard in order to ease the traffic congestion on both roads.

(5) Takhmau – Preak Samroang Bridge and the Connection Road to NR1 (no. 5)
This bridge is a part of the Middle Ring Road project and is already under construction using a loan from China. The bridge width is 11.5 m including sidewalks; therefore, the carriageway will be two lanes for automobiles and two lanes for motorcycles. It is expected to be completed in 2014.

(6) Middle Ring Road Project [NR1 – NR2] (no. 6)
Middle Ring Road (RR-II) is partly under construction already as described above: the section from NR1 to NR2 including Preak Samroang Bridge. Accordingly, the section between NR1 and NR2 is assumed as a committed project. The road width is assumed to be 13.5 m for two vehicle lanes and bike lanes.

(7) NR6 (nos. 7-1 and 7-2)
The widening of NR6 has been under implementation from Phnom Penh to Thnal Kaeng (40 km) using a loan from China. It will be widened from a 2-lane to a 4-lane road.
From East Chrouy Changva roundabout to 4 km of NR6 (8-1), this projected has already been completed by DPWT while (8-2) is expected to be completed sometime in 2015-2016.

(8) Hanoi Road (no. 8)
Around 10 km of Hanoi Road from Russian to the north is under construction.

(9) Veng Sreng Road (no. 9)
Veng Sreng Road is under construction, about 6.5 km in total, and it is expected to be completed in 2015.

(10) Hun Sen Road (no. 10)
Hun Sen Road (from R271 to NR2 about 9.16 km) is already completed; AC, about 1.8 km section, while the rest is still in Base Course.

(11) Outer Ring Road (nos. 11-1 and 11-2)
Outer Ring Road (Russian to north 4 km (11-1)) is completed by PPCC-DPWT; another section (from 4 km until Ly Yongphat Bridge (11-2)) is under construction by China loan and it is expected to be completed in 2015.

(12) Rehabilitation and Widening of NR42 (no. 12)
The rehabilitation and widening of NR42, located near the western boundary of the city is undertaken by DPWT. The carriageway width is assumed to be 7 to 8 m.

(13) NR5 (no. 13)
The road is under construction by China from Ly Yongphat Bridge to Prek Kdam Bridge, and it is expected to be completed in 2015.

8.3.2 The Road Development involved in Private Urban Development Project

Among the many urban development projects, the following projects have already been partly completed and are now at the stage of expansion. The related roads are also now partly open to traffic. Accordingly these related roads will be included in the Base Network. (*Note:* the number after the project name corresponds to the number in Figure 8.3-1)

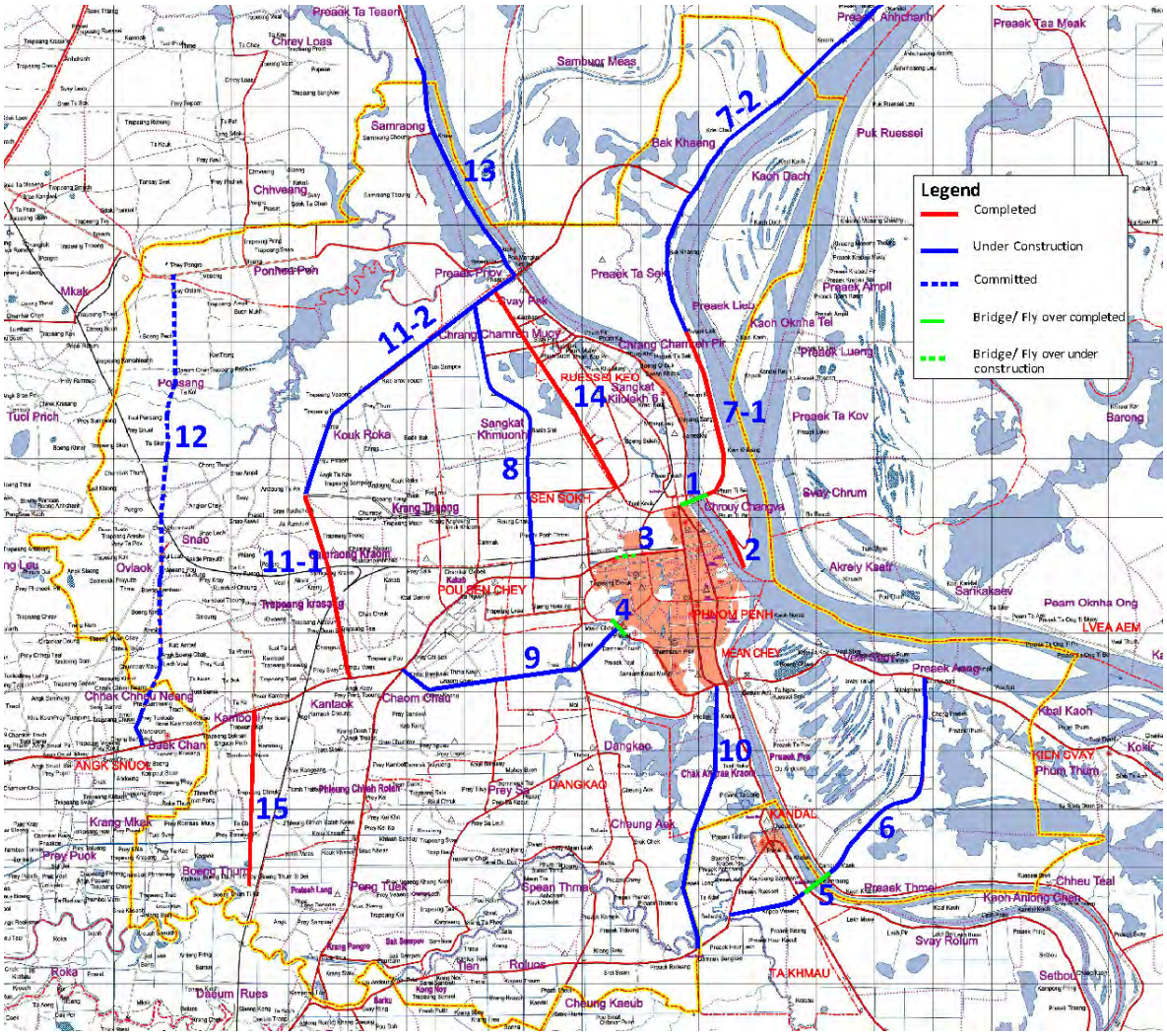
(1) Camko City Road (no. 14)
A considerable part of the Camko project area has been developed already. The road cutting through the project area has been completed. The surrounding roads are also expected to be developed by the end of the project. Among them, the road connecting to Toul Kok and RR-II is the most important one, and is already under construction.

(2) Grand Phnom Penh Road (no. 14)

Grand Phnom Penh project is also on its way for development; some houses have already been sold. The surrounding roads are expected to be developed in order to improve the accessibility from Grand Phnom Penh to the arterial roads. As stated above, the connection road between Toul Kok and Grand Phnom Penh will be important for Grand Phnom Penh as well.

(3) PPSEZ (no. 15)

The Phnom Penh Special Economic Zone (PPSEZ) is partly in operation already, and still on the way of its expansion. The N-S road in PPSEZ connecting with NR4 at the north end has been developed cutting through the project area.



Source: PPUTMP Project Team

Figure 8.3-1 Road Projects to be included in Base Network

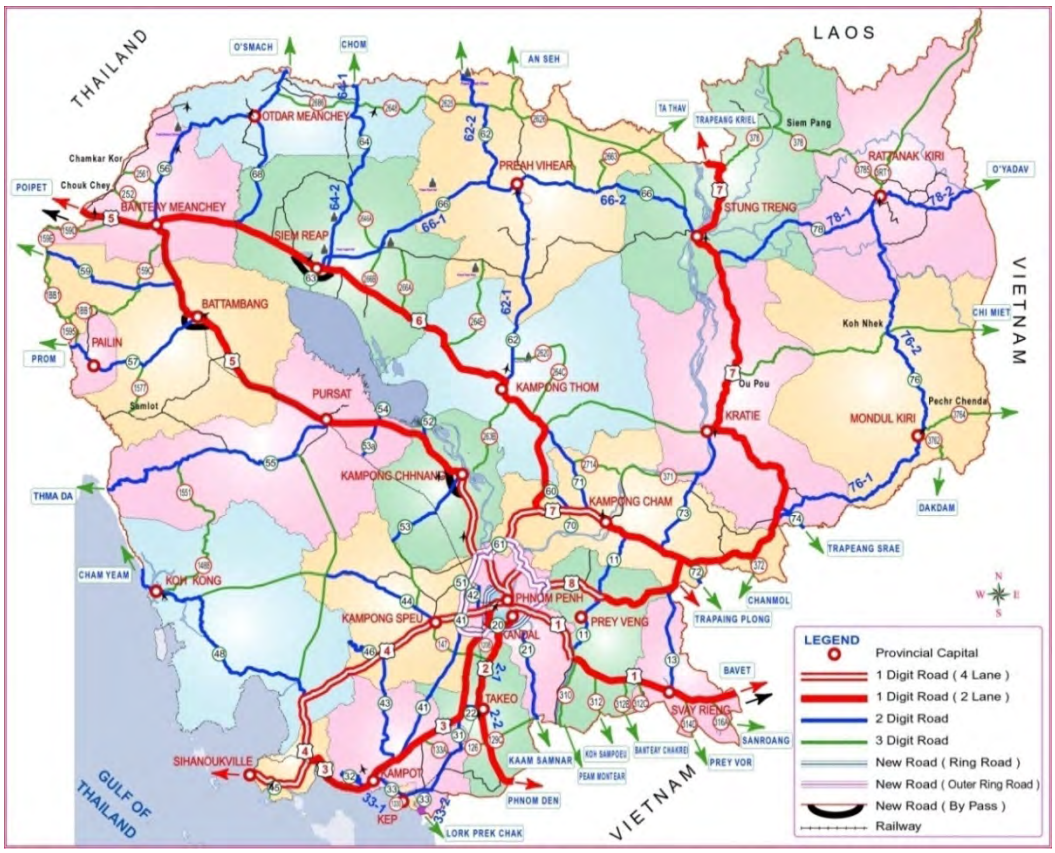
8.4 Preparation of Road Network Proposed for 2035

8.4.1 Inter-regional Road

National Roads will be responsible for the function as an inter-regional road. Several 1-digit National Roads are stretching from Wat Phnom in Phnom Penh toward the East, South and North.

a) NR1
The 4 km section from Monivong Bridge has remained a 2-lane road as of April 2013; however, it will be widened to 4-lane plus a bike lane starting from this year, according to "Data Collection Survey on the Trunk Road Network Planning for Strengthening of Connectivity through the Southern Economic Corridor" (JICA, March 2013).

b) NR2
The section from Wat Phnom to Takhmau roundabout has a width of 4 lanes with bike lane already, while the section from Takhmau to Takeo is still remaining as a 2-lane road.
According to MPWT, the above 2-lane section will be maintained without widening at least until 2020, in accordance with the results of the "Follow-up Study on Road Network Development Master Plan "(March, 2009) (refer to the following Figure 8.4.1).



Source: PPUTMP Project Team

Figure 8.4-1 Proposed Road Network Master Plan 2020

In this project, the section within the Project area will be proposed to be widened from 2 to 4 lanes in order to cope with the future traffic demand.

c) NR3
The section from Chaom Chao Road to Kampot is a 2-lane road at present. It will also remain as a 2-lane road according to the "Follow-up Study". However, as for the section related to urban traffic in the Project area, it is proposed to be widened to a 4-lane road by 2035 taking into account the traffic demand growth.

d) NR4
The section from Chaom Chao Road to Thnal Tor Teung (about 20 km) has already been developed as a 4-lane road. NR4 is being maintained and operated by a private company based on the concession contract of 35 years from 2001. In this project, the rehabilitation of shoulders and provision of sidewalks along NR4 within the Project area are proposed for supporting the bus operation.

e) NR5
The section from Wat Phnom to Prek Kadam (about 30 km) is currently 2-lane plus a bike lane. According to JICA's Data Collection Survey mentioned above, the widening of the section to 4-lane road has been started from last year and will be completed in 2014. The development of sidewalks along NR5 is also proposed in this project.

f) NR6
The section from Wat Phnom to Skun (PK75) is now under construction for widening from 2 to 4 lanes since 2012. Further development will not be needed except for providing sidewalks along the road in the Project area.

g) Expressway for New Phnom Penh Airport
Prime Minister Hun Sen has announced that the new Phnom Penh Airport will be developed by 2030 at Kampong Chhnang, about 90 km north of Phnom Penh. It should be connected with Phnom Penh by an expressway.
Accordingly, an alignment of the expressway is proposed to start from the north end of Hanoi Road to Kampong Chhnang in this project. It will run toward north in parallel with NR5. (Since it is mostly located outside the Project area, it is expressed as a dotted line in Figure 8.4-3)

8.4.2 Arterial roads in Phnom Penh

Based on the road development policy, the road network for 2035 will be prepared from the following viewpoints:

- To complete the ring and radial road network pattern
- To strengthen the East - West transport corridor
- To support the new sub-centers particularly located at North and South of the Central area
- To mitigate the traffic congestions at present as well as that anticipated in the future
- To support the development of public transport system including bus services covering all the Project area

(1) Central Area inside Inner Ring Road (RR-I)

Source: PPUTMP Project Team

Figure 8.4-2 Proposed Road Development Plan in Central Area

a) The present main roads, such as Monivong, Norodom, Russia, Charles De Gaule/Monireth, Sihanouk and Mao Tse Tong, will be used as the arterials in the future as well, although they will mostly remain unchanged because of no space for expansion.
b) Among them, Monireth Blvd. will be an exception as it will be slightly widened within the right of way in order to accommodate a bus service along the road. At the same time, the sidewalks will be developed on account of bus passengers.
c) The northern half and the south short section of the Inner Ring Road (RR-I) will be widened since the carriageway is narrower than the other section. The widening will be mostly carried out within the right of way from 2 lanes to 4 lanes.
d) The vertical road from Russia to Toul Kok will be widened from 4 to 6 lanes to ease the congestion. Simultaneously the sidewalks will be developed for bus passengers.

(2) Suburban Area

1) Ring Roads

In addition to the Inner Ring Road (RR-l), three more ring roads will be developed as follows:

a) Middle Ring Road (RR-II)

RR-II will be developed using the Preak Samroan Bridge currently under construction and Hanoi Road. It has been proposed and now undertaken by a Chinese construction company.

The plan intends to construct the new road from NR1 to Chaom Chao Road via the abovementioned bridge and widen Hanoi Road and extend up to NR5.

In this project, RR-II is proposed to be further extended to NR6, crossing the Tonle River as a 2-lane road (13.5 m in width), assuming the same alignment for other sections from NR1 to NR5 as the Chinese company's.

The original plan by the Chinese construction company is to be completed as a 4-lane road (22 m in total width) for the section from NR2 to NR5 whereas a 2-lane road (11.5 m - 13.5 m in total width) will be constructed for the section from NR1 to NR2.

b) Third Ring Road (RR-III)

RR-III is proposed to start from NR1 near the New Phnom Penh Port, crossing with NR2 at about 3 km east of Cheng Aek Road, and be aligned toward Northwest until NR3 at about 3 km from the junction point of NR3/NR4, and connected to Kob Srob Road, then to NR5 and NR6. This ring road is the one originally proposed by Korea, but the road alignment has been modified by slightly shifting to the north at the section between NR2 and NR3 in order to avoid the precious agricultural area developed in the south-west part of the city. The carriageway width is planned to be 22 m for the section from NR21 to NR5, while the other sections are assumed to be 13.5 m in width. The feasibility study has been completed using Korean fund. The section between NR21 and NR4 will be carried out by Korean loan and the section from NR4 to NR5 will be completed as a BOT project. The financial source for the rest of the section from NR1 to NR21 has not been procured yet, according to MPWT. It will be operated and maintained as a BOT road after the completion.

c) Fourth Ring Road (RR-IV)

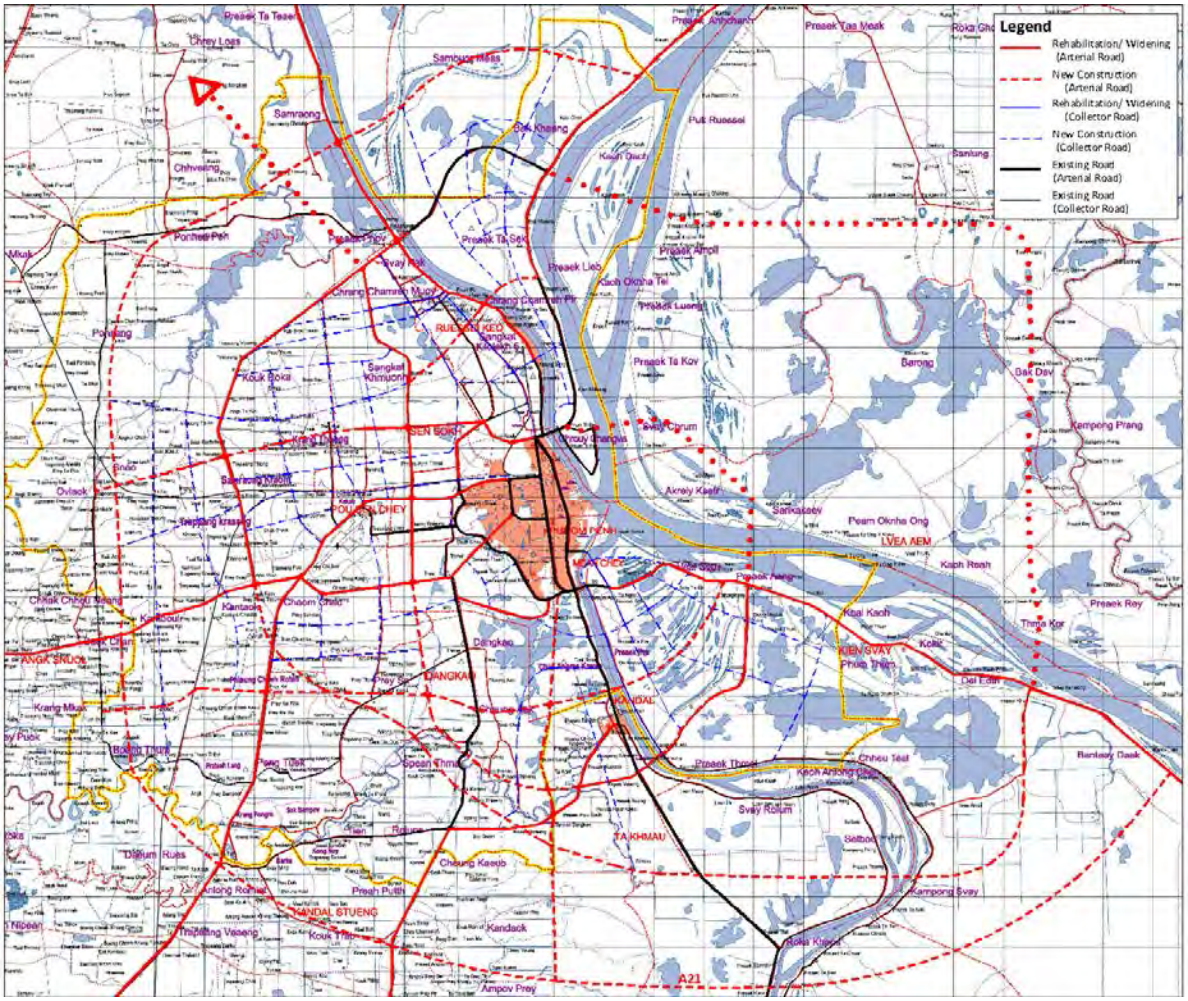
In addition, RR-IV is proposed in this project. This is the outermost ring road aligned at about 4 km to 10 km outside RR-III. It is planned to be developed from NR1 at about 4 km south of New Phnom Penh Port to NR2 at around Preak Slaeng district, and NR3 at around Trapeang Veaeng district, avoiding the Krang Pongro area, which includes a small river and wetland near the south-west city boundary. Then it is aligned to northward slightly eastside of NR42 in parallel and turn to eastward near the north-west city boundary and reaches at NR5 and NR6 at several km outside RR-III. Accordingly, RR-VI is defined as a city boundary ring road and expected to be used as a bypass road of the urbanized area and at the same time expected as a supporting road for the development of the surrounding area.

RR-IV is proposed as an ordinary arterial road with 10.5 m carriageway at the beginning; however, it will be converted to an expressway when the expressway network at national level is developed. Therefore, grade-separated intersections will be prepared at main intersection points. Right of Way (ROW) should be wide enough for converting it to an expressway with side-roads (40 m in width).

RR-III and RR-IV will be mainly used for the traffic with long trip length including heavy vehicles.

An eastern half ring across the Mekong River is proposed to connect RR-II at NR1 and RR-III at NR6 as shown in the figure. It is expected to be used for the through-traffic from NR1 to NR6 or NR5, contributing to the development of the eastern bank of the Mekong. The carriageway is assumed to be 2 lanes with bike lanes.

As the Eastern Half Ring is mostly located outside the Project area, it is illustrated with a dotted line.



Source: PPUTMP Project Team

Figure 8.4-3 Proposed Road Network Plan in Suburban Area of Phnom Penh

2) Radial Roads

a) As for the radial roads, the national roads NR1, NR2, NR3, NR4, NR5 and NR6 will play important roles as suburban arterial roads in the future as well by widening of these roads, as stated above.

b) In addition, Russian Blvd. and Chaom Chao Road will be widened to cope with the traffic growth as well as function as a main public transport corridor in the future.

c) As for E-W arterials, two roads are proposed; one is located at the north of Russian Blvd, starting from RR-1 at Toul Kok to RR-IV via Hanoi Road and RR-III. This is expected not only to accommodate the traffic going to Russian Blvd, but also contribute to the fostering of new sub-centers at Krang Thnong as well as Camko. The other is planned at the south side of Chaom Chao Road and NR4 starting from NR1 to RR-IV, linking with vertical main roads, NR2, Cheng Aek Road, RR-II, RR-III .etc. This road is expected to support the development of AZ Green City located south of the Central area, and Pleung Cheh Roteh new sub-center and the Phnom Penh Special Economic Zone (PPSEZ).

d) With regard to N-S direction, Hanoi Road and Hun Sen Blvd will function as the arterial roads.
Hanoi Road will be widened and the north end will be the starting point of an expressway to the new airport in Kampong Chnang. Hun Sen Road will be developed from the southern end of Monivong Blvd to RR-III connecting with the E-W new arterial mentioned above and RR-II. It

is expected to function as a main corridor of AZ Green City and as an alternative route from city center to Ta Khmau region at the same time.

8.4.3 Collector Road

(1) Central Area

a) Missing Link
Two missing links will be proposed to be completed: one is the extension of St. 608 from St. 610 to St. 273. The traffic from Toul Kok region to the City Center is exclusively dependent on St. 289; therefore, the intersection of St. 289/Russia is becoming a bottleneck. By extending St. 608, the area will be connected with St 221.
Another missing link is between St.430 and St.261. A small river is hindering the direct connection; therefore, the residents are forced to take a long detour via Mao Tse Tong or RR-I.

b) Boeng Kok Roads
Boeng Kok Roads are planned within the Boeng Kok urban development project area.
They will be mainly used for the new residents in the area but may be utilized also as a connection road between Russia and RR-I.

(2) Suburban area

a) The area between NR1 and Tonle Basac River
Some urban development projects are being undertaken in this area. Platinum City is one of those projects. In order to improve the accessibility, a collector road network with a grid pattern is proposed in this project.

b) AZ Green City
In addition to the Hun Sen Blvd., some collector and local roads are planned by a private company.

c) Industrial/Residential Development Area at South of Chaom Chao
For supporting the industrial and residential developments along Chaom Chao area, a collector road network is proposed.

d) Krang Thnong Sub-center and its surrounding area
In this area, the road density is considerably low. In order to increase the potential of the sub-center and support the residential development, a grid pattern collector road network is proposed.

e) Logistics Center and related Industrial area
A logistics center and related industrial zone have been proposed at around the railway junction. To support these developments, several collector roads are proposed.
These developments are expected to stimulate the existing industries along NR4 for expanding their business in relation with the logistics center.

f) Camko/Grand Phnom Penh Area
Camko and Grand Phnom Penh Projects are proceeding at the north of Central Area.
Several collector roads are planned in this area.

g) Chrouy Changvar and Bak Khaeng Sub-center area
Large-scale urban development projects are planned in Chrouy Changvar and Preak Pnob Road area. In order to support these projects and Bak Khaeng Sub-center, a network of collector roads with a grid pattern is proposed.

h) Connection roads between Russia and Chaom Chao Road and Boeng Tumpun roads
Except for Hanoi Road, there is no adequate connecting road between Russia and Chaom Chao at present. The existing one is zigzag road and is too narrow for ordinary vehicles. Accordingly, two connection roads are proposed to be developed. One is a more smooth connection a little to the west of Inner Ring Road, using the existing short section near Chaom Chao Road. The other is the new connection at the east of the Phnom Penh Airport.

In addition, the connection roads in the Boeng Tumpun District are proposed to be developed. They will link Monireth, Boeng Tumpun Road and Inner Road.

8.4.4 Grade-separated Intersections

In the case of the intersections between arterial roads, traffic congestion is likely anticipated. Accordingly grade-separation such as a flyover, underpass or interchange is proposed at such intersections in the maximum network (refer to Figure 8.4.4).

a) Roundabout near old Stadium
This roundabout is located at the intersection of Monivong Blvd., Inner Ring, NR6, France (St. 47) and St. 93. The traffic volumes on Monivong and the Inner Ring from St.273 are considerably large even at present. When the second Chrouy Changvar Bridge currently under construction is completed, a lot of traffic will be coming into the roundabout from NR6; and the traffic from the widened NR5 will be coming from St.93. Therefore, construction of an underpass connecting Monivong and St. 70 is proposed taking into account the landscape.

b) Roundabout with 6 legs at North End of Inner Ring Road
This roundabout is located at the north end of Toul Kok, where 6 streets join from various directions. This roundabout was originally a 5-leg intersection, consisting of Inner Ring (St. 598, St. 355), St. 528, Mong Reththy road and the main road to Traffic Police. The new road (Angkor Blvd.) to Camko/Grand Phnom Penh has recently been added.

c) Intersection of Monivong/Hun Sen Road/Inner Ring Road
At the Khbal Thnol Flyover, the left turn is not possible in spite of the high traffic demand from Ta Khmau district to Monivong or Inner Ring (St. 271). When Hun Sen Blvd., which is to be directly connected to Monivong Blvd. is completed, the intersection will be close to the Kbal Thanol Flyover; therefore, traffic congestion is anticipated. A flyover is proposed to be constructed from Monivong to Hun Sen Blvd., which will not only ease the congestion but will enable a smoother flow of traffic from Ta Khmau area to Monivong Blvd without detour.

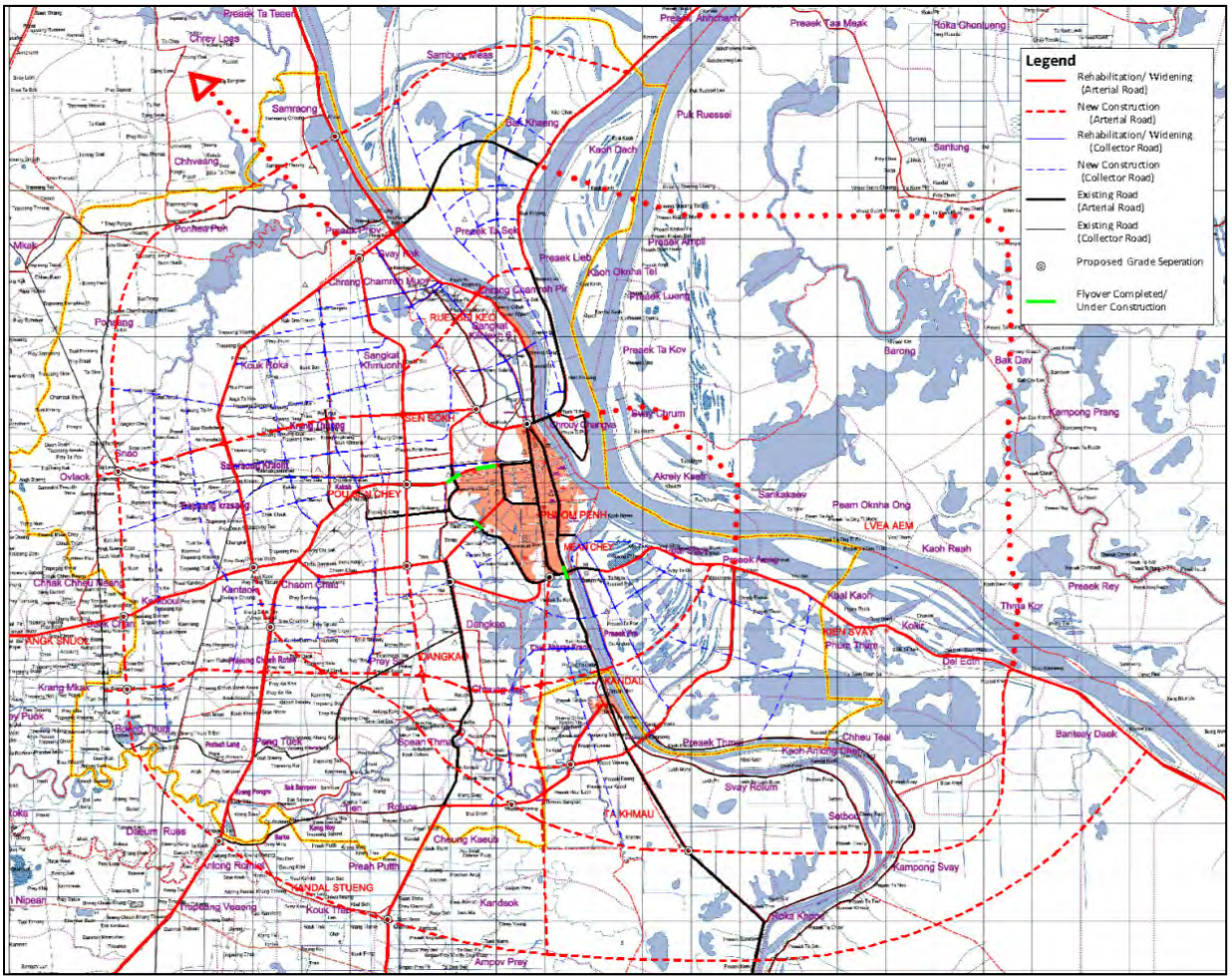
d) Intersection of Russian Blvd./Hanoi Road
At present, the traffic volume on Hanoi Road is not so high, about 30,000 vehicles /day. As a number of urban development projects including Grand Phnom Penh are being undertaken along the road, the traffic demand is forecasted to grow to more than double of the existing demand. The traffic on Russian Blvd. is also likely to increase after the widening of the road.
Hence, a flyover on Hanoi Road across Russian is proposed to be developed.

e) Intersection of Hanoi Road/Chaom Chao Road
A flyover on Hanoi Road will be proposed also at the intersection with Chaom Chao road, when the Middle Ring Road (RR-II) is developed using Hanoi Road as a part of the Ring.
It is expected to create a smooth traffic flow along the RR-II.

f) Intersection of Cheng aek Road/Tumnop Thmei Road
A large volume of traffic demand is already observed at both the roads at present.
The Tumnop Thmei Road will be extended toward west in parallel with Chaom Cho Road.
Hence, it will be possibly used as a bypass road of Chaom Chao road, since a large number of industries and logistics facilities are located in between Chaom Chao and Tumnop Thmei extension. Accordingly, a flyover is proposed along Tumnop Thmei/Extension Road.

g) Intersection related to RR-III
The intersections with main roads along RR-III (RR-III/NR21, RR-III/NR2, RR-III/NR3, RR-III/NR4 and RR-III/Hanoi Road) are proposed to be grade-separated if they become the starting point of the expressway to the New Airport.

h) Intersections related to RR-IV
Also for the intersections along RR-IV, grade-separation is proposed at major intersections if it becomes a part of the National Expressway Network. Some of them will be an interchange type and some will be a flyover type. The planned grade separations are at such intersections with NR2, NR3, new E-W Arterials, NR4 and NR5.



Source: PPUTMP Project Team

Figure 8.4-4 Proposed Grade-Separated Intersections

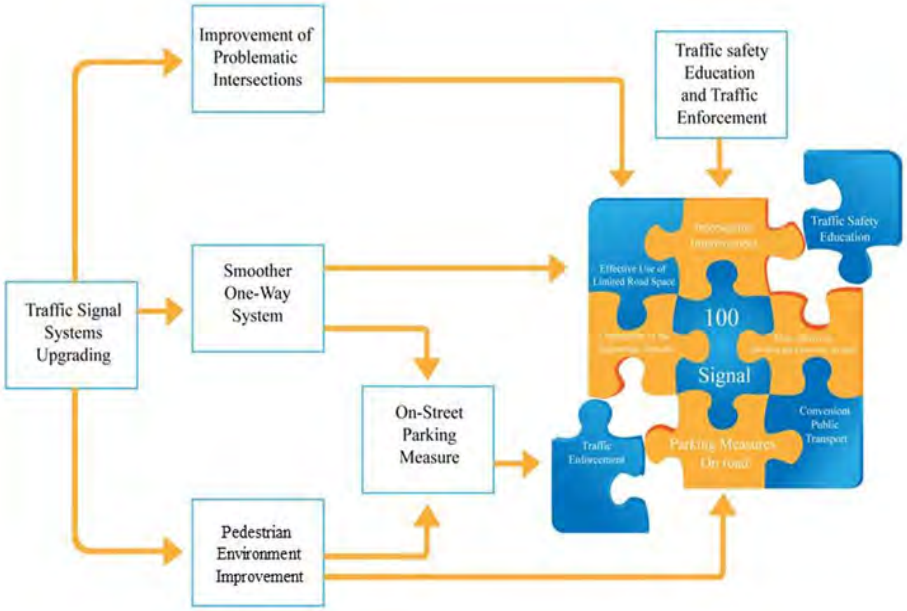
9 TRAFFIC MANAGEMENT

9.1 Overall Plan

The urban district of Phnom Penh Capital City (PPCC) is very densely built up with high rise buildings. There is hardly any space left for the construction of new roads. Under such conditions, the only way out to resolve the traffic congestion problems in the short term is to optimize the efficient use of existing facilities. Major issues in traffic management are those pertaining to traffic utilizing the road space, parking, pedestrian walking environment, drivers' education and enforcement of traffic rules and regulations.
A comprehensive traffic management is planned to maximize the use of the limited urban road space, to prepare a comfortable pedestrian space and to increase the convenience of the public transport.
With a comprehensive traffic management system, safe, comfortable and smooth transportation system is materialized in the dense city center traffic, combining several traffic management schemes.
In other words, implementation by mutual linkage of the following measures, which are triggered by traffic signal system upgrading (refer to Section 9.2), can establish this safe and smooth transportation system in Phnom Penh.

a) Improving problematic intersections together with traffic signal system upgrading -> refer to Section 9.2;
b) Securing traffic safety and ensuring smooth traffic flow along one-way roads together with traffic signal system upgrading -> refer to Section 9.2;
c) Developing on-street parking along local roads together with the introduction of the one-way system -> refer to Section9.2 and 9.3;
d) Developing on-sidewalk parking space using a part of sidewalk space on the trunk roads -> refer to Section 9.3;
e) Looking into the possibility of improving the sidewalk by public side triggered by the traffic signal system upgrading (Control private use on the sidewalk space and restore the original function of the sidewalk). -> refer to Section 9.4;
f) Safely continue the pedestrian network by installing pedestrian traffic signals and pedestrian crossing marking -> refer to Section 9.4; and
g) Strengthening of the traffic safety education and traffic enforcement, which are essential for the efficient functioning of above measures. -> refer to Section 9.5.

A conceptual picture of the comprehensive traffic management scheme is provided in Figure 9.1-1. It shows that improvement in the traffic condition in the dense city center is materialized by all of the above measures when they come together much like pieces of a jigsaw puzzle, but unlike the pieces of a puzzle, each one individually works.



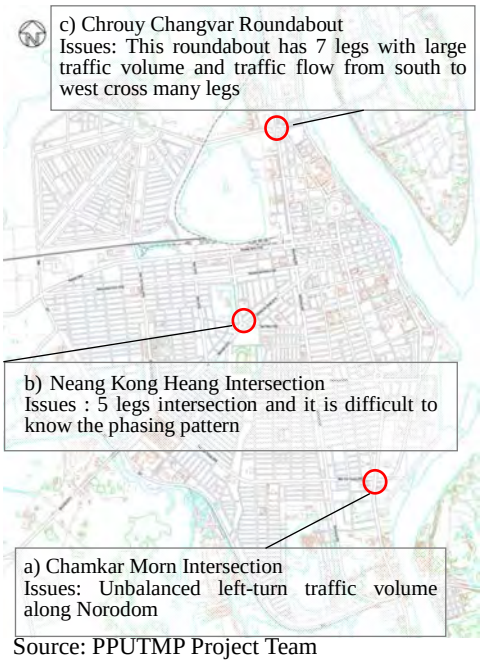
Source: PPUTMP Project Team

Figure 9.1-1 Conceptual Picture of Comprehensive Traffic Management System

9.2 Road Traffic Improvement Plan

9.2.1 Major Problematic Intersections

Many problematic major intersections in the city have been improved under the "PPCC Urban Transport Improvement Project" and other studies. However, the following 3 major intersections are representative of some of those intersections that still face major traffic issues.



Source: PPUTMP Project Team

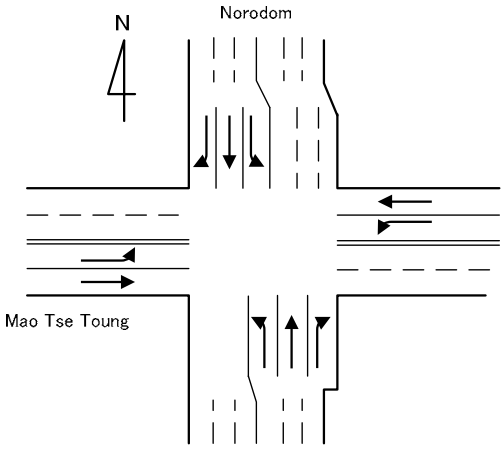
Figure 9.2-1 Location of the Major Problem Intersections

(1) Chamkar Morn Intersection

As described in Section 2.5.1, although Chamkar Morn Intersection has been signalized, it is still facing rather severe traffic congestion during the morning peak hours. The congestion is only somewhat alleviated with the help of traffic police in controlling the traffic during these hours. Therefore, the introduction of a revised signal plan at this intersection that can produce the same results as the manual control by police is examined here.
As a result of the review at Chamkar Morn Intersection, a new phasing sequence is proposed. The signal design procedure basically follows the procedure described as Quick Estimation Method for Signalized Intersection in the Highway Capacity Manual 2000. But the procedure is much simplified for the purpose of selecting phase sequence.
The document is intended to demonstrate the procedure for selecting phase sequence. It does not cover details of signal design such as calculation of timing parameter set that must also be done to operate a signal. For this reason, only north-south direction (Norodom) is considered. Actual directional traffic volume count data at the intersection collected in July 2012 are used. On the other hand, standard lane capacity is assumed as there are no standard figures of lane capacity applicable to Phnom Penh. The consultation with the relevant authorities in PPCC is also required to finalize and implement the design.

1) Site Conditions

Intersection Geometry and Lane Capacity
Norodom - Mao Tse Toung Intersection is a four-leg intersection. The lane assignment at each approach is schematically presented below. Movement in all directions (left turn, through and right turn) is allowed from all approaches. Each lane is dedicated to one movement. Actual vehicle movement, however, does not follow the directional arrow except left-turn lane. There is no shared lane where two movements (through and left-turn movements, for example) share the same lane.

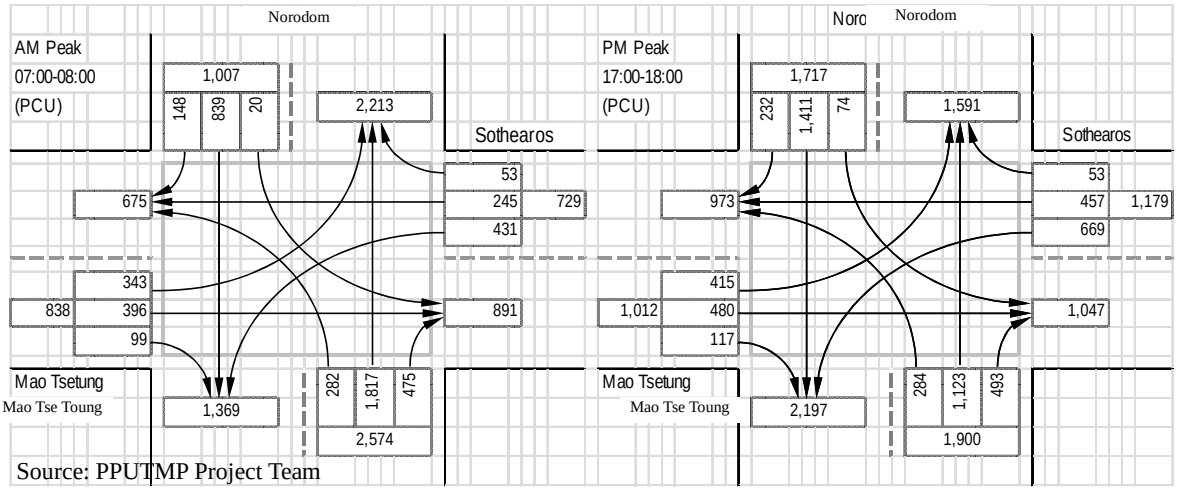


Source: PPUTMP Project Team

Figure 9.2-2 Lane Assignment

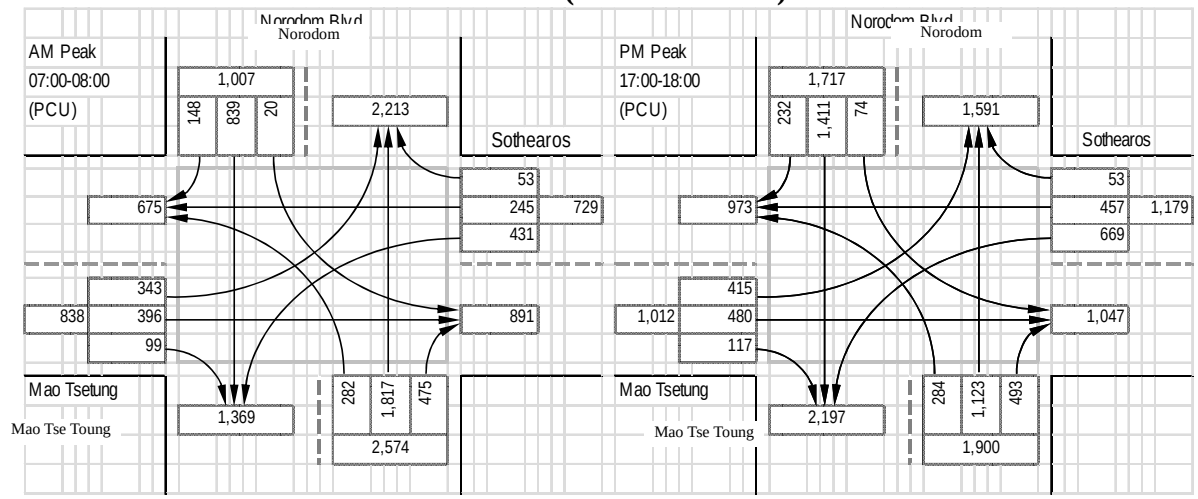
Peak Hour Traffic Volume
In the signal design, traffic volumes during AM peak hour and PM peak hour are used as the signal operation during peak hours are more critical than during off-peak hour. Turning movement traffic count survey at this intersection was conducted on July 31, 2012.

Then peak hour was selected as the hour during which the total volume in Passenger Car Unit (PCU) is highest for morning and afternoon. The peak hour is 7 - 8 o'clock in the morning and 17 - 18 o'clock in the evening. The AM and PM peak hour volume (PCU) thus obtained is shown below.



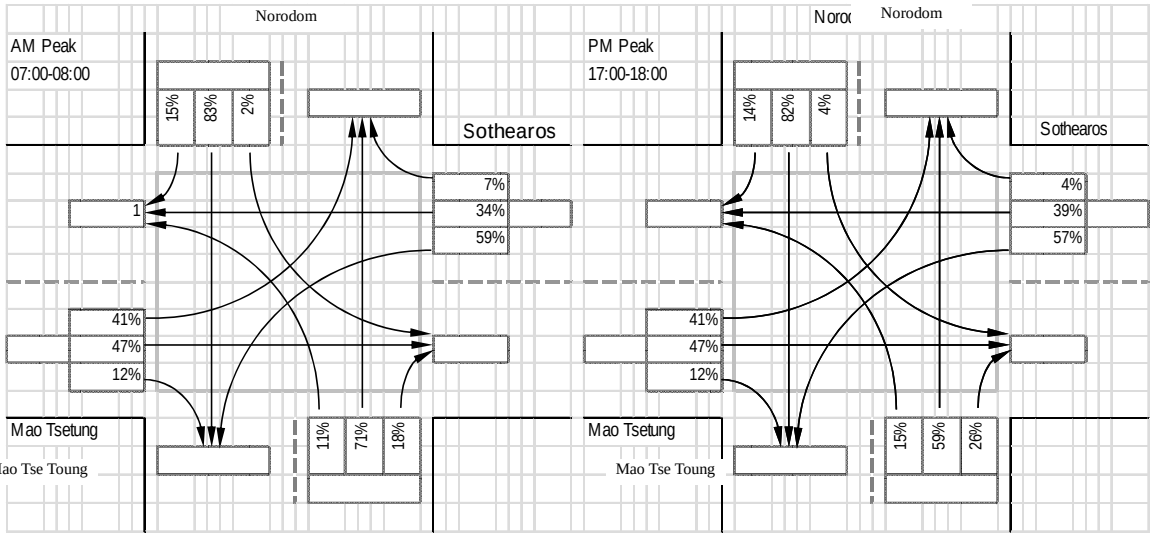
Source: PPUTMP Project Team

Figure 9.2-3 Left Turn, Through and Right Turn Traffic Volume Against the Total Approach Volume (AM & PM Peak)



Source: PPUTMP Project Team

Figure 9.2-4 Traffic Volume Turning Movement Counts (July 31, 2012)



Source: PPUTMP Project Team

Figure 9.2-5 Ratio of Turning Movement

During the morning peak hour, northbound traffic is dominant followed by the southbound traffic. Northbound traffic is also higher than southbound traffic during the evening peak hour. Left-turn traffic from south approach is moderate at 11% and 15% for AM and PM peak hours. On the other hand, left-turn traffic from north approach is small at 2% in the morning and 4% in the afternoon. Thus the left-turn ratios of south and north approaches differ very much. This fact implies that signal design must consider the large difference in the left-turn volume.

The traffic volumes in east-west direction are lower than that in north-south direction and they are at comparable level. But the left turn from east approach shows a very high left-turn ratio of 59% and 57% for morning and evening peak hours, respectively. Left turn from west approach is not as high as that from east approach. But it is still high at 41% for both AM and PM peak hours. The same consideration about difference in the left-turn volume from opposite approaches must also be considered for east-west approaches.

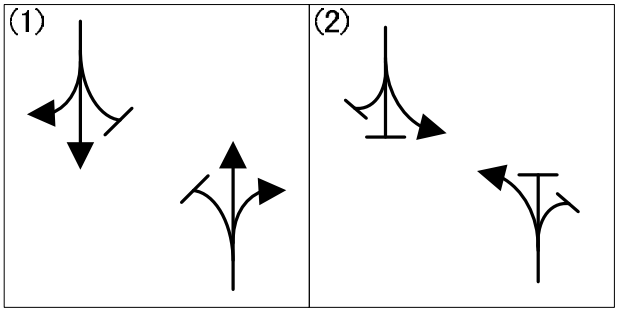
2) Phase Sequence Options

Three phasing sequence options are applicable to this intersection as shown below. It is noted that, permissible left turn that allows left turn when there is a gap sufficiently long enough for left turning in the opposing through-traffic flow is not considered for simplicity in this document. Besides, such phase sequence seems not applicable to the signal in Phnom Penh as it requires establishment of priority rule between through-traffic and conflicting left-turn traffic from the opposite approaches. In other words, there will be no conflicting movements in the signal operation options considered.

Among these phase sequences, the one that requires least duration is most suitable in terms of efficiency. Right-turn movement is included in the through movement and not shown in the phase diagram.

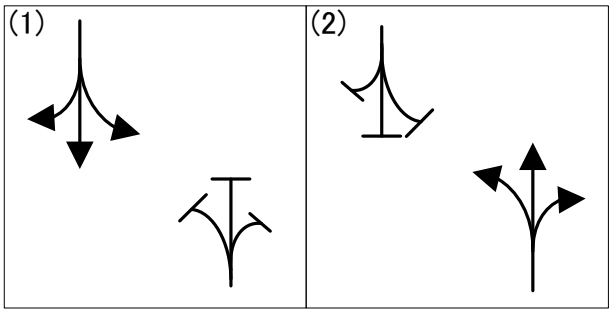
Simultaneous Through Followed by Simultaneous Left Turn

This sequence is the phase sequence currently adopted at this intersection. There are two phases in north-south direction. In phase (1) through-traffic from both north and south approaches is discharged followed by left turn from both approaches. The phase sequence is simple and easily understood by the drivers.



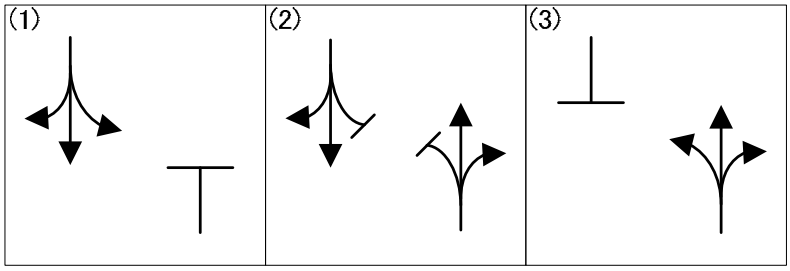
Alternate Approach

This option also consists of two phases. In this phase sequence, movements in all directions from an approach are discharged first followed by all the movements from the opposite approach. The merit of this phase sequence is that interaction or side friction between through movement and left movement that exists in Option (a) above can be minimized as all vehicles on the approach can proceed together.



Lead - Lag Left Turn

This phase sequence consists of three phases and adopts an overlapping phase. Through-movement appears in two consecutive phases as shown below. In the first phase, vehicles in all directions from north approach are discharged. Then left turn from north approach is stopped while through-movement continues and northbound through-movement is added in the next phase. In the third phase, all movements from south approach are discharged. As the left turn from north and south approaches is discharged at different timing, the difference in left-turn traffic volume can be reflected to signal timing by adjusting the duration of left-turn phase separately. The phase sequence may look difficult to understand. But drivers are just required to follow the traffic signal they see and there will be no confusion.



3) V/C Ratio and Critical Movements

Normally in the signal design, right turning traffic and through-traffic are considered as one movement and left turning traffic is considered as one movement. The assumed volume of each movement (through + right turn and left turn) obtained by the traffic volume count survey is summarized in the table below. Using the standard lance capacity of 2,000 or 1,800 vehicles/hour, volume/capacity (V/C) ratio is calculated for each movement and shown in the table.

Table 9.2-1 Volume and V/C Ratio

		North Approach		South Approach	
		TH+RT	LT	TH+RT	LT
Volume	PCU/hour	987	20	2,292	284
Capacity	PCU/hour	4,000	1,800	4,000	1,800
V/C ratio		0.25	0.01	0.57	0.16

Note: TH= Through, RT= Right turn, LT= Left turn
Source: PPUTMP Project Team

By adding up the V/C ratios for all phase sequence, the level of saturation at the intersection is indicated. Thus, a lower total V/C means less congestion. If total V/C exceeds 1.0, it means that volume is larger than capacity and congestion or queue is unavoidable.

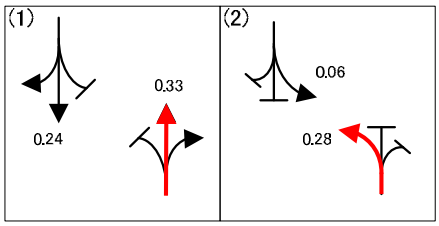
Critical movement is the movement that has the highest V/C ratio among the movements that are allowed simultaneously in a phase. Critical movement requires the longest green time to discharge among the movements concurrently allowed. The duration of a phase must be equal to or longer than the duration for critical movement to prevent congestion.

The critical movement at each phase and its V/C ratio is shown in Table 9.2-2 for Phase Sequence Options (a), (b) and (c). The critical movements are also shown in red wide lines in the figure.

Table 9.2-2 Volume / Capacity Ratio and Critical Movements

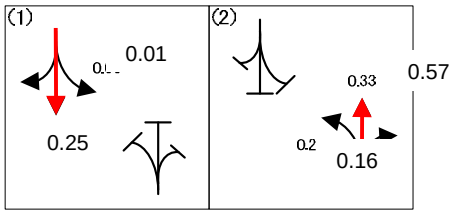
Phase Sequence Option (a)

Option	V/C Ratio			Total
	Phase (1)	Phase (2)	Phase (3)	
(a)	0.57	0.16	NA	0.73



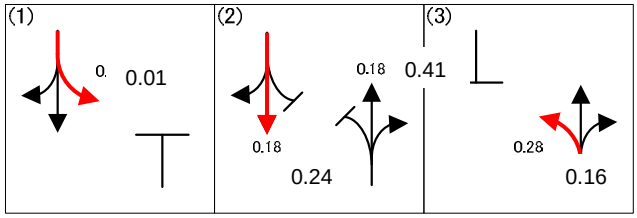
Phase Sequence Option (b)

Option	V/C Ratio			Total
	Phase (1)	Phase (2)	Phase (3)	
(b)	0.25	0.57	NA	0.82



Phase Sequence Option (c)

Option	V/C Ratio			Total
	Phase (1)	Phase (2)	Phase (3)	
(c)	0.01	0.41	0.16	0.58

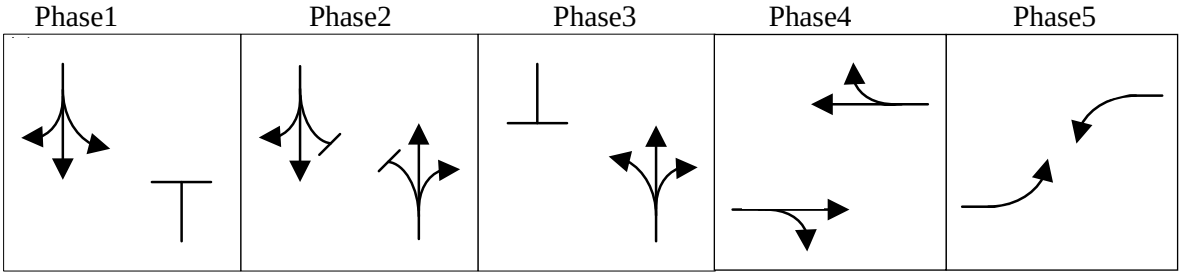


Source: PPUTMP Project Team

The table above shows that Phase sequence option (c) produces the smallest total V/C ratio for traffic in north-south direction. Phase sequence option (a) is second smallest and Phase sequence (b) produces the largest total V/C ratio. This means phase sequence option (c) is most efficient requiring shortest green time for north-south direction, and congestion is less likely.

4) Conclusion

As elucidated in the above section, Type C phase sequence is the most efficient when dealing with traffic demand volumes having significant difference in the northbound and southbound directions. Based on the above examination, a signal plan consisting of 5 phases for Chamkar Morn Intersection is deemed necessary. With the introduction of this new signal plan, it will no longer require the manual control by the traffic police.



Source: PPUTMP Project Team

Figure 9.2-6 Improved Signal Phasing Plan for Chamkar Morn Intersection and Neang Kong Heang Intersection

(2) Neang Kong Heang Intersection

1) Concept

Considering the analyses of traffic issues at Neang Kong Heang Intersection, the following key points need to be addressed in the effort to improve this intersection:

a) The existing signal control using 4 phases for this 5-leg intersection is considered efficient.
b) However, movements in the intersection should be simplified to reduce conflicts, and if necessary those with low traffic demand may be prohibited using control measures.
c) If such measures can be implemented, traffic operation on the existing traffic lanes within the intersection can be more streamlined towards the main movements, thus giving a better chance to achieve a more manageable traffic congestion situation.
d) The landuse conditions of the surrounding buildings offer no extra space for any possible widening work at this intersection. Any improvement measures will have to be carried out within the existing intersection area.

2) Improvement by Simplifying Traffic Movement

Left turning movement is one of the major reasons that contribute to the heavy loading on an intersection. By controlling this movement and directing it to detour to other routes, it is possible to reduce the loading on the intersection. At the same time, such control will give way to other movements in the intersection, hence increasing the overall capacity while reducing the degree of congestion.

To implement such a control measure on left turning traffic having low volume, it is also necessary to consider the following factors:

- There is detour route nearby for the left turning traffic, and
- If left turning traffic volume is too large, such traffic control measure can cause serious congestion on the detour route.

As shown in the following figure, a traffic control measure can be implemented for the low volume left turning traffic from Charles De Gaulle (35 PCU/Hr). This level of traffic volume will not adversely impact on the detour route (St.161). As a result, the left turning lane at the intersection at this approach can be given to the huge through-traffic loading instead.

Table 9.2-3 Left Turning Traffic Volume at Neang Kong Hing Intersection

Inflow	Left turn traffic（PCU）
Charles De Gaulle	35
St.182E	507
Monireth	484
St.182W	0（No left turn）
Tchecoslovaquie	153

Source: PPUTMP Project Team

Source: PPUTMP Project Team

Figure 9.2-7 Suggested Detour Route for Left Turning Traffic on Charles De Gaulle

Table 9.2-4 Changes to Green Time (sec)

	New	Current	New-Current
Phase 1	39	45	-6
Phase 2	20	25	-5
Phase 3	42	45	-3
Phase 4	42	27	+15

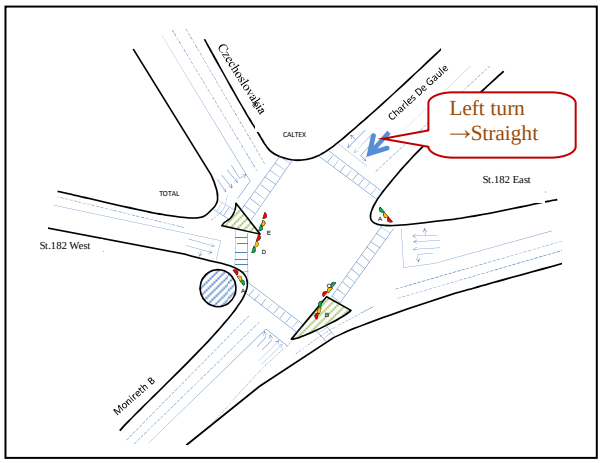
Source: PPUTMP Project Team

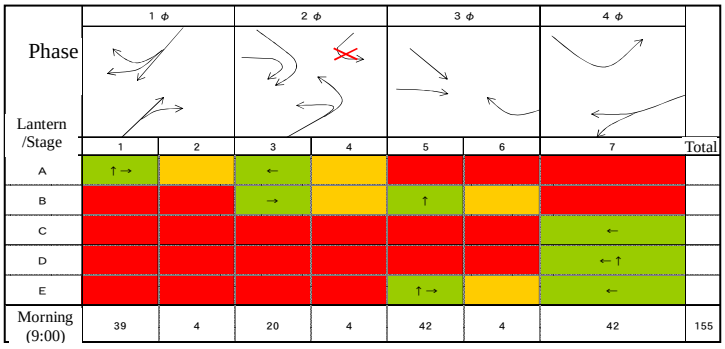
3) Congestion Situation after Applying the Control Measure

The computation of new saturation rate at this intersection is given in the following table. The traffic flow rate at the approach on Charles De Gaulle is reduced from 0.394 before introducing the control measure to 0.262 after the measure. This amounted to about 40% reduction in the traffic loading. With this vast improvement in flow rate, the overall intersection saturation rate is reduced from 1.091 to 0.959, indicating a 10% reduction in traffic congestion rate at this intersection.

With the changes to the saturation rate at this intersection, the green time allocation can be redistributed as indicated in the following table. Savings in green time from the other phases are given to the relatively congested St.182E in Phase 4, thus helping to relief the pressure on this approach.

The above case demonstrates that even when an intersection is faced with severe constraints in altering its configuration or making major changes to its existing traffic operation, a simple control measure applied to the operation of just one approach can produce a significant positive result in helping to alleviate the traffic congestion.





Source: PPUTMP Project Team

Figure 9.2-8 Phasing Plan and Lane Operation after Applying the Control Measure

Table 9.2-5 Computation of New Saturation Rate after Applying the Control Measure

17:00-18:00	Charles De Gaule		R182E			Monireth Blvd		R182W		Tchecovaquie						
	Left	Thr & Righ	Left	Thr	Thr & Righ	Left	Thr	Thr	Right	Left	Thr	Thr				
Number of Lanes	1	3	1	2	1	2	2	2	1	1	1	2				
Lane Capacity	1800	2000	1800	2000	2000	1800	2000	2000	1800	1800	2000	2000				
Saturation Flow Rate	1800	6000	1800	4000	2000	3600	4000	4000	1800	1800	2000	4000				
Traffic Flow	0	1,574	507	891	562	484	711	935	16	153	241	924				
Flow Rate	0.000	0.262	0.282	0.223	0.281	0.134	0.178	0.234	0.009	0.085	0.121	0.231				
Phase	2	1	4	4	3	2	1	3	2	4	2	3	Flow Satulation	Intersection Satulation	Green time	present
Phase 1 ϕ		**0.262**					0.178						0.262		39	45
Phase 2 ϕ	0.000					**0.134**			0.009		0.121		0.134		20	25
Phase 3 ϕ					**0.281**			0.234				0.231	0.281	0.959	42	45
Phase 4 ϕ			**0.282**	0.223						0.085			0.282		42	27
Total	0.000	0.262	0.282	0.223	0.281	0.134	0.178			0.085		0.231	0.959		142	142

Source: PPUTMP Project Team

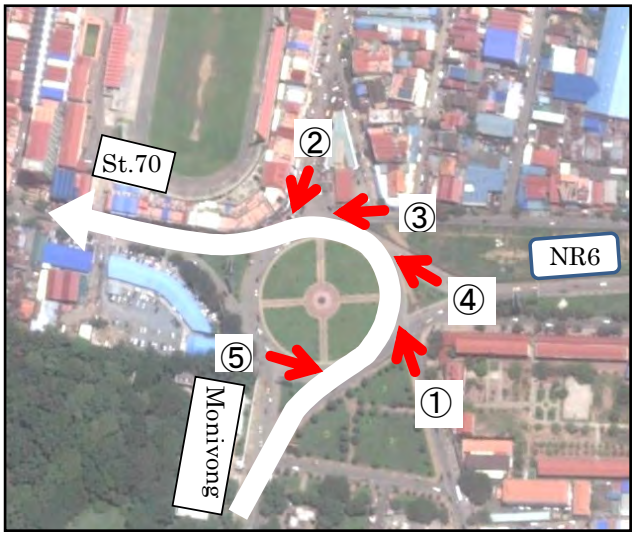
(3) Chrouy Changvar

When traveling along IRR and passing through the Chrouy Changvar Roundabout from the south, a driver has to pass through a longer distance on the eastern arc of this roundabout and faces many merging traffic. To ensure a smooth traffic flow on IRR, some traffic management measures are deemed necessary at this roundabout.

Chrouy Changvar Roundabout is considered to be a landmark in this district. With a widening plan for the Japanese Bridge being underway, any major changes to its configuration and physical shape is not possible. The basic concept in solving the conflicting traffic at this roundabout is to segregate traffic on the Inner Ring from the local traffic passing through the roundabout. To do this, it will be difficult to achieve at-grade given the constraints. One possible solution is to provide an exclusive underground passageway below the western arc of the roundabout for traffic traveling on IRR to pass through the roundabout.

By this method, all merging points can be avoided and any weaving movement when passing through the roundabout can also be prevented. The function of IRR can therefore be strengthened significantly for providing a better traffic flow condition.

Finally, as traffic on IRR is also being segregated from the local traffic, the proposed underground passageway can also contribute to a safer and smoother traffic condition for the local traffic.



Source: PPUTMP Project Team

Figure 9.2-9 Problematic IRR Section at the Eastern Arc of Chrouy Changvar Roundabout (red arrows indicate merging traffic points)

Source: PPUTMP Project Team

Figure 9.2-10 Proposed Improvement Measure at Chrouy Changvar Roundabout (underground passageway)

9.2.2 Signal System Improvement

(1) Outline of the Proposed Area Traffic Control (ATC) System

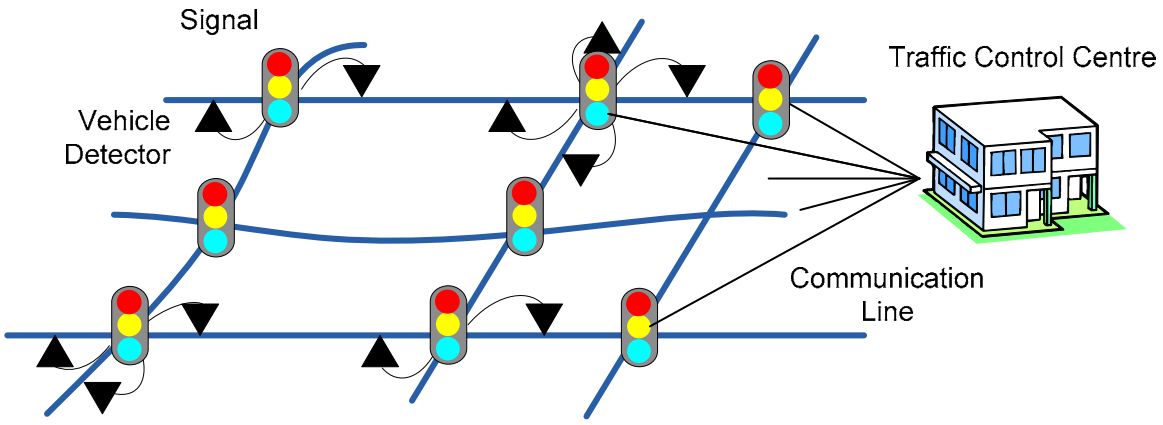
1) Rationale

Although there are more than 60 signals, the traffic signal system in PPCC is at very primitive state as they are isolated signals operating with a single fixed timing plan regardless of traffic condition. On the other hand, the number of vehicles is steadily increasing due to high economic growth during past several years and traffic congestion has become common these days. To cope with the worsening traffic condition and prevent traffic accidents, a more efficient traffic signal system is required. Because of the limited capability of the device, upgrading the existing traffic signal to more sophisticated system is not possible and a new signal system must be introduced.

ATCS is a computer controlled signal system in which all traffic signals are controlled by the computer placed at the traffic control center. Signal timing is optimized to handle the prevailing traffic demand measured by the vehicle detector placed at strategic locations in the road network. In an ATC System, operation of traffic signals is coordinated to minimize the delay caused by the signal. The traffic condition in Phnom Penh has reached the level that warrants an area traffic control system.

2) System Configuration

An area traffic control system controls traffic signals with the signal timing parameters best suited to the prevailing traffic condition to manage the traffic efficiently and minimize the delay. Thus, it needs to gather the traffic condition data, and vehicle detectors are installed for this purpose. In addition, a communication line is required to send and receive data between each signal and Control Center. A conceptual configuration of an ATC system is shown below.



Source: PPUTMP Project Team

Figure 9.2-11 Concept of ATC System

3) System Operation

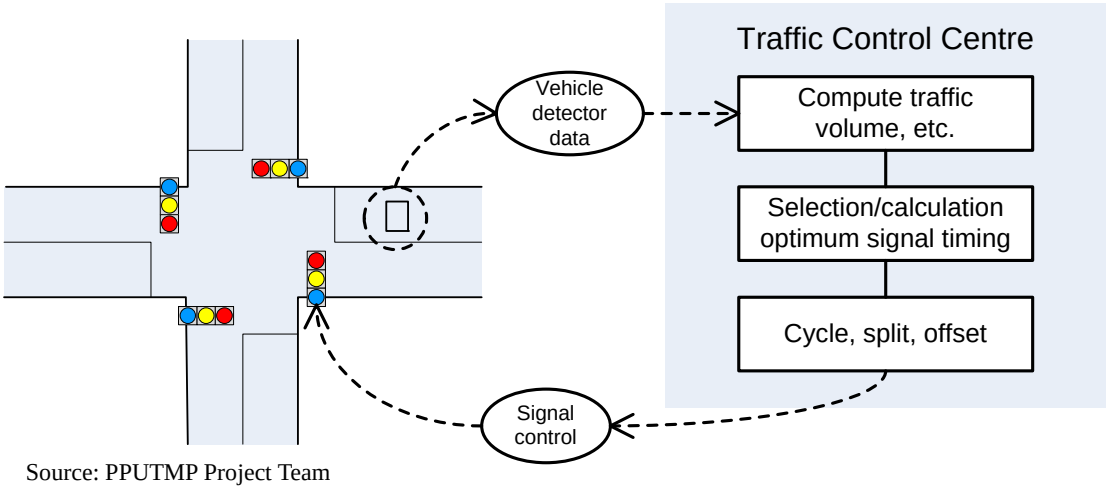
In order to gather traffic condition data, vehicle detector, a device that detects presence or passage of vehicle, is installed at the suitable location in the road network. Depending on the type of signal control method, vehicle detector is installed at different location, such as at stop line, before stop line, exit side of upstream intersection, etc.

Vehicle detection data from vehicle detector are sent to the Traffic Control Center normally through local controller at regular interval. Data from several vehicle detectors will be multiplexed together to share same transmission line.

The data received from the vehicle detectors are processed at the Traffic Control Center and traffic flow parameters such as traffic volume, occupancy rate, and average speed is calculated.

Based on the traffic condition data thus gathered and processed, the signal timing parameters are determined. There are several different methods to calculate or select signal timing parameters.

Timing parameters are then converted to real-time command, and signal is remotely controlled by the command sent from the Control Center through the data transmission system. The same communication line is used for both data uploading and command issuing.



Source: PPUTMP Project Team

Figure 9.2-12 Control Mechanism

4) Benefits of ATCS

Benefits to be brought about by an ATC system are generally recognized as follows:

- Efficient traffic operation (less number of stops, shorter delay and higher travel speed)
- Safer traffic (less number of accidents)
- Reduction of fuel consumption resulting in less emission of Carbon Dioxide (CO2) and other pollutants

The extent of the benefit depends on various factors such as the road network, traffic volume and its composition, congestion level, and type of existing signals. The examples in other cities show that cost of ATC system can be recovered in a couple of years. It is pointed out that the benefit to each vehicle is marginal and may not be tangible for drivers. The total benefit will be, however, significant as large numbers of vehicles receive benefits.

The existing signals in Phnom Penh are isolated type with fixed pattern, and no coordination is maintained among the signals. Thus, there would be large room for improvement and the size of the benefits is expected to be significant.

5) Coverage area of Proposed ATCS

Currently there are a total of 69 units of traffic signals in PPCC. The proposed ATC System will cover most, but not necessarily all, of these signals. If a signal is located far from other signals, traffic volume is not at a critical level and coordination is not required, the signal may not be connected with the Control Center system. Vehicle actuation or other signal control techniques can be applied to these intersections to improve their operation.

In order to select the signals to be covered by the area traffic control system, selection criteria have been established as described below.

- Signal at critical intersection where volume/capacity ratio is high during peak hours and signal control that reflects traffic condition is required.
- Signals located along arterial streets, coordination of which is effective and required for better signal performance.
- Signal located in the vicinity of other signals and coordinated operation is required.

Based on the criteria above, a total of 100 intersections have been selected for area traffic control system. Of this number, 61 will replace existing signals while a new signal will be installed at 39 intersections where currently no signal exists. A signal at a critical intersection where volume/capacity ratio is high during peak hours and signal control that reflects traffic condition is required.

Source: PPUTMP Project Team

Figure 9.2-13 Proposed ATC Signal Location

6) Traffic Signal Components

A traffic signal at an intersection consists of the following components:

- Local controller
- Vehicle detector (for actuation and traffic responsive control)
- Signal lantern
- Signal pole
- Signal cable

Currently, a variety of local controllers are in operation and all of them are not compatible with the centralized traffic control system. Therefore, all existing local controllers need to be replaced with a new local controller if they are to be connected to the system.

Components other than the local controller need not be replaced to introduce an area traffic control system. The existing LED type signal lantern will be used and only the incandescent type lanterns will be replaced with LED type. Likewise, the existing signal poles and signal cables do not need replacement except when signal phase sequence is to be modified.

The vehicle detector, which is not used in the existing system, is required to gather the traffic condition data to efficiently control traffic flow.

7) Type of Local Controller

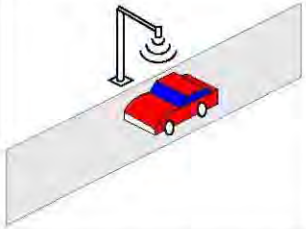
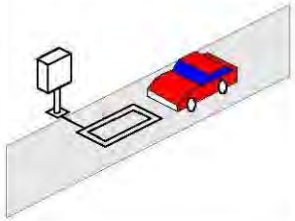
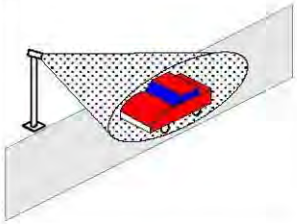
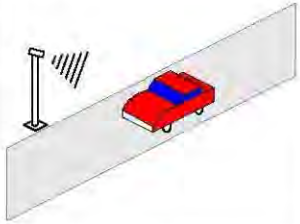
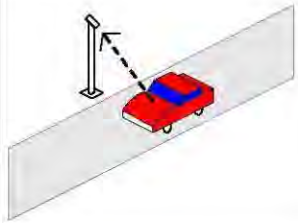
The type of local controller for ATC system differs from supplier to supplier, or from country to country. They are not compatible with each other. Besides, there is no global standard for local controllers for an ATC system. Thus, selection of the local controller for the first stage system determines the type of local controller in the future expansion.

On the other hand, ATC local controllers currently available and used in other systems have almost same functionality and performance so that their selection is not a critical factor in designing and introducing an ATC system. In other words, functional requirements must be defined for the procurement of local controllers, and selection of the type of control mechanism and local controller model will be left to the system supplier.

8) Vehicle Detector

There are several types of vehicle detectors used for an ATC System. A brief summary of different vehicle detectors is shown in Table 9.2-6. Each type has its own advantages and disadvantages. For Phnom Penh, the inductive loop type vehicle detector is recommended as it is simple in configuration and mechanism, and relatively low in cost. In addition, this type of vehicle detector is most commonly used and there are many suppliers.

Table 9.2-6 Comparison of Vehicle Detector

Type	Ultrasonic	Inductive loop	Video	Doppler	Infrared
Model					
Principle	Ultrasonic wave is emitted from a sensor installed above road. Presence of vehicle is detected by time difference of wave reflected by road surface and vehicle	Loop coil is embedded under the road surface. Vehicle is detected as it changes inductance of loop.	Video image taken by video camera is processed and vehicle is detected as moving objects.	Radio wave or ultrasonic wave is emitted to vehicle and moving object is detected by the wave frequency shift cause by the object.	Vehicle is detected as difference in temperature of road surface and vehicle body.
Advantage	Not affected by pavement condition and road work. Sensor head can be relocated.	Simple configuration. Most commonly used.	Multiple lanes can be measured by one unit. Detection area can be set by software. Able to measure various flow parameters	Accurate speed can be measured if radio wave is used. Ultrasonic type can detect motorcycles	No cantilever is required. Not affected by pavement condition and road work. Simple device construction
Disadvantage	Pole and cantilever are required. Aesthetics.	Loop coil and feeder line can be damaged by road work and heavy vehicle. Loop coil is disposable and cannot be relocated.	Requires good camera position and angle for accurate measurement. Cannot be used for surveillance as camera must be fixed.	Use of radio wave may require permit and be affected by heavy rain. Limitation on projection angle. Counting may not accurate.	Installation record is not many.

Source: PPUTMP Project Team

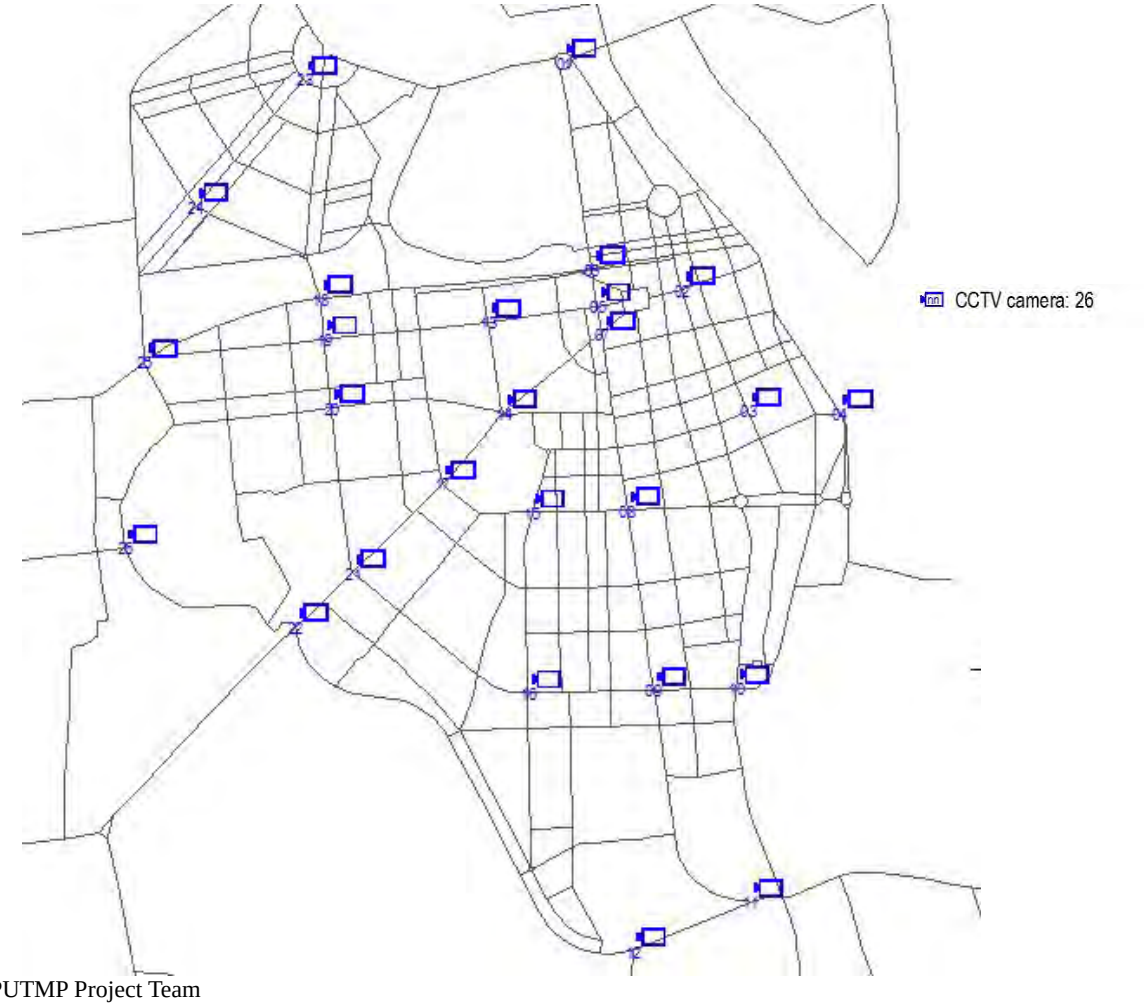
9) CCTV Camera

Although a Closed Circuit Television (CCTV) camera is not required directly for signal control, virtually all existing ATC systems are equipped with a CCTV camera to monitor traffic condition at a critical intersection. Although the traffic condition can be obtained through vehicle detectors and expressed by such traffic flow parameters as traffic volume, average speed and queue length, they are not effective in intuitively understanding traffic condition. Image taken by CCTV camera provides traffic condition at a glance, thus it is a very helpful tool of traffic management.

A CCTV camera for traffic monitoring will be installed at major intersections. The camera must have pan, tilt and zoom (PTZ) functions so that a close-up image of the target object can be taken.

It is noted that transmission of image data requires a much higher bandwidth or speed even though standard TCP/IP protocol is adopted. Thus, cost of transmission line is higher than the cost of communication line that signal control system requires. If more cameras are to be installed, sufficient amount of operation and maintenance budget must be secured.

A total of 26 locations are tentatively selected as location where CCTV camera is installed based on the traffic condition and road network configuration.



Source: PPUTMP Project Team

Figure 9.2-14 Proposed CCTV Camera Location

10) Data Transmission System

An ATC system exchanges data between Control Center and traffic signal, and between Control Center and CCTV camera. For these data exchange, a data transmission system must be established. Contents of data and their bandwidth requirements are summarized below.

Table 9.2-7 Requirements for Data Transmission System

Equipment	Direction	Data	Bandwidth
Traffic signal	Uplink	Controller status data Vehicle detector data	9.6 k bit/sec
	Downlink	Signal control command	9.6 k bit/sec
CCTV camera	Uplink	Video image (MPEG4)	4 M bit/sec
	Downlink	Camera control command	9.6 k bit/sec

Source: PPUTMP Project Team

In a conventional signal system, telephone grade line is used for signal control between traffic control center and each signal controller. With the recent development of digital transmission system, data transmission using Internet Protocol (IP) has been increasing becoming popular for traffic control. Use of IP protocol has two advantages. As it allows sharing of cable with multiple users, cost of data transmission is much lower than the case of dedicated telephone line. Secondly, IP protocol has become so popular and there are many suppliers of data transmission equipment resulting in the lower device cost. Considering these benefits, use of IP protocol is recommended for a new traffic control system.

11) Availability of Cable Network in Phnom Penh

There are basically two approaches about securing communication lines: a leased communication line or self-owned cable. If the communication line is available from a telecommunication company, it is normal practice and more economical to lease lines from the company in exchange for the payment of a monthly fee. It is the telecommunication company's responsibility to maintain the line and no maintenance staff is required on the side of the Traffic Control Center. On the other hand, an annual budget for the communication line must be secured.

There are a number of telecommunication service providers who offer IP based network service in Phnom Penh. CamNet is one of the Internet Service Providers (ISP) in Cambodia, operated by the Ministry of Post and Telecommunications. A discussion with CamNet was held with regard to the data transmission system requirements summarized above and they said they can provide the system. The details of the arrangement and the initial and monthly costs are yet to be examined by them after receiving the details of the ATC system in terms of traffic signal and CCTV camera locations.

Another option is to use the communication line owned and managed by the National Information Communications Technology Development Authority (NiDA). The Authority has a fiber communication network connecting government agencies within Phnom Penh and in all provinces. A meeting was held with NiDA representatives and their response with regard to the use of their optical fiber cable network is very positive.

Various possibilities of communication system for signal system still need to be examined.

12) Traffic Control Center

A Traffic Control Center where traffic condition and signal operation are monitored needs to be established. At the same time, it is the place where servers and other devices for signal system are placed. The Center will consist of several rooms as summarized below.

Table 9.2-8 Traffic Control Center

Room	Equipment	Function
Control room	Video wall Control console	Traffic monitoring Manual control of signal
Sever room	Signal control server CCTV system server Administrative server Data storage system Data transmission equipment	Signal control and monitoring Detector data processing CCTV camera control Operation and maintenance log
Power room	Generator UPS	Uninterruptible and stable power supply
Workshop	Measuring instrument Tools Spare parts	Maintenance work Spare parts inventory
Office		Office work

Source: PPUTMP Project Team

A total floor area of 200 - 300 m^2 will be required to set up the control center.

13) Organizational Setup

An ATC system requires competent staff for its introduction, operation and maintenance. The work requires more management skill and capability than isolated signals currently in operation. As pointed out above, the management capability of the Public Lighting Division of DPWT is not satisfactory to operate an area traffic control system. Capacity building is thus required to strengthen the human resources of the agency. The following subjects need to be strengthened:

- Knowledge of traffic engineering
- Traffic count survey, analysis and application to signal design
- Intersection geometric design
- Signal design guidelines
- Computer and communications
- ATC system operation manuals
- ATC system maintenance manuals
- Documentation and drawing management

14) ATC System Project Implementation

The introduction of an ATC system requires careful planning as the system is highly technical and each stage takes several months to one year. A tentative schedule is shown below assuming that fund for the system introduction is available.

The design of the system requires involvement of a consultant team who specialize in the traffic signal and ATC system design. On-the-job training will be provided to the counterpart team during the design stage in addition to capacity building of the agency mentioned above. The agency staff must become knowledgeable of the system design and develop the capability of expanding the system in the future as these works will be undertaken by the counterpart team members.

Manufacturing of local controllers and other equipment will take six to ten months including time for testing and shipment. Establishment of the Control Center and installation of 100 units of local controllers at each intersection are expected to take one year.

The Traffic Control Center must be established with the adequate number of staff of required skill and knowledge. It must be in place before the start of design stage so that the staff will be involved in the design, and technology transfer will be made.

The second training will be provided by the system supplier during the latter half of the construction stage so that when the system is completed, there will a team of local staff who is familiar with the system.

Table 9.2-9 System Implementation Schedule

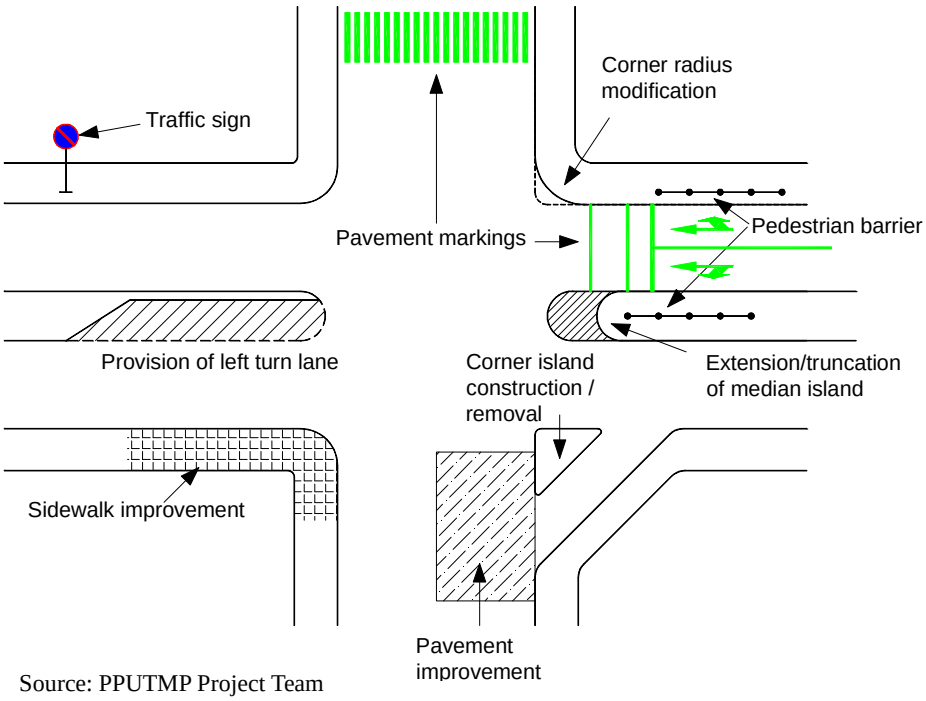
	2014	2015	2016	2017
Traffic survey and system design				
Tender document preparation				
Tendering and contractor procurement				
Manufacturing, database development, factory test				
System construction, testing and commissioning				
Training-On-the-job System training				

Source: PPUTMP Project Team

2) Intersection Improvement

An intersection is a location where traffic streams intersect each other and congestion occurs. Performance at intersection determines the service level of the route as the capacity of an intersection is always lower than a road section's. Signal performance is also affected by the intersection geometry. There are various measures that can be applied to intersections to improve traffic condition and enhance traffic safety. The figure below shows typical traffic management measures that can be applied to intersections.

Improvement measures at a particular intersection depend on such factors as intersection geometry, traffic demand, left and right-turn volume, lane assignment, and roadside conditions. Thus, there is no standard way that can be applied to all intersections uniformly. Improvement measures must be developed individually for each intersection.



Source: PPUTMP Project Team

Figure 9.2-15 Intersection Improvement Measures

If an area traffic control system is to be introduced for Phnom Penh and new signals will be installed at intersections, a review of each intersection must be made from the viewpoint of traffic management, and necessary improvement work must be made at the same time with the replacement of traffic signal to maximize the benefits.

9.2.3 Traffic Information System

The proposed area traffic control system gathers traffic condition data through a vehicle detector installed at strategic points in the road network. The data thus collected can be used not only for traffic signal control but also for traffic information system. Traffic information system is a system that provides current traffic condition information to road users through various media. It also uses the traffic condition data gathered by CCTV traffic monitoring system and other sources of traffic information.

Traditionally, a Variable Message Sign (VMS) installed along major roads is a key component for traffic information dissemination. It is an effective device in conveying traffic-related information in text and graphic symbol to road users. But the amount of information is limited and the number of information recipients is also limited as only those road users who pass by the sign can obtain the information. Nonetheless, VMS is a very useful device to disseminate traffic information.

Source: PPUTMP Project Team

Figure 9.2-16 Examples of VMS

With the proliferation of smart phones, traffic information service using mobile phones has been becoming popular and there are a variety of services for mobile phone users. Although the requirement of the road users for traffic information seems not large at the moment, such services will become a standard function of area traffic control systems.

Source: PPUTMP Project Team

Figure 9.2-17 Road Traffic Information on Internet

9.2.4 Transit Signal Priority

One of the urgent and important tasks for the transportation system in Phnom Penh is the introduction of public transportation system. If public transport system introduced is not attractive, however, modal shift from private vehicles to public transport will not occur and traffic congestion will remain or become worse. One measure that makes a public transport system more attractive is transit signal priority by traffic signal.

Transit signal priority is a signal control technology that provides buses with priority treatment at signalized intersections to realize better adherence to the bus schedule. Approach of a bus at an intersection is detected by the system and green signal is extended or red signal is truncated to reduce delay of bus at the intersection.

Transit signal priority system comprises three components as follows:

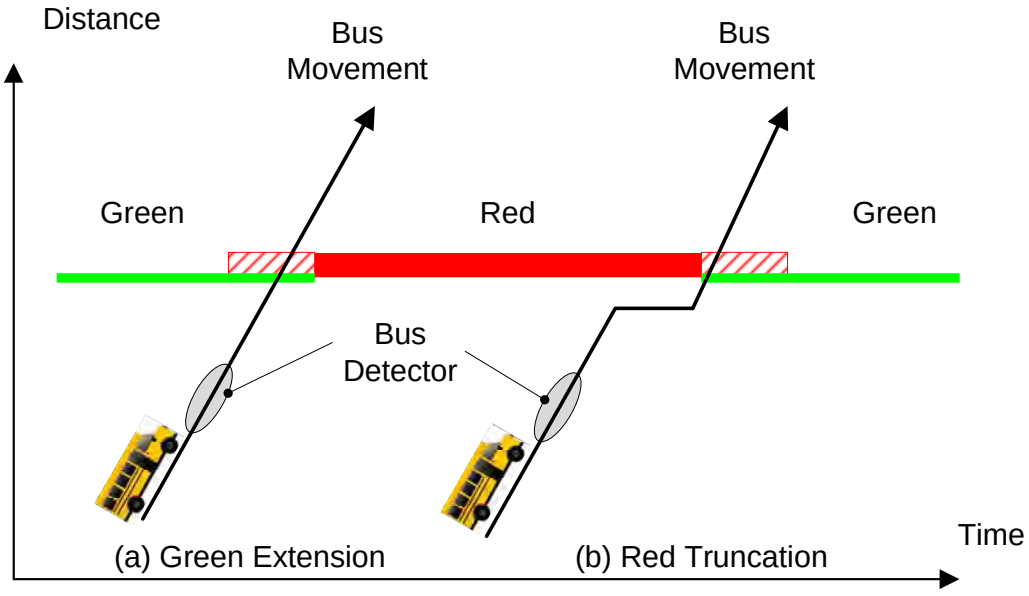
- Signal control software installed in local controller to modify signal display in real-time
- Automatic vehicle location system that determines the current location of bus
- Bus detection mechanism at intersection approach

(1) Transit Signal Priority Mechanism

The figure below shows transit signal priority mechanism. Arrival of a bus at intersection is detected at intersection approach. The detection signal is sent to the local controller. If expected bus arrival at intersection is calculated within a few seconds of a red display, green signal is extended to allow the bus to go through the intersection without stopping (green extension). If a bus arrives during red signal, then red display duration is shortened and green signal is displayed earlier than normal signal cycle. In both cases, waiting time of the bus at the intersection is shortened.

If adherence to bus schedule is important, priority is given to the buses that are running behind schedule only. If the purpose of the system is to shorten the total travel time of a bus, priority will be given all buses regardless of whether a bus is ahead or behind schedule.

Transit signal priority software that performs the function described above must be installed in the local controller. The mechanism can be implemented regardless of the signal type (isolated signal, coordinated signal or area traffic control signal).

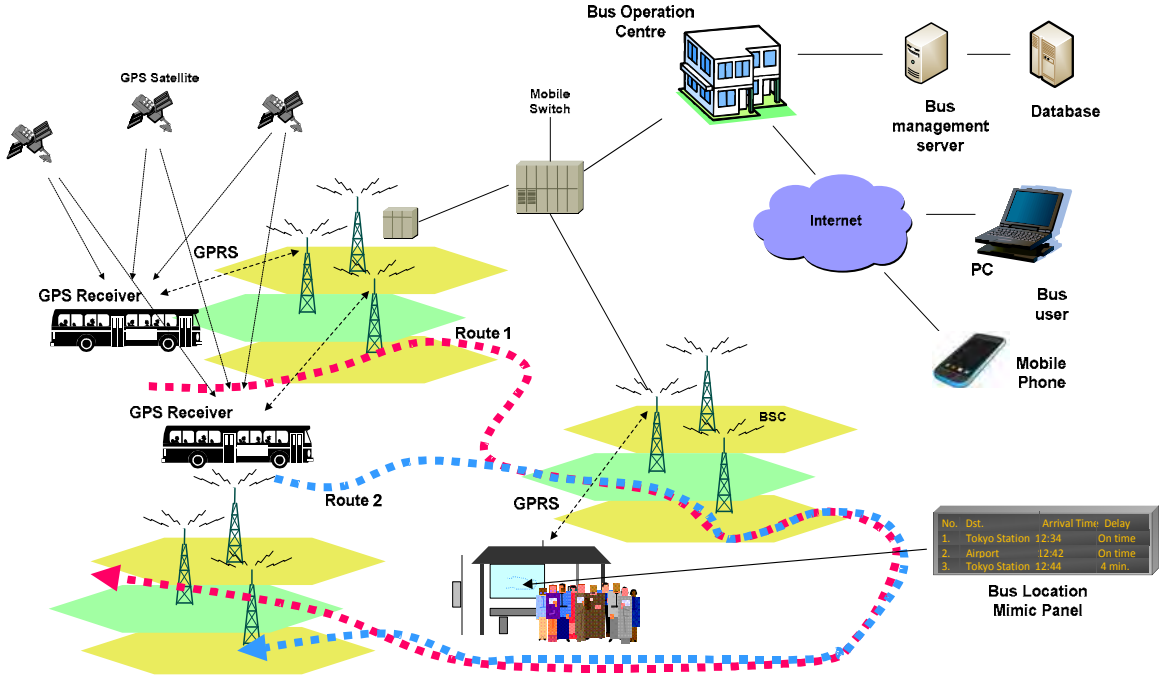


Source: PPUTMP Project Team

Figure 9.2-18 Transit Signal Priority Mechanism

(2) Bus Location System

Global Positioning System (GPS) based automatic vehicle location system has become popular and devices and management software are easily available. Once current location of a bus along the route is determined, it is compared with the schedule and deviation from the schedule is determined. If the bus is behind schedule, transit signal priority will be applied.
If an automatic bus location system is introduced, the bus location information can be used for not only bus operation control but also bus user services. Bus users waiting at bus stop will know when the next bus will come reducing the stress of waiting. The concept of the bus information system is shown below.



Source: PPUTMP Project Team

Figure 9.2-19 Concept of Bus Location Information System

(3) Bus Detector

There are mainly three types of bus detection systems:

- Vehicle detector
- Tag
- Optical emitter/detector

Some types of vehicle detector are capable of distinguishing buses from other types of vehicles by measuring vehicle length and height. The detector is low in cost and easy to operate. No device is required for bus. Thus the system will have a simple configuration and can be easily introduced. But it does not provide bus ID data. The detector cannot determine whether the bus is ahead or behind schedule. This type of detector is useful only in the bus system that often suffers from the delay due to traffic congestion.

Tag type bus detection system uses a tag attached to the bus body. The tag contains the bus ID, which is read by a system interrogator installed on the roadside near the signal for transit priority. As deviation from schedule is not considered, the system always works to shorten the delay at the intersection in a localized system. If the system is centralized and the bus ID is sent to the center; however, it is possible to determine the bus location relative to the bus schedule.

In optical emitter/receiver system, an optical transmitter mounted on the bus roof sends a request signal to the receiver normally mounted on the traffic signal pole, when a bus is behind schedule. Upon receiving the request signal, the local controller activates the transit signal priority program and implements priority.

The design of transit signal priority and selection of equipment type will be carried out after the details such as route, frequency, bus fleet and management organization for bus operation have been decided.

9.2.5 One-Way System

(1) Planning Direction

As discussed in 'Section 2.5.3: Inefficient Utilization of Roads', PPCC is facing a myriad of urban transport problems such as the worsening traffic congestion situation brought about by the increasing trend of vehicle ownership, decreasing road capacity and a deteriorating pedestrian walking environment caused by unlawful parking on the street and sidewalks.
A more efficient utilization of the limited urban road space within the city center is the key to solving all these urban transport problems.

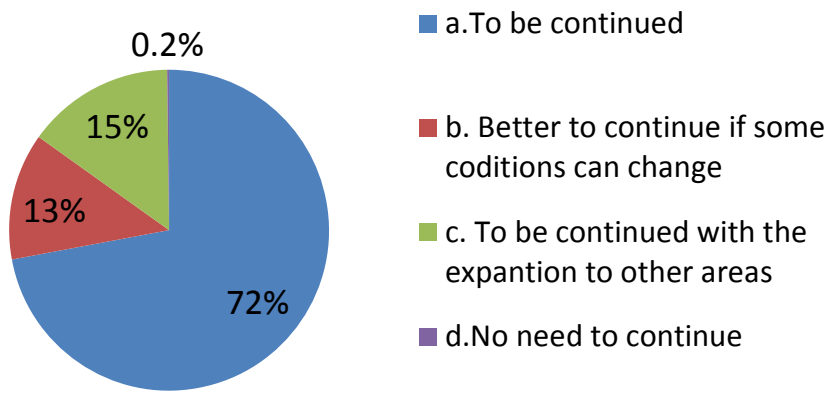
On-street parking along narrow streets has resulted in difficulty for opposing traffic streams to pass, hence creating serious traffic congestions. To overcome this problem, converting such narrow streets into one-way streets is a reliable measure as it effects a more efficient usage of the limited roadway space by increasing its operational capacity for a smoother traffic flow while reducing traffic accidents.

For this reason, a Public Experiment was conducted in this project within the city central tourist area, to test the effects of one-way traffic system coupled with parking management measures that include parking enforcement on sidewalks to free up pedestrian walking space for tourists and pedestrians while rationalizing curbside parking provisions. In this section, using the results from the Public Experiment, an expanded one-way traffic system covering the entire city center, with the high traffic demand tourist central district as the main focal point, is considered.

(2) Evaluation on the One-Way Traffic System Based on Responses from the Driver Interview Survey

The Public Experiment conducted in this project has proven the effectiveness of the one-way traffic system. Responses from drivers interviewed during this experiment have indicated that most drivers wish to see the one-way traffic system expanded and continued to be applied in the city.

About one-way traffic system〔After PE〕(Driver Interview: n=555)



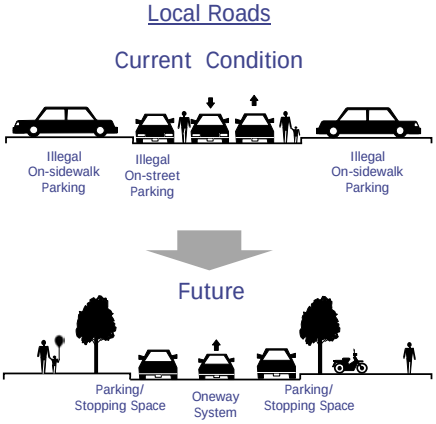
Source: PPUTMP Project Team

Figure 9.2-20 Driver Interview Result

(3) Image on the Effective Usage of Road Space by the Introduction of One-way Traffic System

When introducing the one-way traffic system, the following measures are proposed as means to promote more effective usage of the urban road space.

On narrow streets, part of the roadway space will be used as parking space with the remaining width designated as one-way traffic roadway. In this manner, the traffic operation capacity of such narrow streets is increased.



Source: PPUTMP Project Team

Figure 9.2-21 Road Space Usage

(4) Basic Concept on the Introduction of One-Way Traffic System

Basic Functions of a One-Way Traffic System

The following are the basic functions expected of a one-way traffic system for the city center.

- A one-way traffic system that is able to increase the traffic operation capacity of all the narrow and congested streets, and
- A one-way traffic system that can enhance and complement the operation and functions of a future urban public transport system (bus).

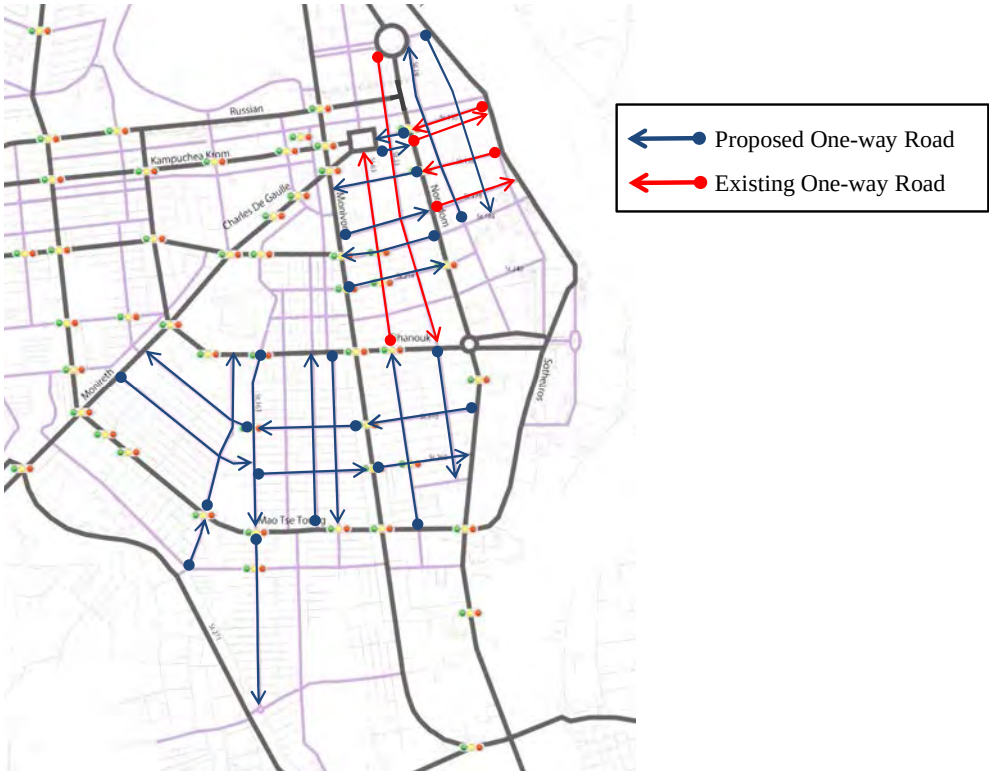
In principle, one-way traffic system will not be introduced to the major arterial roads in the city.

Proposed One-Way Traffic Streets / District

- Retain all the existing one-way traffic streets as they are,
- The existing routes are basically extended or expanded to those routes or areas included in the Public Experiment Study Area,
- One-way traffic streets are paired up based on their features such as similar class of road, parallel and close by, and similar length.
- Each pair of one-way streets must be basically within 300 m of each other.
- Routes are selected if they do not cause exceptionally long distance detours,
- Routes that may cause further complication to the travel pattern will not be selected, and
- Narrow streets that have sections or intersections which attract particularly large traffic will also not be considered.

(5) Proposed One-Way Traffic System

Based on the concept and considerations listed above, the final one-way traffic system for Phnom Penh is proposed as illustrated below.



Source: PPUTMP Project Team

Figure 9.2-22 One-Way System

9.3 Parking Measures

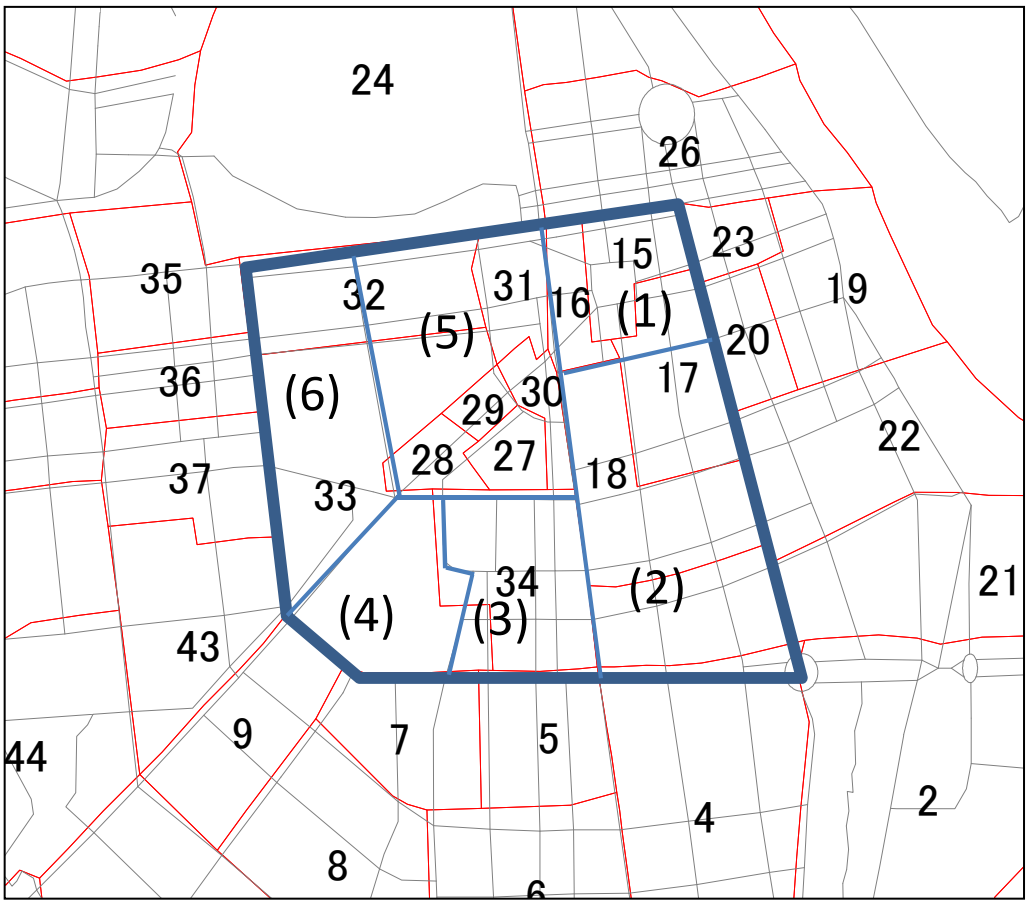
Referring to Chapter 2 which examined the balance of parking demand and supply within the city center, the analyses showed that there is currently an acute shortage of parking spaces amounting to 12,000 bays for motorcycles and 6,000 for passenger cars within that area. In this chapter, the analysis on the existing parking demand presented in Chapter 2 will be used for forecasting the expected future demand for parking by 2016, 2020 and 2035; and subsequently a recommendation will be made on a future parking system taking into account the special characteristics of the traffic pattern in Phnom Penh in meeting the future parking demand in the city.

9.3.1 Forecasting Future Parking Demand

The future parking demand is forecasted based on results of the Person Trip (PT) Survey and correlating this travel demand to the results of the parking demand by zone. Using the forecasted future trip attraction (in PCU) to these zones in 2035 and their growth rates in relation to the current travel demand (in PCU) in 2012, the future parking demand by 2035 is estimated. Parking demand in the intermediate years of 2016 and 2020 are interpolated based on this future demand.

(1) Growth in Parking Demand

The zoning pattern used in the PT survey is superimposed on the 6 blocks or zone division used in the parking demand survey as illustrated in the figure below. Tables 7.3-11 and 7.3-12 show the results of the forecasting of future trip attraction (in PCU) by the 6 parking zones for motorcycles and passenger cars from 2012 to year 2035 and the interpolated results by 2016 and 2020, respectively. Overall for all the parking zones, growth of PCU for motorcycle is 1.39 times by 2035 and for cars, by 2.47 times. Growth of car PCU is therefore expected to be much higher than those for motorcycles.



Note: Numbers in parentheses ( ) are zoning number for parking survey, other numbers are for PT survey.
Source: PPUTMP Project Team

Figure 9.3-1 Correlation of Parking Survey and PT Survey Zoning

Table 9.3-1 Forecast of Motorcycle PCU and Growth by Zone

Parking survey Zone number	2012 (PCU)	2035 (PCU)	2035 /2012	2016 /2012	2020 /2012
1	10,557	15,430	1.46	1.08	1.16
2	12,144	15,612	1.29	1.05	1.10
3	5,033	9,546	1.90	1.16	1.31
4	4,873	7,103	1.46	1.08	1.16
5	30,789	39,512	1.28	1.05	1.10
6	10,889	16,371	1.50	1.09	1.18
Total	74,285	103,574	1.39	1.07	1.14

Source: PPUTMP Project Team

Table 9.3-2 Forecast of Car PCU and Growth by Zone

Parking survey Zone number	2012 (PCU)	2035 (PCU)	2035 /2012	2016 /2012	2020 /2012
1	5,132	14,257	2.78	1.31	1.62
2	7,728	17,115	2.21	1.21	1.42
3	4,078	12,934	3.17	1.38	1.76
4	2,188	6,137	2.80	1.31	1.63
5	17,791	39,708	2.23	1.21	1.43
6	7,037	18,557	2.64	1.28	1.57
Total	43,954	108,708	2.47	1.26	1.51

Source: PPUTMP Project Team

(2) Future Parking Demand

The future parking demand is therefore computed by multiplying the growth ratios of the future travel demand as forecasted above, with the existing parking demand by zone. This forecasting is shown in the table below. The total motorcycle parking demand by the year 2035 in all the 6 parking zones is estimated to be 23,000 bays while for cars, it is 22,000 bays.

Table 9.3-3 Future Motorcycle Parking Demand

Block Number	Existing Parking Demand			Future Parking Demand					
	Existing Parking Demand			Motorcycle PCU Growth Ratio from PT Survey (B)			Future Parking Demand (C= A x B)		
	On street	Off Street	Total (A)	2016	2020	2035	2016	2020	2035
1	4,422	139	4,561	1.08	1.16	1.46	4,927	5,293	6,666
2	2,735	22	2,757	1.05	1.10	1.29	2,894	3,031	3,544
3	1,774	0	1,774	1.16	1.31	1.90	2,051	2,327	3,365
4	310	114	424	1.08	1.16	1.46	458	491	618
5	4,498	211	4,709	1.05	1.10	1.28	4,941	5,173	6,043
6	1,821	0	1,821	1.09	1.18	1.50	1,980	2,140	2,738
Total	15,560	486	16,046	1.07	1.14	1.39	17,251	18,456	22,974

Source: PPUTMP Project Team

Table 9.3-4 Future Passenger Car Parking Demand

Block Number	Existing Parking Demand			Future Parking Demand					
	Existing Parking Demand			Passenger Car PCU Growth Ratio from PT Survey (B)			Future Parking Demand (C= A x B)		
	On street	Off Street	Total (A)	2016	2020	2035	2016	2020	2035
1	2,785	39	2,824	1.31	1.62	2.78	3,697	4,571	7,845
2	1,916	16	1,932	1.21	1.42	2.21	2,340	2,748	4,279
3	1,091	0	1,091	1.38	1.76	3.17	1,503	1,915	3,460
4	185	26	211	1.31	1.63	2.80	277	343	592
5	1,679	28	1,707	1.21	1.43	2.23	2,073	2,438	3,810
6	752	0	752	1.28	1.57	2.64	966	1,180	1,983
Total	8,408	109	8,517	1.26	1.51	2.47	10,856	13,196	21,969

Source: PPUTMP Project Team

9.3.2 Parking Countermeasures

(1) Concept

As indicated in the preceding section, the travel demand by motorcycles and especially by passenger cars in the 6 survey zones is expected to grow rapidly in the future. With just the existing parking provisions and system, the future parking situation will become very chaotic and unmanageable.

As Phnom Penh is a developing city, exchanges within the city center must be given priority. Hence, parking demand in the city center has to be accommodated as much as possible to encourage such exchanges in business, trade, people movement and commerce. However, land in the city center is seriously constrained. For this reason, comprehensive parking countermeasures that include soft measures like parking demand restraint must be applied.

In addition, in the proposed Urban Transport Master Plan for Phnom Penh, public transport system is expected to become the main backbone of the future urban transport system of the city with a significant overall travel mode share in the future. Hence, mode transfer to public transport from the private modes must also be carefully considered as part of the hard measures in solving the increasing parking demand.

(2) Transfer to Public Transport

In Chapter 6 where future public transport demand is forecasted, a 30% mode transfer rate from the private transport modes such as motorcycles and cars to public mode is applied. This rate of mode transfer is hence used to multiply with the forecasted future parking demand. As a result, the final future parking demands for motorcycles and passenger cars, after accounting for mode transfer to public transport, are estimated to be 16,000 bays and 15,000 bays, respectively.

Table 9.3-5 Forecasted Motorcycle Parking Demand after Accounting for Mode Transfer

Block NO	Conversion of public transport								
	Public transport conversion rate(D)			Public transport conversion amount(E=C×D)			Public transportation after conversion(F=C-E)		
	2016	2020	2035	2016	2020	2035	2016	2020	2035
1	5	10	30	246	529	2,000	4,681	4,764	4,666
2	5	10	30	145	303	1,063	2,749	2,728	2,481
3	5	10	30	103	233	1,009	1,948	2,095	2,355
4	5	10	30	23	49	185	435	442	433
5	5	10	30	247	517	1,813	4,694	4,656	4,230
6	5	10	30	99	214	821	1,881	1,926	1,916
Total				863	1,846	6,892	16,388	16,610	16,082

Source: PPUTMP Project Team

Table 9.3-6 Forecasted Passenger Car Parking Demand after Accounting for Mode Transfer

Block NO	Conversion of public transport								
	Public transport conversion rate(D)			Public transport conversion amount(E=C×D)			Public transportation after conversion(F=C-E)		
	2016	2020	2035	2016	2020	2035	2016	2020	2035
1	5	10	30	185	457	2,354	3,512	4,113	5,492
2	5	10	30	117	275	1,284	2,223	2,473	2,995
3	5	10	30	75	192	1,038	1,428	1,724	2,422
4	5	10	30	14	34	178	263	309	414
5	5	10	30	104	244	1,143	1,969	2,195	2,667
6	5	10	30	48	118	595	918	1,062	1,388
Total				543	1,320	6,591	10,314	11,876	15,378

Source: PPUTMP Project Team

(3) 'Hard' Measures

The very basic 'hard' measure for meeting increasing future parking demand is to develop off-street parking facilities. Off-street parking facilities are seriously lacking in Phnom Penh at this moment, which has directly resulted in the widespread illegal parking on streets and pedestrian sidewalks. The situation has in turn created serious traffic congestion and obstructed the safe passage of pedestrians. Although there is a need to provide off-street parking facilities, the reality is that there is a shortage of available urban land for this purpose.

In the city center, many buildings especially those along Monivong and around the Central Market area have become dilapidated with age. These buildings are expected to make way for urban redevelopment in the near future. In this respect, off-street parking facilities can be developed in conjunction with this urban redevelopment plan for these areas.

Furthermore, sidewalks along the major arterials in the city are very wide. It is possible that a portion of such urban space be effectively used to provide the much needed space for parking. However, the use of such spaces for parking must be treated as a secondary source only, after having accommodated as many parking demand in all the available spaces in the existing and possible future off-street parking facilities.

1) Existing Off-Street Parking Spaces

There are a total of 3,900 existing off-street parking spaces for motorcycles and 2,600 spaces for cars in the city center. Hence, after allowing for these existing parking supplies, there is still a need to provide for a total of 12,000 spaces for motorcycles and 13,000 spaces for cars in the year 2035.

Table 9.3-7 Future Parking Demand for Motorcycles

Block NO	Status parking spaces(G)	After Status situation space subtraction(H=F-G) (Status space、Public transportation)		
		2016	2020	2035
1	570	4,111	4,194	4,096
2	180	2,569	2,548	2,301
3	0	1,948	2,095	2,355
4	900	-465	-458	-467
5	2,290	2,404	2,366	1,940
6	0	1,881	1,926	1,916
Total	3,940	12,448	12,670	12,142

Source: PPUTMP Project Team

Table9.3-8 Future Parking Demand for Cars

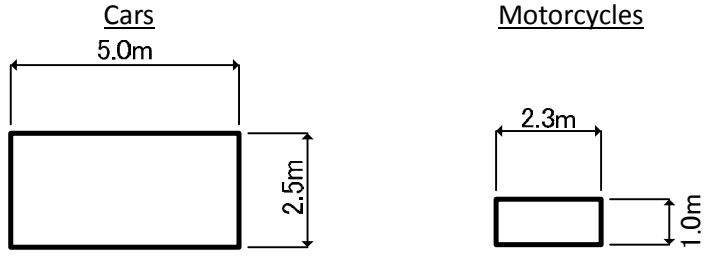
Block NO	Status parking spaces(G)	After Status situation space subtraction(H=F-G) (Status space、Public transportation)		
		2016	2020	2035
1	825	2,687	3,288	4,667
2	370	1,853	2,103	2,625
3	0	1,428	1,724	2,422
4	620	-357	-311	-206
5	750	1,219	1,445	1,917
6	0	918	1,062	1,388
Total	2,565	7,749	9,311	12,813

Source: PPUTMP Project Team

2) Off-Street Parking in Conjunction with Urban Redevelopment

The provision of off-street parking spaces in conjunction with future urban redevelopment within the city center is examined with the following assumptions:

- Each of the blocks is expected to undergo a certain level of redevelopment in the future. Considering that Block 1 has a large concentration of commercial and other business enterprises, this Block is assumed to have 20% of its total land area for redevelopment in the future. Other blocks are assumed to have 5% of their land area undergoing redevelopment.
- The parking space for each block is assumed to be equivalent to the area of the assumed redevelopment area.
- Considering the ratio of space requirement and demand for motorcycle and car parking, the proportion in allocation of parking space for cars to motorcycles shall be 95:5,
- The standard parking area is set at 30 m^2 for a passenger car and 5.5 m^2 for a motorcycle.
- Development for such off-street parking is assumed to be fully completed by 2035. Supply of parking for intermediate years of 2016 and 2020 are interpolated from the final figure.



Source: PPUTMP Project Team

Figure 9.3-2 Proposed Grade-Separated Intersections

The supply of off street parking in conjunction with urban redevelopment within the city center by block is estimated based on these assumptions and the results are given in the table below. By 2035, an estimated total of 8,600 bays for cars and 2,500 bays for motorcycles are expected to be provided.

Table 9.3-9 Estimated Future Off-Street Parking Spaces in Conjunction with Urban Redevelopment by Block in the City Center

Block	2035							2020		2016	
	Block area(m^2)	Expected development rate(%)	Development area(m^2)	Car parking area (95% of the total)	Bike parking area (5% of the total)	Car parking spaces	Bike parking spaces	Car parking spaces	Bike parking spaces	Car parking spaces	Bike parking spaces
1	430,000	20	86,000	81,700	4,300	2,723	782	867	249	371	107
2	1,240,000	5	62,000	58,900	3,100	1,963	564	625	179	268	77
3	490,000	5	24,500	23,275	1,225	776	223	247	71	106	30
4	470,000	5	23,500	22,325	1,175	744	214	237	68	101	29
5	890,000	5	44,500	42,275	2,225	1,409	405	448	129	192	55
6	630,000	5	31,500	29,925	1,575	998	286	317	91	136	39
Total	4,150,000	-	272,000	258,400	13,600	8,613	2,473	2,741	787	1,175	337

Source: PPUTMP Project Team

Allowing for these off-street parking spaces computed by block above, the future parking demand balance is estimated to be about 9,700 bays for motorcycles and 4, 200 bays for cars.

Table 9.3-10 Forecasted Motorcycle Parking Demand after Accounting for Redevelopment

Block NO	Off-street parking spaces associated with the development(I)			After development subtraction(J=H-I) (Status space、Public transportation、Redevelopment)		
	2016	2020	2035	2016	2020	2035
1	107	249	782	4,004	3,945	3,315
2	77	179	564	2,492	2,368	1,737
3	30	71	223	1,918	2,024	2,133
4	29	68	214	-494	-526	-681
5	55	129	405	2,349	2,237	1,536
6	39	91	286	1,842	1,835	1,630
Total	337	787	2,473	12,111	11,883	9,669

Source: PPUTMP Project Team

Table9.3-11 Forecasted Passenger Car Parking Demand after Accounting for Redevelopment

Block NO	Off-street parking spaces associated with the development(I)			After development subtraction(J=H-I) (Status space、Public transportation、Redevelopment)		
	2016	2020	2035	2016	2020	2035
1	371	867	2,723	2,316	2,422	1,943
2	268	625	1,963	1,585	1,479	662
3	106	247	776	1,322	1,477	1,646
4	101	237	744	-458	-548	-950
5	192	448	1,409	1,027	996	508
6	136	317	998	782	745	391
Total	1,175	2,741	8,613	6,574	6,571	4,200

Source: PPUTMP Project Team

3) On-Street Parking Space

The sidewalks along the major arterial roads in Phnom Penh are relatively wide at an average width of 5.0 m. Ideally, when illegal parking on such sidewalks is removed to off-street parking, such sidewalk space should be fully utilized to create an environment conducive to pedestrians befitting that of an international class capital city for Cambodia. However, since the city is faced with a difficulty in finding land available for providing off-street parking facilities, and also the fact that sidewalks are generally underutilized (there is little or no walking habit among local residents), a portion of such sidewalk spaces are to be considered for the provision of vehicle parking as shown in the figure below.

For roads with narrow widths, parking is still possible on one side when traffic operation on these roads is converted to one-way.

Applicable scenarios by Year

The different applicable scenarios by year are shown in the table below:

Table 9.3-12 Conditions on the Use of Sidewalk Spaces for On-Street Parking

	2016	2020	2035
On-street parking along major Arterial Roads	On both sides	On both sides	On both sides
One-way traffic operation	Yes (One Side)	Yes (One Side)	Yes (One Side)

Source: PPUTMP Project Team

Proposed One-Way Traffic Operation

By 2035, other additional roads that require the introduction of one-way traffic operation are proposed in section 9.1 (3) and are indicated in the figure below.

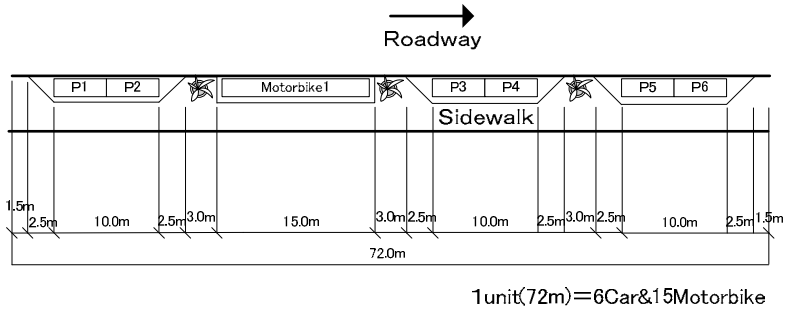
Source: PPUTMP Project Team

Figure9.3-3 Proposed New One-Way Traffic Operation Roads (2016, 2020, 2035)

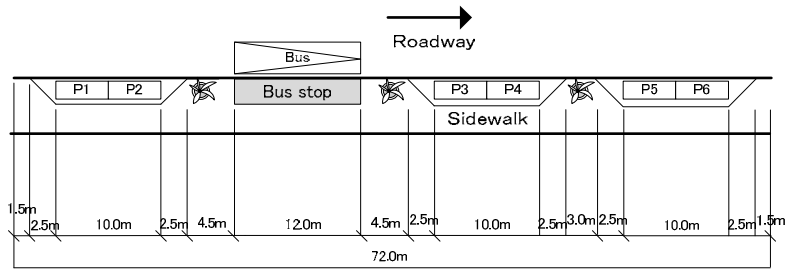
Parking Space Allocation On Arterial Road

Within a 72.0 m long (per unit) of curbside space on the arterial road, 6 car parking bays and 15 motorcycle parking spaces can be accommodated on one side. On the other hand, the unit length on one-way traffic roadway is set at 52.0 m, and within this span, 6 car parking bays and 13 motorcycle bays can be accommodated.

<Basic structure>



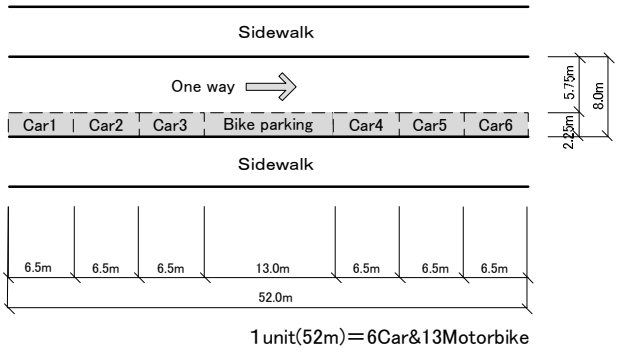
<With bus stop>



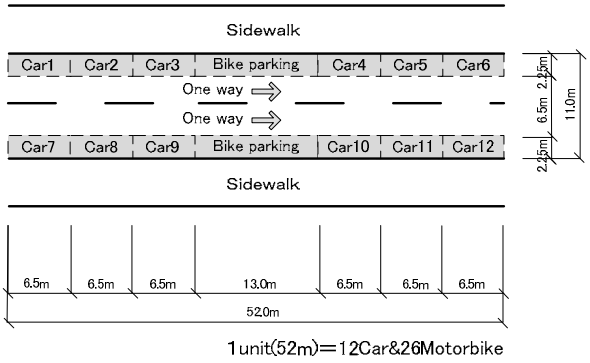
Source: PPUTMP Project Team

Figure 9.3-4 Parking Bay Allocation with Dimensions on the Arterial Road

<One side parking>
(Roadway width >5.5 m but< 11.0 m)



< Parking on both sides >
(Roadway width >11.0 m)



Source: PPUTMP Project Team

Figure9.3-5 Parking Bay Allocation along Narrow Road (With One-Way Traffic Flow)

Table 9.3-13 On-Street Parking Spaces Allowable by Block by Year

<2016, 2020, 2035>

One-way path

	Number of cars	Number of bikes
Block 1	229	497
Block 2	536	1,162
Block 3	0	0
Block 4	0	0
Block 5	0	0
Block 6	0	0
Total	765	1,659

Main line (Both sides)

	Number of cars	Number of bikes
Block 1	484	600
Block 2	206	517
Block 3	233	584
Block 4	236	590
Block 5	897	2,243
Block 6	398	997
Total	2,454	5,531

Total

	Number of cars	Number of bikes
Block 1	713	1,097
Block 2	742	1,679
Block 3	233	584
Block 4	236	590
Block 5	897	2,243
Block 6	398	997
Total	3,219	7,190

Source: PPUTMP Project Team

Parking Demand after Accounting for Future On-Street Parking Provisions

Parking demand for passenger cars is estimated to increase from the present 8,500 bays to 22,000 bays by the year 2035. With introduction of various 'hard' measures in the future as discussed above, only about 5% of the total future demand is not satisfied. However, comparing this to a shortfall of 70% in the existing situation, the future scenario would be significantly improved. On the other hand, 10% of the future motorcycle parking demand will not be met in the future. However, compared to 75% in the existing situation, this has also improved greatly.

Table 9.3-14 Forecasted Motorcycle Parking Demand after Accounting for On-Street Parking Provision

Block NO	Street space(K)			Final excess or deficiency amount after street space subtraction(J-K)		
	2016	2020	2035	2016	2020	2035
1	1,097	1,097	1,097	2,907	2,848	2,218
2	1,679	1,679	1,679	813	689	58
3	584	584	584	1,334	1,440	1,549
4	590	590	590	-1,084	-1,116	-1,271
5	2,243	2,243	2,243	106	-6	-707
6	997	997	997	845	838	633
Total	7,190	7,190	7,190	4,921	4,693	2,479

Source: PPUTMP Project Team

Table 9.3-15 Forecasted Passenger Car Parking Demand after Accounting for On-Street Parking Provision

Block NO	Street space(K)			Final excess or deficiency amount after street space subtraction(J-K)		
	2016	2020	2035	2016	2020	2035
1	713	713	713	1,603	1,709	1,230
2	742	742	742	843	737	-80
3	233	233	233	1,089	1,244	1,413
4	236	236	236	-694	-784	-1,186
5	897	897	897	130	99	-389
6	398	398	398	384	347	-7
Total	3,219	3,219	3,219	3,355	3,352	981

Source: PPUTMP Project Team

Besides the above measures, the following are other possible measures to be considered:

a) Residential District
- Mandatory provision of parking space in residential district (for example, through the use of parking garage certification system)

b) Commercial District
- Provision of goods loading parking facility
- Mandatory provision for buildings above a certain scale (related to preceding section b) on off-street parking)
- Promote the construction of private parking facility (including mini parking) with such incentives as capital investment assistance or tax incentives

(4) 'Soft' Measures

The preceding sections have discussed in detail the impacts of various plausible 'hard' measures, whereby the computations have shown that future increased parking demand can be almost resolved. With this, a good pedestrian walking environment and a better city landscape can be assured. However, this can only be achieved if we assumed that drivers are willing to park their vehicles in these parking facilities especially the off-street parking facilities. For this very reason, it is essential that other soft measures be also implemented to ensure the most efficient use of all the parking facilities while preventing any unlawful parking on non-designated parking spaces.

1) Methods in Ensuring the Efficient Usage of Parking Facility

Use of Flexible Parking Rates

If the parking rates are set too high, they would only encourage illegal parking. Parking rates, therefore, must be set at a reasonable level to induce drivers to park at the parking facilities. Special concession rules such as free parking for short-time parking (less than 30 minutes) can also be used to encourage off-street parking.

Common Usage of Parking Facility

For off-street parking system to function effectively, it must be carefully developed in such a way that the demand for parking in any particular zone is closely matched with the supply. A lopsided supply and demand in any district would create surplus in some areas while shortage in others. A system that encourages the common usage of parking must be considered.

Free Usage of Parking in Public Amenities on Sundays and Public Holidays

Public buildings or amenities having sizeable parking spaces may be opened up for use by the general public on Sundays or during holidays, after having taken measures to ensure security and other requirements.

Parking Information System

When a user found out that the parking facility is 'full' on arrival, he or she would require circling around to look for another parking spot. Such traffic can often cause serious traffic congestion in the city especially on streets adjoining these parking facilities. To reduce such unwanted circulating traffic, a parking guidance or information system can be introduced to help drivers find parking.

2) Prevention of Illegal Parking

Strengthen the Enforcement on Illegal Parking

Illegal parking can adversely affect the safety, comfort of residents and operation of vehicles. It can also badly affect the aesthetics of a city's urban landscape. Therefore, regular and effective enforcement of parking laws and regulations by the authorities is very important so as to encourage the use of parking facilities, and at the same time, discourage haphazard illegal parking on streets and sidewalks.

Increase Penalty on Illegal Parking

Closely related to the above are the relatively low penalties on offenses related to parking and stopping, regarded as Minor penalty No.3 H. under the 'Cambodia Road Transport Law, Clause No.88'. In comparison to costs of goods, these penalties are too low to offer any deterrents to offenders.

-Fine of Riel 5,000 for motorcycle or 3-wheeled car
-Fine of Riel 10,000 for passenger car
-Fine of Riel 20,000 for large vehicle or truck

This involves amending the country's law or ordinance, which would require the cooperation of DPWT, the Police and other related governmental agencies.

9.4 Development of Comfortable Pedestrian Environment

The city center has a legacy from the French colonial era that influenced the formation of recent street scenes. Wide sidewalks of up to 5.0 m are found on one side along major roads. Even on local roads, sidewalks of 2.0 to 3.0 m are commonly found on one side of these roads. However, most of these wide sidewalks have lost their public spaces status. To ensure a comfortable and conducive walking environment in the city, it is now necessary to reclaim these public sidewalk spaces. The following are the development policy in order to achieve a good pedestrian environment in the Master Plan.

9.4.1 Development Policy

(1) Reclaim the continuous public walking space for pedestrians to move about comfortably and safely

In the public experiment, a pedestrian survey was conducted targeting four experimental routes. Results of the pedestrian volume survey indicated that by ensuring the continuity in the sidewalk spaces, pedestrian sidewalks usage has increased from 37.6% to 59.9% (refer to Figure 9.4-4). This result has firmly verified the positive effect of having continuous sidewalks in improving the walking environment in the city.
Given such verification, for many of the areas where pedestrians have difficulty in using the sidewalks, it is necessary to reclaim the continuous sidewalk spaces in order to promote a better walking environment in the city center.

(2) Formation of a pedestrian network in promoting tourism

Presently, many foreign tourists visiting Phnom Penh choose to move about on foot for visiting tourist sites within the city center. However, their movement is often impeded by the lack of a continuous pedestrian network. To promote tourism in the city center, therefore, it is necessary to develop a network of comfortable and continuous sidewalks that link up all the tourist spots so that foreign tourists can move about and visit them safely and comfortably.

9.4.2 Current Problems/Issues

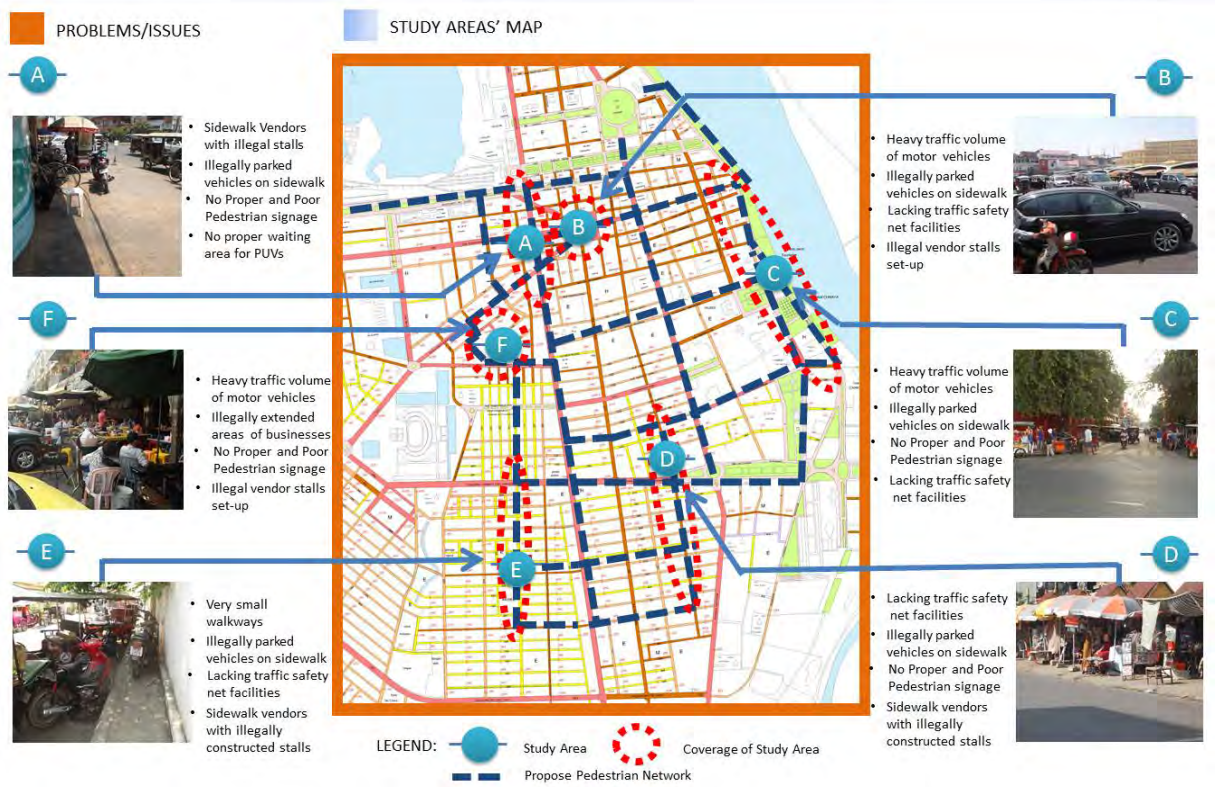
(1) Pedestrian Environment Condition

1) Sidewalk Condition

Based on the survey of the study areas involved, there are six specific problems identified which cause the accessibility and mobility of pedestrians to be slow and dangerous. These are:

- Illegally parked vehicles on sidewalks
- Illegal waiting areas for Motodop and other para-transit vehicles
- Illegally constructed stalls on sidewalks
- No accessible railings and ramps for the handicapped
- No proper pedestrian signage
- Lack of traffic safety nets facilities and regulations

However, these problems are not permanent obstructions that cannot be solved. The present physical condition of the proposed pedestrian network walkways in general is fair with an average width of 5 m, except in the Toul Sleng area where practically all pedestrian walkways are usurped by lot owners. The figure below shows the current condition and problems of the pedestrian network covered.



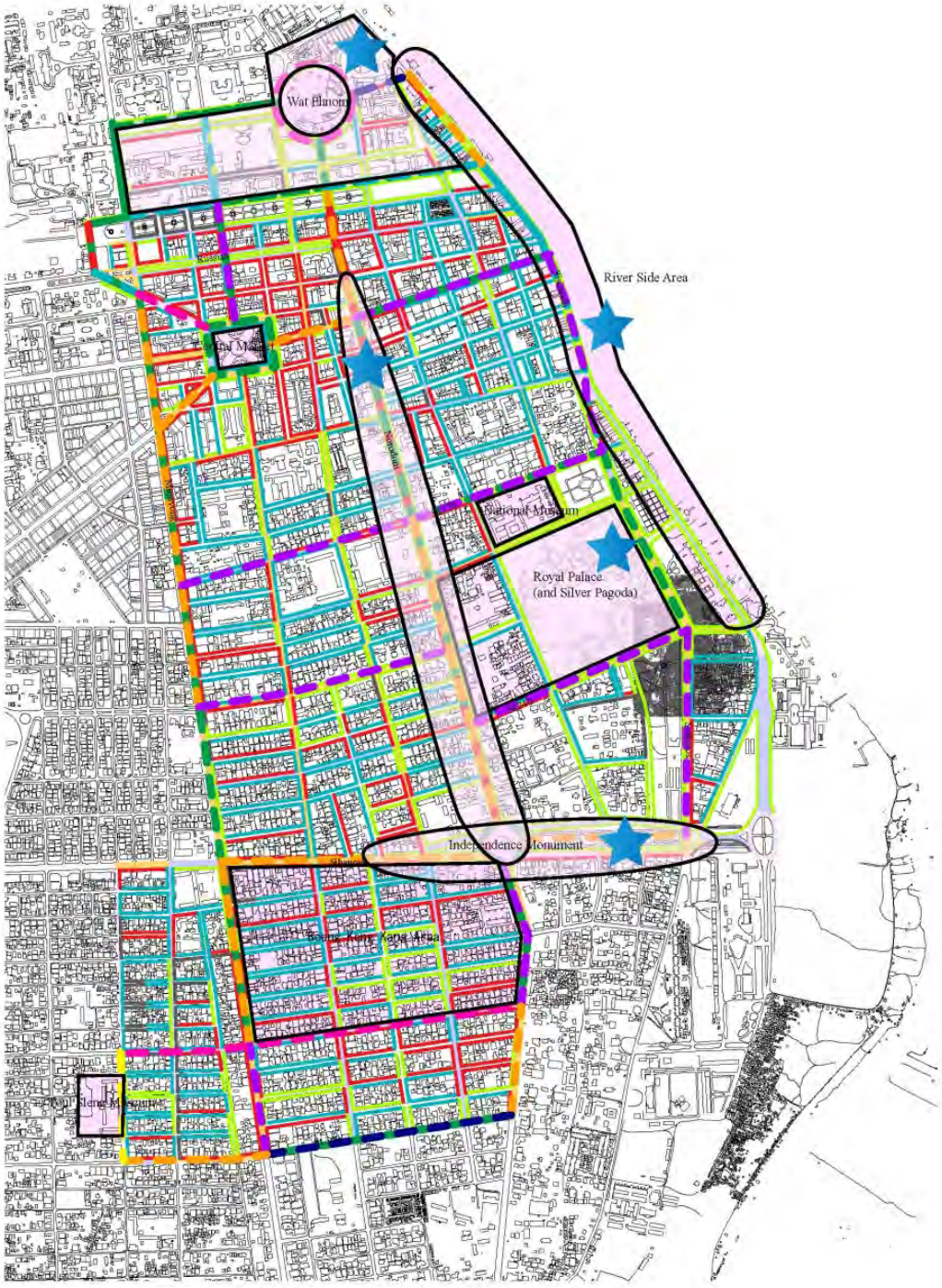
Source: PPUTMP Project Team

Figure 9.4-1 Current Conditions of the Pedestrian Network

Sidewalks around Wat Phnom, the National Museum, the Royal Palace (and Silver Pagoda) and Independence Monument as well as the Riverside District toward Norodom are relatively wide and continuous enabling ease and comfort in walking.

This condition of the sidewalk is conducive to visiting tourist spots in the city center that include Wat Phnom, Central Market, Riverside area, St.178, the National Museum, the Royal Palace (and Silver Pagoda), St. 240, Independence Monument, Boeung Keng Kang area and Toul Sleng Museum.

In addition, the figure below explains the present condition of the pedestrian environment and sidewalk width.

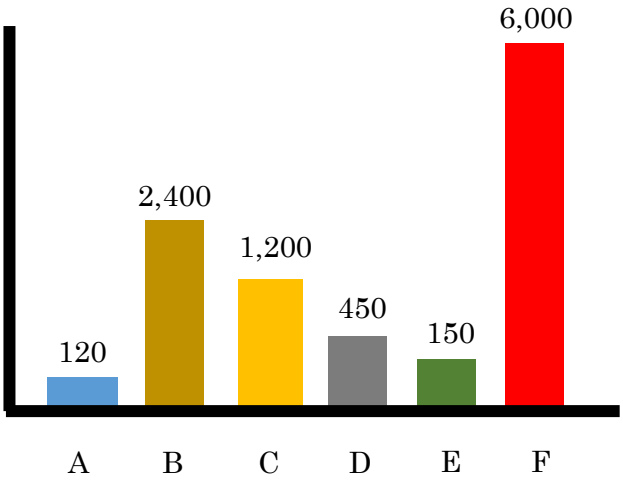


Source: PPUTMP Project Team

Figure 9.4-2 Condition of Pedestrian Environment and Sidewalk Width

2) Pedestrian Traffic

The pedestrian density is a sample taken on different times and days. During the ocular inspection, the results were of mixed variables per study area. It is noticeable that study area 'F' ranked well ahead of the rest, followed by study area 'B'.
This implies that these two leading areas are major pedestrian corridors which are very relevant areas to be studied for pattern of other areas in Phnom Penh that will be advancing for urban development.



Note:
Pedestrian density is in person/hour

Refer to Figure 9.4-1

Study Areas:

A. Kampuchea Krom St. (Kampuchea Krom St. represents Study area A as the median of the group
B. Central Market
C. Riverside Area
D. St. 51
E. St. 103(113) Genocide Museum Area
F. Orussey Market

Source: PPUTMP Project Team

Figure 9.4-3 Increases in Pedestrian Use of Sidewalks (Total for All 4 Routes)

3) Traffic Accidents

Under the existing pedestrian environment, foot travelers are susceptible to injury or death. According to Handicap International, pedestrians for the entire Cambodia are "very vulnerable due to roads lacking sidewalk, traffic sign, traffic light and other safety measures. Pedestrians accounted for 13% of total fatalities in 2011. A high increase (17%) was observed in 2011, compared to 2010. Over the last 5 years, the number of pedestrian fatalities increased by 23%."
Although the figures in the table below show that the total number of pedestrian fatalities for the entire country is less than 0.2% of total population, their impact on economic cost based on the calculation of Handicap International is very alarming.
The data shown in Table 9.4-1 suggests that pedestrians ranked second in terms of number of fatalities. It is very clear that pedestrian safety is very weak in terms of the road users landscape condition in Cambodia, which includes Phnom Penh.

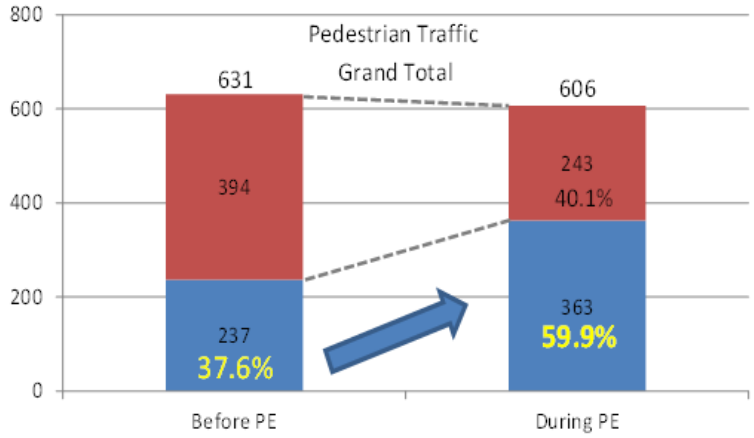
Table 9.4-1 Percentage of Fatalities by Mode of Transport, 2011

Type of road user	2010		2011		Comparison
	#	%	#	%	
Motorbike	1209	67%	1262	66%	4%
Pedestrian	217	12%	254	13%	17%
Bicycle	72	4%	51	3%	-29%
Family car	140	8%	144	8%	3%
Passenger vehicle	28	2%	36	2%	29%
Good vehicle	76	4%	81	4%	7%
Agriculture vehicle	49	3%	51	3%	4%
Other	25	1%	26	1%	4%
Total	1816	100%	1905	100%	5%

Source: Handicap International

(2) Before and After the Public Experiment

As a result of the public experiment, a 30% improvement is seen where before there was difficulty in sidewalk use in the experiment area caused by illegally parked vehicles. Pedestrians interviewed who indicated that they feel safe walking on the sidewalks have increased from 10% before the experiment to more than 50% after the experiment.



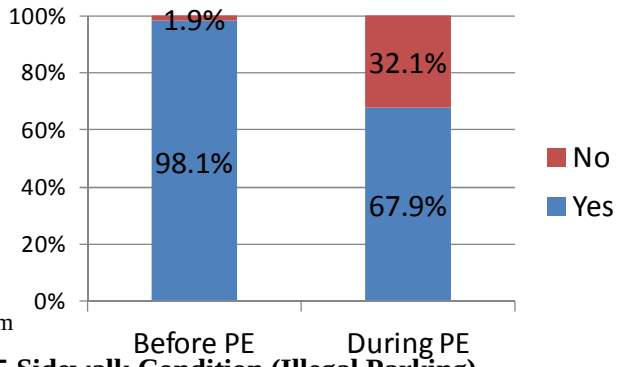
Source: PPUTMP Project Team

Figure 9.4-4 Increases in Pedestrian Use of Sidewalks (Total for All 4 Routes)

Q: How do you feel when you walk on this sidewalk?
a) Difficulty of walking due to illegal parking

Before PE:
Yes 98.1%, No 1.9%

During PE:
Yes 67.9%, No 32.1%



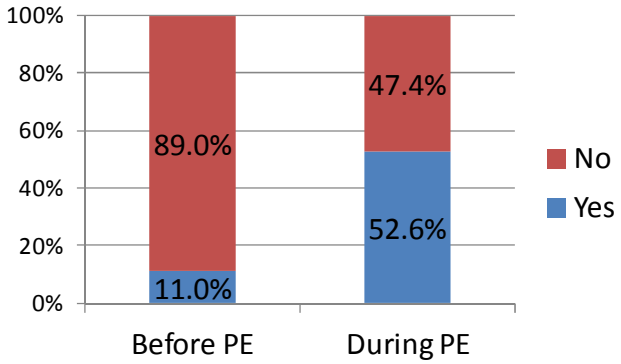
Source: PPUTMP Project Team

Figure 9.4-5 Sidewalk Condition (Illegal Parking)

b) Security of walking safely

Before PE:
Yes 11.0%、 No 89.0%

During PE:
Yes 52.6%、 No 47.4%



Source: PPUTMP Project Team

Figure 9.4-6 Sidewalk Condition (Safety)

9.4.3 How to Materialize the Development Policies

(1) Considering the Functions of Sidewalks

Sidewalks in the city center have various kinds of functions; they not only serve as space for walking but also for resting, especially those found in the tourist area, for transiting purpose along bus/transit routes, for ensuring safety (basically all sections of the sidewalk), for landscaping purpose such as planting trees and for providing benches and parking for wide sidewalks which are usually found in the business/commercial area (see Figure 9.4-8).
Considering the land use, number of pedestrians, potential accident risks and location of tourist spots/urban facilities along the sidewalk, it is important to provide the necessary functions to increase the charm of the sidewalk environment.

(2) Considering Networking

To connect tourist spots or urban facilities without interrupting the route is one of the most important factors for the development of a comfortable and charming pedestrian environment.

(3) Maximize use of the Project for Development of Traffic Management System

Installation of traffic lights at intersections, pedestrian signals and pedestrian crossing markings also improve the continuation of the pedestrian space.

(4) Reflect the Voices of Citizens and Tourists through Public Experiment

According to the public experiment, many citizens and tourists support the use of sidewalks as they are originally intended as a pedestrian space, and not as a parking space.

(5) Proposed Pedestrian Network for Tourists

Tourists in the city have been increasing steadily for the past five years. Based on statistics from the Ministry of Tourism, tourist arrivals by air alone in Phnom Penh average around 650,000/year from 2009 to 2013.

Table 9.4-2 Cambodia Tourist Arrival Statistics, 2013

Tourist Arrival by Travel Mode	Year					% Inc. bet. 2013/2009	CAGR
	2009	2010	2011	2012	2013		
By Air	**1,111,729**	**1,304,300**	**1,480,407**	**1,722,083**	**2,017,658**	**1.81**	**13%**
Phnom Penh Tourist Arrival by Air	527,745	591,628	645,235	716,584	836,377	1.58	10%
Sirem Reap Tourist Arrival by Air	583,984	712,672	835,172	1,005,499	1,181,281	2.02	15%
By Land and Water ways	**934,006**	**1,203,989**	**1,401,455**	**1,862,224**	**2,192,507**	**2.35**	**19%**
By Land	855,697	1,125,974	1,320,311	1,785,726	2,117,454	2.47	20%
By water	78,309	78,015	81,144	76,498	75,053	0.96	-1%
Total Tourist Arrival in Cambodia by all Travel mode	**2,161,577**	**2,508,289**	**2,881,862**	**3,584,307**	**4,210,165**	**1.95**	**14%**

Source: Ministry of Tourism

The above data shows that the number of tourists coming to Cambodia has been increasing by a compound annual growth rate of 14% for the last five years; hence, tourists have multiplied by nearly two-fold in just half a decade. A comparison between Phnom and Siem Reap based on air passenger arrivals for the last 5 years indicates that Phnom Penh lags behind by as much as 55%. Regarding tourist destinations in Cambodia, the data implies that Siem Reap is the tourist capital of the country.
While Phnom Penh boasts being the prime commercial and industrial haven of the whole country, it lacks attraction or charisma to tourists who wanted to enjoy the panorama of the country as a whole. In view of this, one measure in order for the city to be able to increase tourists is by way of developing the necessary facilities such as a comfortable pedestrian environment that will make tourists visit landmarks in the capital with ease and safety.
In line with these figures, PPCC is encouraging tourists to explore the city on foot. As a matter of fact, as of 2012, the city government has planned to create a pedestrian tourist site. By 2013 it has identified the French Colonial Quarter's area to be developed as a Promenade, which is targeted for tourists to enjoy the views and historical sites while walking.
For this similar reason, the Project Team has proposed a loop of connecting road network that is to be developed as a comfortable pedestrian network linking major tourist spots in the city for the convenience of both local and foreign tourists.
Figure 9.4-7 shows a clear view of the Proposed Pedestrian Road Network linking major tourist spots in Phnom Penh.

Source: PPUTMP Project Team

Figure 9.4-7 Tourist Spots Covered by Proposed Pedestrian Network

The proposed pedestrian road network is based on the functions or usage of the walkway. Figure 9.4-8 explains the walkway functions that are present on each study area involved. These functions are a vital component for the consideration of the study area involved.

Source: PPUTMP Project Team

Figure 9.4-8 Functions for Sidewalk by Section

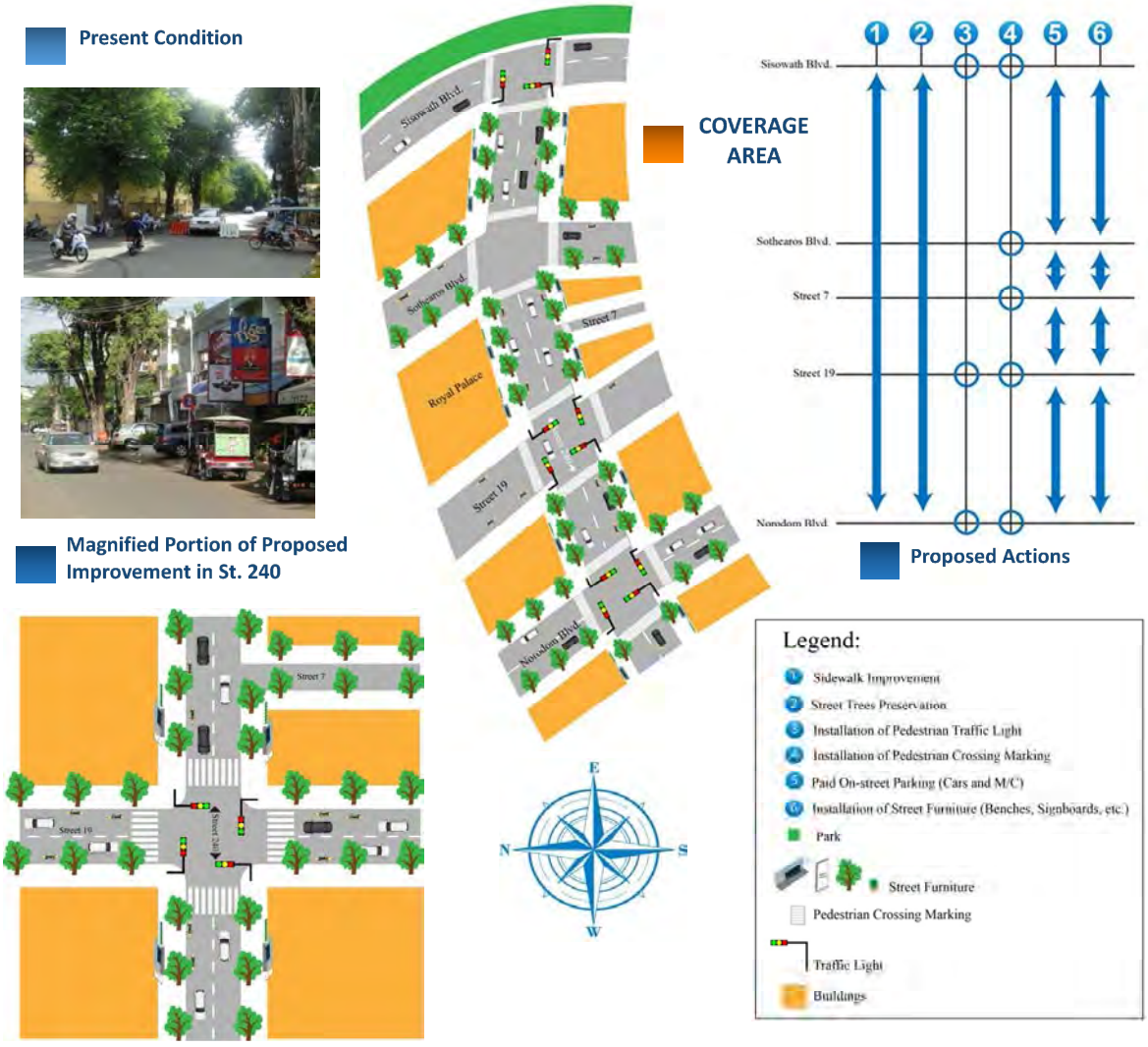
9.4.4 Pilot Sidewalk Section for the Medium-term Plan

The proposed pilot sidewalk section for the medium-term plan for PPCC is St.240 between Norodom and Sisowath based on the following reasons:

a) This section is a popular tourist spots/street/area. There are many nice restaurants and souvenir shops. The sidewalk is relatively wide and trees line the street.
b) There are many tourist spots near this street such as the Royal Palace, Riverside area, Independent Monument and St.240 itself.
c) There is a need to strengthen the east-west pedestrian network to be able to catch up with the north-south network, which has a better pedestrian environment with its many trunk roads with enough sidewalk spaces.
d) New traffic signals are installed at three intersections along St.240, and this improvement secures the pedestrian network continuation and safety, especially at St.240/St.19.

Proposed actions for better pedestrian circumstances and increase of tourists along St.240 are as follows:

a) Organize a St.240 committee, with members from among its citizens and owners of shops along the street;
b) Discuss the merits and demerits of St.240 to tourists, residents and shop owners;
c) Prepare a street problems/issues map including (b) above and develop the countermeasures based on the St.240 Planning Directions, which is developed among committee members;
d) Carry out street improvement based on the above countermeasures together with PPCH and DPWT; and
e) Conduct a seminar for the citizens and disseminate information about their activities throughout the city.



Source: PPUTMP Project Team

Figure 9.4-9 Proposed Pedestrian Circumstance Improvement Plan along St.240

9.5 Driver's Education and Traffic Enforcement

Traffic accidents are often caused by a complex combination of reasons such as poor road environment, inclement weather conditions, abnormal driving behavior or poor vehicle conditions. The topography of PPCC is relatively flat with no steep slopes or sudden curves. None of the city roads has poor alignment that may adversely affect the level of traffic safety. On the other hand, however, the population of Phnom Penh is expected to increase significantly, which will produce many more new drivers in the near future. As the new and less experienced drivers overtake the number of experienced drivers in the city, this indirectly increases the risk of traffic accidents. In many developing countries, new drivers are often issued a driving license without sufficient training on their driving skills and knowledge on traffic safety. Furthermore, traffic accidents in these countries are commonly due to speeding and drunk driving.

With such background, it is thus necessary to implement a combination of measures that include installing traffic safety amenities such as road medians and guardrails; increasing the level of awareness on traffic safety and educating the drivers to completely understand various traffic regulations and rules; and finally, diligently monitoring the implementation of the above measures with proper guidance and support. Enforcement to remove or correct undesirable behavior is equally important whenever actual problematic situations are timely reviewed in order to propose the most suitable countermeasures to overcome them.

9.5.1 Drivers' Education

Traffic safety is basically aimed at ensuring smooth traffic operation, but in developing countries, it also encompasses the important issue of educating drivers on the consequences and importance of safe driving. It is very necessary to implement a comprehensive system of traffic education which includes the mandatory education for the young way before they are eligible to apply for a driving license.

- Beginning with mandatory education on traffic safety for children (school-going age groups), with repeats if necessary to ensure full completion and full coverage.
- Adult education (license holders) focusing on traffic safety during renewal of license. Careful consideration should be given to the score cards records obtained during license application.
- The education should not be limited to imparting knowledge on traffic safety only, but more importantly, it should also focus on the penalties and to emphasize the fact that accidents not only bring about adverse effects to the victim but also to the perpetrator.

9.5.2 Traffic Enforcement

Enforcement is but the other necessary half to driver education in ensuring the observance of traffic regulations by road users. Generally, just with the presence of traffic police, observance of traffic rules and regulations can be expected from the drivers. In PPCC, however, the presence of traffic police patrolling the city streets is generally considered not conspicuous. In other words, as long as the issues of lack of effective law enforcement or the relatively light penalties meted out to offenders are not overcome, the beneficial effects from traffic enforcement in improving traffic safety levels cannot be expected. Furthermore, in relation to traffic enforcement, it is also very necessary to carry out capacity building in nurturing appropriate manpower specializing in traffic enforcement, providing the necessary equipment and facilities, and finally technology transfer on such training and manpower development. In summary, the necessary measures on traffic enforcement are as follows:

- Conduct timely and periodic enforcement exercises,
- Strengthen the system of penalties,
- Nurture traffic police officers,
- Equip police force with latest enforcement equipment, and
- Transfer suitable enforcement technology and know-how.

9.6 TDM including Mobility Management

9.6.1 Basic Concept in TDM

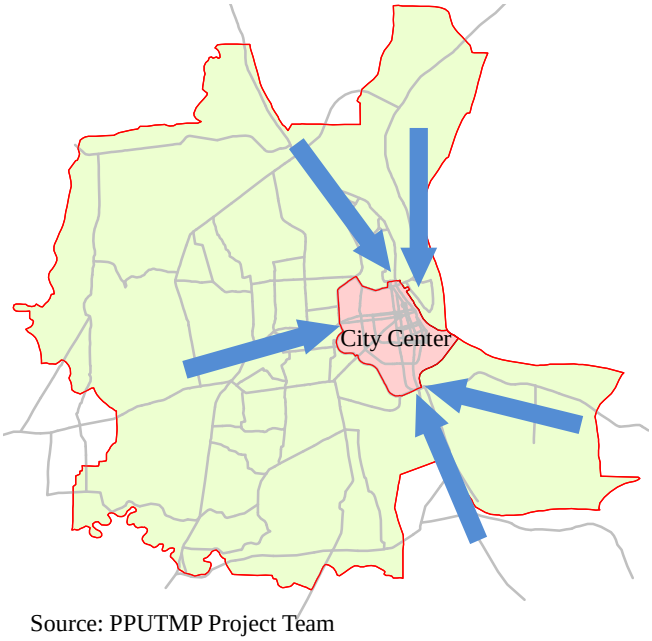
TDM is one of the many traffic countermeasures used to influence and change the travel needs of people with the eventual aims of reducing traffic congestions, improving traffic safety, saving on fuel consumption, and hence reducing vehicle exhaust gases.

Basically, it is an approach that attempts to control the supply side of the transportation economics, by controlling the supply of road and parking spaces in restraining the less efficient private transport modes, while promoting more efficient modes like mass railway transit system in meeting the increases in travel demand brought about by increased economic activities. In this manner, it tries to strike a balance between the increases in demand and supply within the environmental limitations such as urban land and financial constraints.

9.6.2 Target of TDM

The City Center will continue to face an increasing influx of urban population in the future. PPCC's population is projected to increase from 1.85 million in 2012 to about 2.87 million by 2035. Notwithstanding this rapid increase, PPCC is expected to provide lively urban spaces in support of its various social and economic activities.

The challenge is how to meet such increases in motorization while working with a very limited urban land area within this city center for more road network development. With the current transportation system in this city center, the increases in travel demand will generate tremendous pressure on the transport facilities, thus aggravating further the present urban transport problems. The restraint on use of private motor vehicles and motorcycles thus becomes necessary.



Source: PPUTMP Project Team

Figure 9.6-1 Target of TDM (Image)

Hence, the 'target' of traffic demand management for the city center is to restrain the influx of vehicular traffic into the city center.

9.6.3 TDM Measures and Implementing Examples

TDM measures or schemes have gained worldwide acceptance in the latter half of 1990s, whereby various measures were tried and implemented in many cities. In this section, these implemented examples of TDM measures are summarized and categorized into 'Effective Transport Mode Transfer Measures', 'Effective Commodity Transport Measures', 'Commuting Travel based Measures', 'Effective Traffic Flow Improvement Measures', and 'Others', based on their specific applications in response to the respective circumstances.

Table 9.6-1 Implementing Examples of TDM Measures

Category according to Application	Type of TDM Measures	TDM Measures	Contents and Implemented Examples
Effective Transport Mode Transfer Measures	A	Share a ride (car pool, van pool, shuttle bus)	【City Center Circular Bus】Urban area 'one coin' bus and others. 【Commuting shuttle bus】Suburban residential districts to city center, and others. 【Tourist shuttle bus】Bus serving all major tourist spots and others. 【Share rides by regional organizations】 【HOV priority lane】Priority lane for High Occupancy Vehicles (two or more persons in a vehicle).
	B	Park & Ride, Park & Bus Ride, and others	【Park & (Bus) Ride】System that provides parking spaces for private vehicles at rail station or bus stop, in encouraging the transfer of travel modes from private vehicles to public modes for traveling to the city center.
	C	Encourage the use of mass public transport modes	【Bus Exclusive/Priority Lane】Installation of bus exclusive (priority) lanes or corridors. 【Bus priority signal control system】Signal control with priority given to approaching buses on the roads. 【Bus service coupon system】Bus coupons given to shoppers to encourage the use of public transport mode. 【Raining Bus】Additional bus services provided along congested routes during high rainfall days.
	D	Encourage the use of bicycles or walking	【Bicycle parking】provide special bicycle parking facilities. 【Bicycle exclusive lane】provide bicycle lane segregated from vehicle lanes on the roads, 【Bicycle Commuting Club】
	E	Pedestrian/bicycle zones or transit mall	【Transit Mall】Provision of streets or zones with exclusive entries given to public transport modes users or pedestrians while prohibiting entries by other vehicular traffic.
Effective Commodity Transport Measures	F	Common collection and delivery of commodities	【Optimization of Commodities Loading】Time sharing system for commodities loading/unloading and others, 【Commodity distribution center】Terminals or center with facilities for consolidation of commodities from line haul trucks and efficient distribution/delivery by smaller lorries or vans.
Commuting Travel based Measures	G	Staggered commuting time, Flexi time,	【staggered commuting time】Staggering of commuting times so as to alleviate congestion caused by over concentration of commuters, 【staggered commuting time seminar】Seminars for encouraging such practice and disseminating knowledge and benefits on the importance of staggered commuting time.
	H	Others（working days adjustment, work from remote locations, work from home, etc.）	【working days adjustment】Compress work schedule structure to reduce commuting travel, 【work from remote locations】Reduce commuting travels by working from home or other remote location.
Effective Traffic Flow Improvement Measures	I	Disseminating road traffic and parking information	【Dissemination of road traffic information/ parking guidance system】
	J	Optimization of on-street parking	【Unloading parking bays】Installation of off-street common parking bays for loading and unloading of goods, 【curbside parking control】Provision and designating suitable on-street parking facilities and strict enforcement by police to ensure smooth traffic flow.
Others	K	Traffic control, entry prohibition	【traffic control zone】Designating zones for restricting the use or entry of motor vehicles, etc., 【travel restriction】Travel restriction by registration number plates or days of week, etc.
	L	Road licensing system	【area licensing】Restricting the entry of general traffic into a designated zone except those with mandatory purchase of entry passes, 【toll】Collection of toll on motor vehicles entering the city center from suburban districts.
	M	Mobility management	Effective application of a multiple of traffic measures to encourage the initiatives from individuals or organizations in changing their mobility patterns.

Source : PPUTMP Project Team - adapted from "Seiji MORISHITA, 'Implementing Situations of TDM in Japan and Other Countries', Special Edition on Traffic demand management (TDM), Japan Automobile Industry Association.

9.6.4 Applicable TDM Measures for Phnom Penh

TDM measures should not be implemented individually but rather as a collection of measures or package, in order to achieve the desired benefits and maintain the sustainability of such measures. Therefore, TDM measures in this project are to function as a package in relation to the soft and hard measures or plans in each of these related sectors. The following table presents the relation between the soft TDM measure types and the related hard sector plans or measures.

Table 9.6-2 Relation of the General TDM Measures or Types with Each Sector

Sector	Hard measures (Construction of facilities)	Soft measures (TDM)		
			Type of TDM	TDM measure
Road System	○			
Public Transport System	○	●	B&C	Park & Ride, Park & Bus ride, etc.
Traffic Management				
Intersection improvement	○			
Traffic Signal System upgrading	○	●	C&I	Provision of road traffic information
Parking measures	○	●	J	Optimization of on-street parking
Development of comfortable pedestrian environment	○	●	D&E	Encouragement of walking and bicycle use, Installation of transit mall
Driver's education		●	M	Mobility Management
Commodity Transport	○	●	F&J	Joint collection and delivery, Optimization of on-street parking.

Source：PPUTMP Project Team

TDM measures recommended for application in Phnom Penh include those measures classified as 'Effective Travel Modes Transfer' and other measures involving the introduction of public transport modes to wit:

- Measures in promoting the transfer from passenger cars and motorcycles to public transport modes,
- Measures in upgrading the convenience and connectivity of public transport systems and the promotion of their usage.

Table 9.6-3 Applicable TDM Measures for Phnom Penh

Sector	Applicable TDM measures taken from the Implementing Examples	Outlines of proposed measures
Public Transport System	Park & (Bus) Ride	Install parking facilities at bus stops at the outskirts of the City Center for mode transfer. This is to promote and enable the direct transfer from passenger cars and motorcycles to the more efficient public transport modes of travel.
Traffic Management		
Traffic Signal System upgrading	Bus Lane	On the arterials roads in the city center district where road width is sufficient to provide for 3 lanes in each direction, one of these lanes can be designated as bus exclusive or priority lane, either for specific time periods or for the entire day. Such a measure is to upgrade the punctuality and reliability of the bus transport system.
	Bus priority signal control system	By giving signal priority for buses to pass through the signalized intersections along the major arterials in the city center area, it is possible to maintain the travel speeds of buses and hence improve the punctuality of the bus service. This is to promote the usage of bus transport and at the same time improve the overall efficiency on the function of the intersections.
	Disseminating road traffic information	Provide information such as road congestion or bus operation situations at bus stops or over the internet to the public. This measure can improve on the convenience of travelers to the city center as well as promote the use of bus transport.
Parking measures	On-street parking control	Strict enforcement of on-street parking along the bus routes on the major arterials roads in the city center by the use of road surface markings and warning signs. This measure can also indirectly support the improvement on the reliability and punctuality of the public transport and hence encourage its usage.
Development of comfortable pedestrian environment	Installation of Transit Mall	Allow for the co-existence of public transport and pedestrian walking space within the central commercial district in the city center. As a supplementary measure, upgrade the bus stops and ensure the continuity of pedestrian network. Such measures would improve the convenience of public transport and hence encourage its usage.
Driver's education	Mobility management	TDM requires the pre-requisite that road users have a high level of understanding on the traffic rules and regulations, good etiquette and self-restraint, good thinking before taking mobility actions. Therefore, the upgrading of traffic education in Phnom Penh is very necessary.
Commodity Transport Improvement	Installation of Commodity Loading and Parking Bays	Strict enforcement on curbside commodity loading / parking along bus routes on the major arterials in the city center by the use of effective road surface markings or warning signs. This is to support the punctuality and reliability of public transport and hence encourage its usage.

Source：PPUTMP Project Team

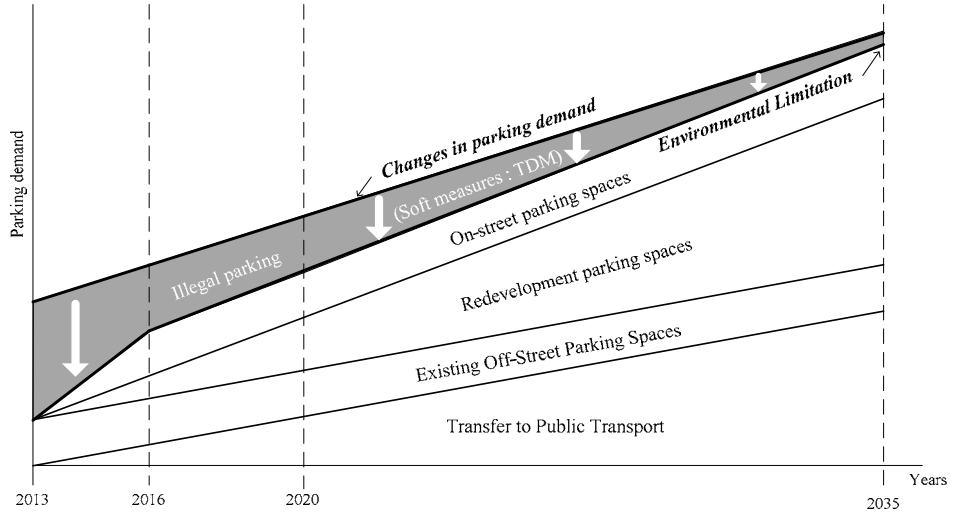
9.6.5 TDM as A Parking Countermeasure

This section describes the basic concept of TDM using the example of the parking countermeasure.
In the figure below, the horizontal axis displays the year against the vertical axis which displays the parking demand. At the year 2013, only the existing off-street parking facilities are provided which resulted in a huge volume of illegal parking on the roads.

As time progresses, in spite of more travelers having transferred to public transport modes, more development of off-street parking spaces in conjunction with urban redevelopment, increase in on-street parking provision due to implementation of one-way traffic measure and better utilization of arterial road space, illegal parking will still happen.

As a policy to resolve such illegal parking problem in the future, the authorities should not try to supply an equal amount of parking spaces to meet the future demand. Instead, the authorities should apply a series of soft TDM measures that compliments each other in bringing down the increase in parking demand. The supply side of parking spaces should only provide spaces that the city's urban land limitation allows while preserving a good urban living environment and without jeopardizing the urban landscape as well as the intended functions of the roads. It must also include the setting of a suitable parking rate in consideration to the public transport fare charges, common or sharing of parking facilities, free usage of parking in public buildings and introducing parking guidance information system. Other measures that will complement the above are strengthening the enforcement on illegal parking, increasing the utilization efficiency of existing parking spaces, imposing stiffer penalties on illegal parking and introducing driver safety education.

By introducing all these measures, a comprehensive mobility management mentality can be slowly nurtured among the urban residents focusing on achieving mobility that takes into consideration the creation of a health-conducive living environment with collective as well as individual communication abilities. Such a mentality shall enable the gradual shift from over dependence on private and personal transport modes like passenger cars and motorcycles to a more balanced but multi-mode transportation system that includes a more predominant share of public transport and walking among the residents. The ultimate goal is to achieve a society that possesses good initiatives both on the individual level as well as on the collective or organizational level in changing how they satisfy their travel needs in and around the city. At the same time, it is essential to impart the basic education for the young generation to heighten their awareness on the importance and necessity of some kind of mobility management that does not destroy the urban living environment while sustaining a healthy lifestyle for all citizens.



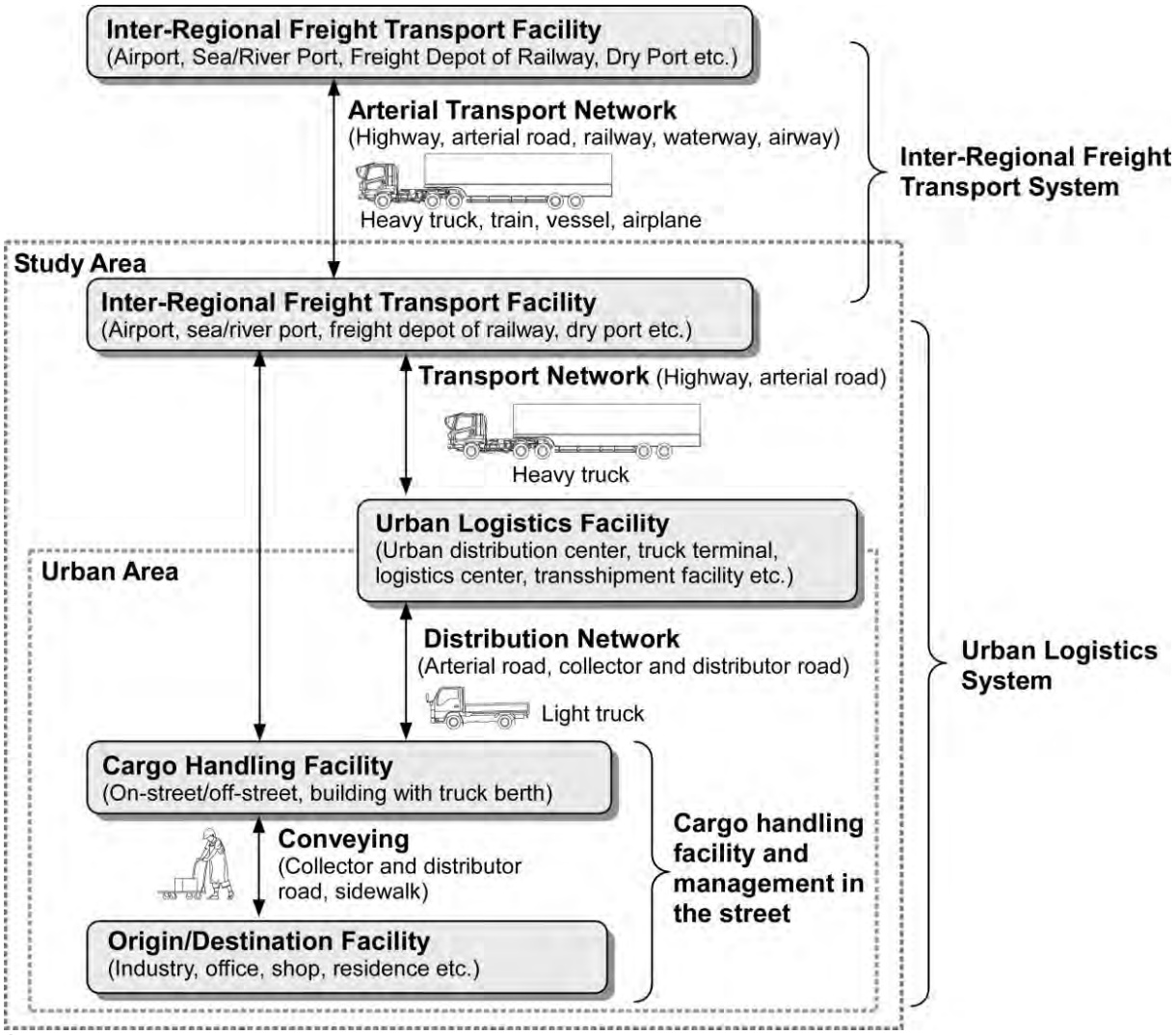
Source：PPUTMP Project Team

Figure 9.6-2 Image of TDM Adoption for Parking Policies and Measures

10 COMMODITY FLOW

10.1 Planning Strategy

The master plan for freight transport in the Project area should be considered on three levels, namely, 1) an inter-regional freight transport system consisting of large-scale cargo facilities and a transport network connecting those facilities, 2) an urban logistics system such as distribution centers or truck terminals that are established in order to reduce the number of trucks visiting an urban area by improvement of loading efficiency of trucks and 3) a cargo handling facility and management of on-street/off-street parking at final destination.



Source: PPUTMP Project Team

Figure 10.1-1 Typical Urban Freight Transport Systems

10.1.1 Inter-Regional Freight Transport System

An inter-regional freight transport system consists of large-scale cargo facilities such as a port, an airport, cargo terminals of railway stations, a Special Economic Zone (SEZ) and industrial area, and a

transport network connecting those facilities. Aside from the long distance, the other characteristics of inter-regional freight transport are as follows:

- Theoretically, large-scale cargo facilities such as a port, a dry port and industries should be located outside urbanized areas to avoid poor living environment in the urban area.
- Large-scale cargo facilities should be located at important traffic positions such as the junction of highways or arterial roads.
- The inter-regional freight transport route considered as the industrial road should be separated from the community road as much as possible.
- The inter-regional freight transport route should be constructed or improved by appropriate design standards in accordance with heavy truck traffic.
- To maintain a comfortable living environment in the urban area, through-traffic of heavy trucks should be restricted by adequate area or hour in accordance with development and expansion of urbanized areas.

10.1.2 Urban Logistics System

Urban logistics systems such as a logistics center or distribution center is established for a) the reduction of lead-time, namely, time from order of goods to delivery of goods by placing deposit of goods near destination of delivery, and b) reduction of freight transport cost by improvement of efficiency of truck transport such as consolidation of goods. This is further explained below.

- Small-scale warehouses and wholesale distributors in the city center should be integrated into urban logistics centers on the edge of urban areas in order to reduce truck trip generation in the city center and inharmonious facilities with existing and future land use.
- Urban logistics centers should be located far enough so as to avoid mixed traffic with daily traffic such as commuter traffic but close enough to destination of deliveries.
- Urban logistics centers should be located complying with relevant laws and regulations such as landuse control.
- Considerable truck traffic is generated at urban logistics centers; therefore it should be located along highways or arterial roads with sufficient road width and number of lanes.
- Urban logistics centers are expected to provide service of secured cargo deposit and shipment of required volume of cargo at required time. Therefore, these centers should have a proper area for deposit of cargo, assorting of cargo, truck berth and loading space, etc.

10.1.3 Cargo Handling Facility and Management in the Street

Cargo is eventually picked up or delivered by truck at residence/shop/office along the street in the urbanized area.

- On-street or off-street parking space for loading/unloading trucks near to destination should be provided in the city center to avoid blocking other through-traffic and pedestrian.
- Parking management such as time-sharing with other vehicles also should be considered in case of difficulty of finding proper parking space for loading/unloading.

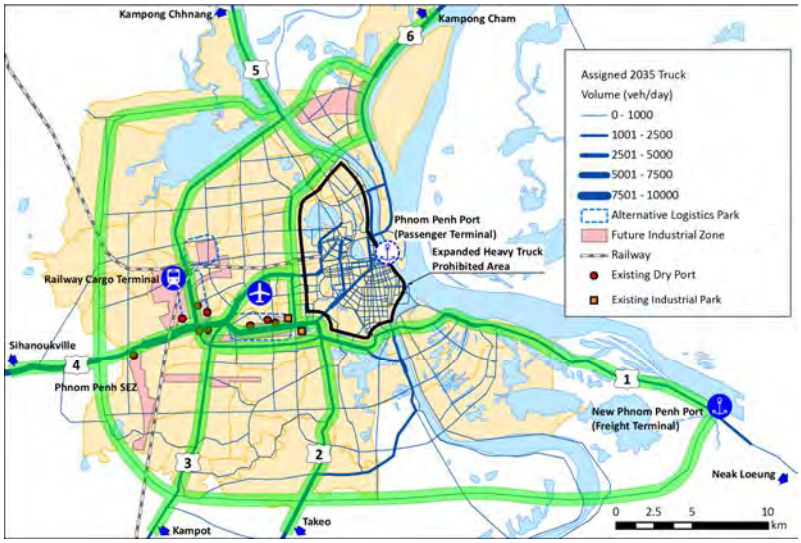
10.2 Sector Plan of Freight Transport

10.2.1 Inter-Regional Freight Transport System

- Inter-regional freight transport facilities in the future are the new Phnom Penh Port along NR1, existing Phnom Penh International Airport, the railway freight depot at the junction of the northern and southern lines, and existing and future industrial areas such as PPSEZ and the industrial area along Chaom Chau Road and RR-II.
- The existing Phnom Penh Port will be used for cargo in the future by the Phnom Penh Autonomous Port (PPAP). However, from the point of view of urban transport planning of Phnom Penh, a cargo port in the city center is not desirable because it generates considerable truck trips. Thus, all function and equipment relevant to cargo handling at port should be integrated with the new Phnom Penh Port along NR1 in the future. When this is done, the site of the existing Phnom Penh Port should be developed as a tourist attraction with a promenade, shopping street and water restaurant coordinated with the existing passenger wharf.
- Inter-regional freight transport routes connecting above inter-regional freight facilities are existing NR1 to NR6 and Chaom Chau Road, RR-II and RR-III. Those roads should be constructed or improved with appropriate standard. Ideally, an inter-regional freight transport route should be more than 4 lanes or with frontage road.
- To avoid mixed traffic conditions with heavy cargo traffic and daily traffic, land use along inter-regional freight transport routes should be strictly controlled.
- In accordance with expansion of urban development in the future, heavy truck prohibited area should be expanded. Expansion of prohibited area should be considered such as the area bounded by Hanoi Road and NR1 during 5:00 - 21:00 on weekdays.
- To maintain an adequate level of service for roads, an organization should be created or an existing one enhanced to carry out surveys and monitoring of road conditions and repairs.

Source: PPUTMP Project Team

Figure 10.2-1 Example of Promenade (Nong Khai, Thailand)



Source: PPUTMP Project Team

Figure 10.2-2 Phnom Penh Urban Freight Transport System

10.2.2 Urban Logistics System

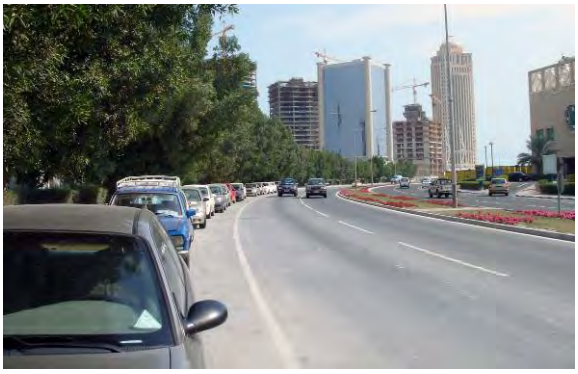
An urban logistics center is a facility which receives and deposits large lot cargo carried by heavy trucks such as a trailer truck, and ship required cargo by small lot by small trucks on demand. It should be located along arterial roads in the neighborhood of urban area. Thus, two types of urban logistics centers are considered, namely:

- Development in an existing or future industrial area outside the urban area; and
- Development of urban logistics center in accordance with redevelopment of several old local markets in the city center.

10.2.3 Freight Transport System in Urban Center

The following are ways to prepare parking spaces for loading/unloading trucks in the city center:

- For a street with sufficient road shoulder, reservation of parking space with road surface marking and placement of traffic cone is effective.




Source: PPUTMP Project Team

Figure 10.2-3 Example of Secured On-Street Parking and Reserved Space

- For a street with insufficient shoulder width for parking, a) parking space reserved on the sidewalk is proposed. To specify parking space on the sidewalk, marking of parking lot is effective. In the case of parking on the sidewalk, securing sufficient space for pedestrians is important; b) establishment of truck bay or parking bay prepared by reducing of sidewalk is another method to reserve parking space. Securing sufficient space for pedestrians is important also.


Source: PPUTMP Project Team

Figure 10.2-4 Example of Parking Lot on Sidewalk and Parking Bay

- For a street with insufficient shoulder and sidewalk, soft measures should be considered such as a) strict enforcement of regulation against illegal truck parking except loading/unloading trucks during off-peak hour, b) parking time sharing between trucks and other vehicles, c) establishment of loading/unloading space for trucks through cooperation such as from existing off-street parking or petrol stations.
- Concerning off-street parking, a) to make parking provision in large-scale facilities compulsory, and b) prohibit use of existing off-street parking space for other purpose.

11 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

11.1 Existing Environmental Condition

11.1.1 Natural Environmental Condition

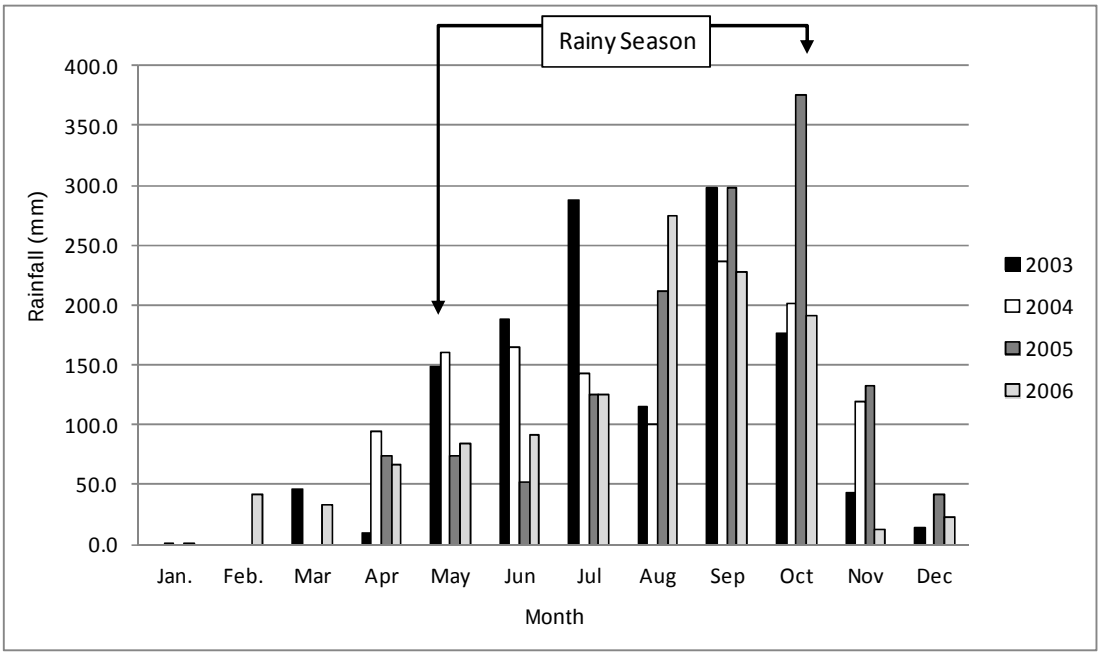
(1) Geographic Features

Cambodia is located in the middle of the Indochina Peninsula and its area is approximately 181,035 km^2. The country shares a common border with Thailand, Vietnam and Lao People's Democratic Republic. The Mekong River, which flows through Cambodia from north to south, provides natural resources and contributes to the people's livelihood. Besides, Tonle Sap, which is the largest freshwater lake in Southeast Asia, is located almost in the middle of Cambodia and flows as Tonle Sap River into the Mekong River at Phnom Penh.

Phnom Penh locates at a corner of the triangle formed by the Mekong Delta and faces a meeting point of two large-sized rivers as explained above. The land is fertile and relatively flat of which altitude ranges from two to four meters above sea level in general.

(2) Climate

Phnom Penh enjoys a tropical monsoonal climate and has two major seasons: rainy season from May to October, and dry season from November to April. Monthly average rainfall of Phnom Penh ranges from 0 to 300 mm in general. The average rainfall from 2003 to 2006 is indicated in the following figure and table.



Source: Statistical Year Book of Cambodia 2008

Figure 11.1-1 Monthly Average Rainfall in Phnom Penh from 2003 to 2006

Table 11.1-1 Monthly Average Rainfall in Phnom Penh from 2003 to 2006 (unit: mm)

	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2003	0.0	0.0	46.6	10.1	148.1	188.0	288.0	115.1	298.5	175.8	42.8	13.4	1,326.4
2004	0.4	0.0	0.0	94.8	160.6	164.2	142.7	101.1	237.2	202.1	118.8	0.0	1,221.9
2005	-	-	-	73.7	73.5	52.3	125.2	212.1	298.4	375.1	132.7	42.6	1,385.6
2006	0.1	42.1	32.8	66.4	84.0	92.0	124.8	274.2	228.2	190.9	12.4	23.0	1,170.9

Source: Statistical Yearbook of Cambodia 2008

In the rainy season, the temperature tends to go down around 22 degrees Celsius because of the wind from the Gulf of Thailand, while in the dry season the highest temperature reaches 40 degrees Celsius. The average temperature is around 29 degrees Celsius and humidity is high in Phnom Penh.

Table 11.1-2 Average Temperature in Phnom Penh, 2003 to 2006 (Celsius)

	2003	2004	2005	2006	Average of 4 years
Highest Temp	35.6	35.5	33.8	33.5	34.6
Lowest Temp	22.2	21.8	24.5	24.8	23.3

Source: Statistical Year Book of Cambodia 2008

Under such natural condition including the geography and climate, Phnom Penh sometimes experience flooding in rainy season due to rivers nearby.

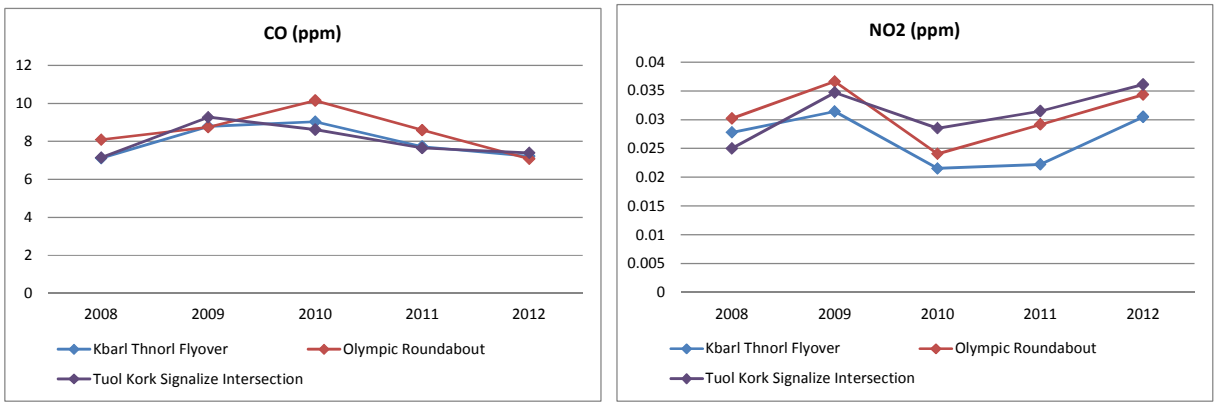
(3) Air Quality, Noise and Vibration

Air quality, noise and vibration are regulated by the sub-decree No.42 declared in 2000. This sub-decree indicates actual standards and allowable limits related to air quality and noise including ambient air quality and vehicle gas emissions. According to the sub-decree, air quality monitoring has been carried out regularly at three points in Phnom Penh, namely, Kbarl Thnol Flyover near Monivong Bridge, Olympic Stadium Roundabout and Tuol Kok Intersection by MOE since 2000. In this monitoring, data of major air pollutants such as carbon monoxide (CO), sulphur dioxide (SO2) and nitrogen dioxide (NO2) have been collected every month. The results from 2008 to 2012 are shown in the following table figure. According to the data, CO and NO2 were generally below the standard and large increase could not be identified. SO2 was not detected.

Table 11.1-3 Air Quality Monitoring in Phnom Penh

Monitoring Point	2008	2009	2010	2011	2012
CO (ppm)					
Kbarl Thnol Flyover	7.12	8.78	9.03	7.72	7.22
Olympic Stadium Roundabout	8.09	8.75	10.15	8.59	7.08
Tuol Kok Intersection	7.15	9.27	8.62	7.65	7.39
NO2 (ppm)					
Kbarl Thnol Flyover	0.028	0.031	0.022	0.022	0.030
Olympic Stadium Roundabout	0.030	0.037	0.024	0.029	0.034
Tuol Kok Intersection	0.025	0.035	0.029	0.031	0.036

Note: 24-hr survey
Source: Ministry of Environment, Cambodia



Note: Data shows 1 hour average based upon monthly 24-hr sampling
Source: Ministry of Environment, Cambodia

Figure 11.1-2 Monitoring Data of CO and NO2 at 3 Stations from 2008 to 2012

Air quality, noise and vibration are assumed to become worse due to the increase in the number of vehicles in Phnom Penh even though the monitoring results at three locations did not show a large growth as shown above. According to the data on vehicle registration, the number of light and heavy vehicles and motorbikes has been soaring upward in these years. In a decade from 2001, the annual growth rate of light vehicles was 13.9% and that of motorcycle was 11.2%. Thus exhaust gas is increasing in proportion to the number of vehicles. The standard of vehicle emission is enacted; however, the system has room for improvement. For instance, the vehicle inspection system is applied only for new vehicles, not for in-use vehicles.

On the other hand, the increasing concentration of factories also contributes to deterioration of air quality since the economy of Phnom Penh is driven by textile and related industries. Air pollutants being discharged from the factories and freight shipping by trucks are anticipated to increase in the future.

The Department of Environment, Phnom Penh Capital City (DOEPP) does not compile data on air quality and noise in Phnom Penh due to lack of responsible organization and necessary equipment for monitoring. In order to take appropriate countermeasures against the deterioration of air quality and noise, accumulated data and monitoring are vital for conducting a current situation analysis and for forecasting future emission levels.

(4) Biological Feature

Cambodia has a broad diversity of fauna and flora, and many protected conservation areas have been designated by the Ministry of Environment (MOE) into the following: “National Park”, “Wildlife Sanctuary”, “Protected Landscape” and “Multiple Use Management Area”.

There are not any natural and historical conservation areas protected by MOE in Phnom Penh. However in order to conserve diversification of ecosystem, four wetlands are designated close to the Project area, namely, Prasat Tuyo Lake, Boeung Veal Samnap, Coeung Prang and Chhok Veal Rench. Besides, Phnom Penh has many historical, religious and cultural buildings such as Wat Phnom, the Royal Palace, Silver Pagoda and buildings constructed in the French colonial era. These constructions not only serve as landmarks but also as tourist attractions in Phnom Penh.

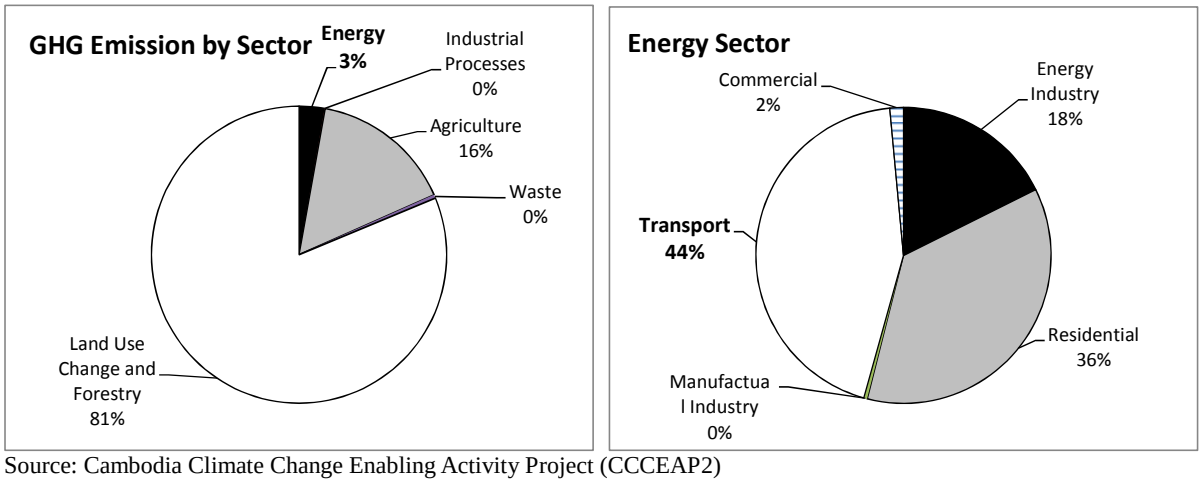
Table 11.1-4 Wetlands in Phnom Penh

Wetlands	Type of Wetland	Location	Elevation AV(m) (max)	Area (ha)			Wetland types	Soil types
				Water surface	Marshes	Total		
Prasat Tuyo Lake	Fresh Water	About 57 km East of Phnom Penh	7	7,000	65,000	72,000	Lakes, flooded forest, marshes, rice fields and lotus ponds	Brown alluvial
Boeung Veal Samnap	Fresh Water	About 10 km NE Phnom Penh	9	2,800	8,050	10,850	Lakes, flooded forest and marshes	Clay and alluvial
Boeung Prang	Fresh Water	11 km NE of Phnom Penh	6	1,700	10,900	12,600	Lakes, flooded forest, rice fields and marshes	Clay and alluvial
Chhok Veal Rench	Blackish Water	170 km SW of Phnom Penh	3	na	na	14,500	Mangrove, marshes, rear mangrove and rear fields	Peat, mud and sand

Source: Statistical Yearbook of Cambodia 2008

(5) Climate Change

Climate change has become a universal issue in recent years, and Cambodia is also considered one of the most affected countries owing to extreme-weather events caused by global warming. In order to cope with climate change, the Cambodian Climate Change Office was established in MOE in 2003, which was the predecessor of the Department of Climate Change (DCC). Since then, estimation of the greenhouse gas emission in Cambodia has been conducted every five years based on statistical data by DCC. According to the data, as of 1994, greenhouse gas (GHG) emission from activities related to fuel combustion, namely the energy sector, in entire Cambodia was equivalent to 1.88 billion tons of carbon dioxide (CO2). Of this amount, the GHG emission from transport sub-sector accounted for 44%. According to future projections, in 2020, the transport sub-sector is expected to account for as much as 62% of total GHG emissions.



Source: Cambodia Climate Change Enabling Activity Project (CCCEAP2)

Figure 11.1-3 Projection of GHG Emissions by Sector in Cambodia, 1994

GHG emission data for Phnom Penh is not available since the estimation is only for the entire country, not for each province. In Phnom Penh, same as the situation of air quality, the increase of vehicles in

recent years is assumed to greatly contribute to climate change. However, again here is not monitoring data for GHG emission including CO2. Moreover, the standard of GHG emission applied for the vehicle inspection is not yet prepared in Cambodia. Taking into account the increasing travel demand of the urban population, appropriate countermeasures are necessary such as monitoring of CO2 emissions, development of legal system and introducing public transportation.

11.1.2 Social Environmental Condition

(1) Population

The population in Phnom Penh reached approximately 13.4 million in 2008, which comprised almost one-tenth of the national population. Compared to the data in 1998 and 2008, annual population growth rates in Phnom Penh reached 2.9% in a decade. This indicates a rather higher rate than the national average, which was 1.6%, in the same period. Urbanization contributes to such population growth in Phnom Penh.

Table 11.1-5 Population in Phnom Penh from 1981 to 2008

	Area (km2)	1981	1994	1998	2004	2008
Cambodia	181,035	6,682	9,752	11,436	12,824	13,389
Phnom Penh	290	329	812	1,000	1,044	1,326
(%)	(0.2%)	(4.9%)	(8.3%)	(8.7%)	(8.1%)	(9.9%)

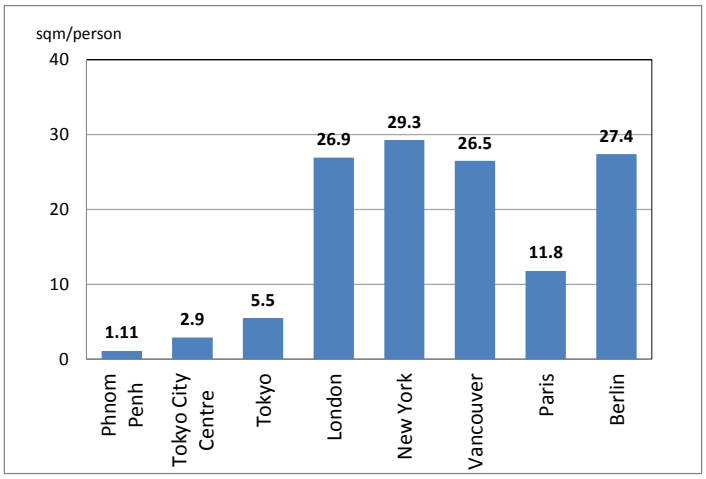
Source: General Population Census 2008

(2) Land Use

The center of Phnom Penh Capital City (PPCC) is covered by built-up areas such as commercial and public buildings and residences. Industrial facilities such as factories, container depot and industrial zones are likely to concentrate south of the International Airport, mainly along Veng Sreng Road. Industrial development has been actively growing toward the west along NR4. Meanwhile, residential development tends to be stretching out to the north and south of Phnom Penh.

Looking at the green space in the urban area of Phnom Penh, there are only limited public parks and green areas because Boeung Kak Lake no longer exists to make way for urban development and Tra Bek Lakes are used for a lagoon system of wastewater treatment. Urbanization triggered by urban population growth and economic development is likely to decrease open spaces that may be utilized as parks. Based on a simplified map prepared, the total area of urban green spaces in the central area of Phnom Penh including Tra Bek Lakes is around 2.1 km^2. Accordingly, the green area per capita in the central area is around 1.1 m^2. This is remarkably small compared to other major cities. Moreover, recently 20 m^2/person[1] is considered as appropriate urban green space per capita.

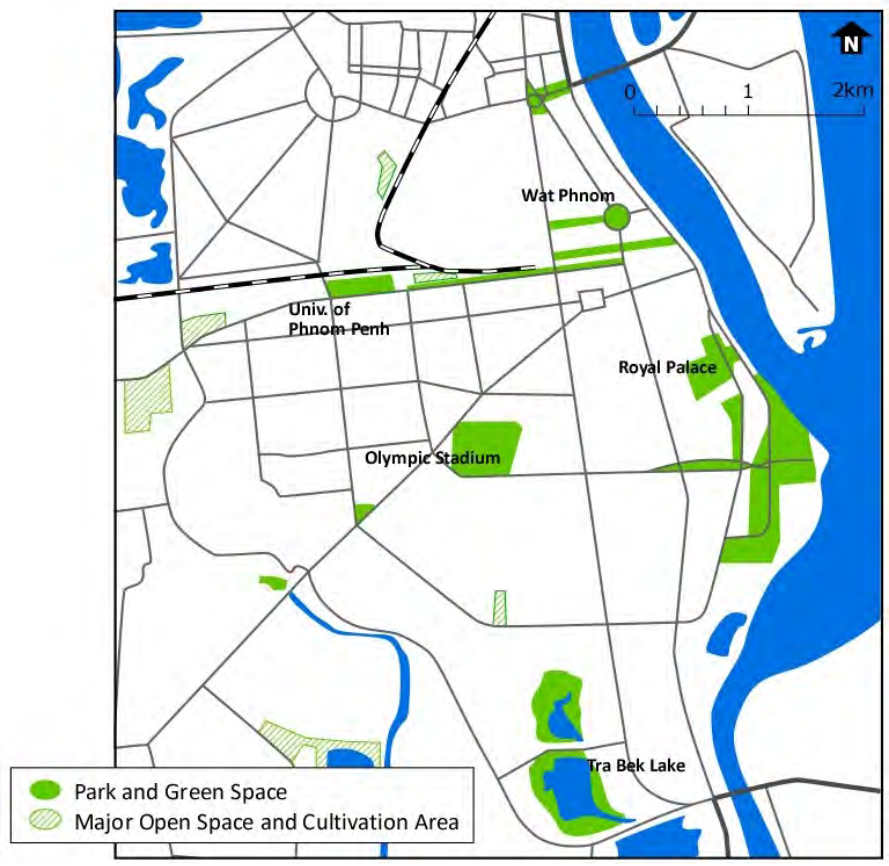
[1] Wang, X.-J. 2009. Analysis of problems in urban green space system planning in China. Journal of Forestry Research.



Source: PPUTMP Project Team based on the data from MLIT, Japan

Figure 11.1-4 Size of Urban Green per Capita

Meanwhile, in the suburban area, plenty of green spaces including agricultural land still remained. However, urban sprawl is recognized in the suburbs due to rapid urbanization. To avoid decreasing such green areas by the sprawl, a practical land use plan and appropriate land development control are necessary.



Source: PPUTMP Project Team

Figure 11.1-5 Existing Green Spaces and Public Parks in Central Area of Phnom Penh

(3) Water Supply

Water supply and treatment are handled by the Phnom Penh Water Supply Authority (PPWSA). This public cooperation had four water facilities and the total design volume is 430,000 liters/day (2012 data). The service coverage ratio in former Phnom Penh municipality area was 90% in 2010. With an additional 20 districts, according to PPWSA, the coverage ratio might be lower than that. PPWSA aims to achieve 100% coverage ratio by 2020.

Some areas are not supplied with water due to lack of road access, since installation of water pipes is carried out basically under the road. Road development, therefore, contributes not only to provide mobility but also to improve the service of urban infrastructure including water supply. Furthermore, road construction including development of tunnels and flyovers is likely to interact closely with water pipes installed under roads. Therefore, mutual cooperation between DPWT and PPWSA is important for carrying out urban development efficiently.

(4) Solid Waste Management

Solid waste management is under the purview of the Department of Public Works and Transport (DPWT), Phnom Penh Municipality. In practice, collection of solid waste has been contracted out to a private company, the Canadian and Cambodian Joint-Venture (CINTRI), except in some specific area[2]. In Phnom Penh, there are two disposal facilities: one is an open dumping site called Stung Mean Chey Disposal Site and the other is a landfill site called Dorng Kor Landfill Site.

In some areas such as inside the city center, garbage is collected, while in many other residential areas, there is no garbage collection service and this has caused tons of wastes to be dumped on roadsides and footways, and even in rivers and ponds. As a result of inappropriate dumping, foul smell is generated, sewage pipes are clogged and flooding occurs in the end. Besides, the environment in surrounding areas of open dumping sites is anticipated to deteriorate due to the odor and fires at waste site, and contamination of ground water and soil by leachate.

(5) Water Sewage

Wastewater in Phnom Penh basically is collected by sewage pipes and open channels into Tra Bek Lake in order to be treated by the lagoon system then discharges into Bassac River. So far, there are no wastewater treatment plants for public use in Phnom Penh.

Furthermore, flood triggered by heavy rains is also another serious urban problem related to sewage. This issue also influences road traffic and contributes to traffic jams. Shortages of pipe capacity and clogging of pipes by street litter are considered as main reasons. For coping with this, implementation of “The Project for Flood Protection and Drainage improvement in PPCC” is currently ongoing. After completion of the project, flood mitigation is expected.

Some odors and mosquitos are generated in the area near such open channels and Tra Bek Lake due to running wastewater. The lagoon system has both advantages and disadvantages. The system is reported to have a risk of water pollution problems in case natural waterbody in used. Further, the system is not very effective at removing heavy metals from wastewater. Taking into account the increase in wastewater due to population growth and the industrial development in the area, the preservation of biodiversity near Tra Bek Lake and the installation of a wastewater treatment plant need to be considered in the future.

[2] A Neighborhood Improvement Program (NIP) is carried out by Phnom Penh Waste Management (PPWM) under DPWT.

11.2 Environmental Regulations

11.2.1 Environmental Regulations and EIA Procedures in Cambodia

On December 24, 1996, the Cambodian government enacted the "Law on Environmental Protection and Natural Resources Management (LEPNRM)" aimed at protecting and promoting natural and social environments. LEPNRM consists of four sub-decrees as follows:

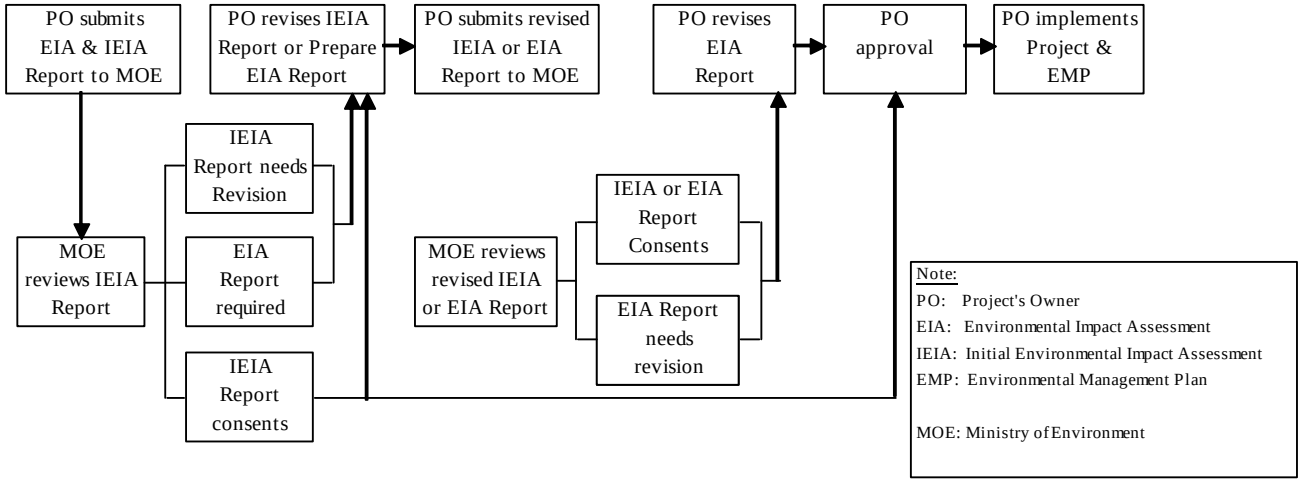
- Sub-Decree No.27 on Water Pollution Control
- Sub-Decree No. 36 on Solid Waste Management
- Sub-Decree No. 42 on the Control of Air Pollution and Noise Disturbance
- Sub- Decree No.72 ANRK.BK on Environmental Impact Assessment (EIA)Process

Pursuan to article 6 of LEPNRM, all of the development projects and activities proposed by any owner either individual, private, joint-venture or public, in the form of government ministry or agency shall carry out essential environmental screening such as initial environmental assessment (IEIA) or EIA. These assessments will be reviewed by MOE. The projects will not be approved by the Royal Government without approval of MOE in principal. The process of environment assessments is defined in the sub-decree of EIA.

11.2.2 IEIA and EIA

As explained above, all of the development projects are to be implemented with the environmental approval by MOE. The process of environmental screening basically takes two steps: IEIA and full-scale EIA.

All of the project owners (PO) shall conduct IEIA which shall be included in the pre-feasibility study report to be submitted to MOE. MOE reviews the submitted IEIA and appraises the necessity of two things: one is revising the IEIA report and the other is conducting a full-scale EIA. In case that the IEIA report is insufficient, PO will be required to revise and submit it again to MOE. After finalization of IEIA, PO is able to obtain the environmental approval. In case that PO is required to conduct a full-scale EIA, PO will take further steps. Basically, the need of conducting a full-scale EIA will depend upon the size and depth of negative impacts on natural and social environments caused by the project implementation. In case that the project expects to cause large impacts, it is supposed that PO will be asked to carry out the study for full-scale EIA and submit the report to MOE. MOE coordinates with relevant ministries in assisting the appraisal committee, and then the committee will evaluate the submitted EIA. After the evaluation, PO is able to obtain the approval and to start construction. If the EIA is insufficient, MOE and the committee will require PO to revise the EIA report. The general flow of the process is illustrated in the following figure.



Source: Sub-decree on Environmental Impact Assessment Process, No.72 Council of Minister, August 11, 1999

Figure 11.2-1 General Flow of IEIA and EIA

The EIA sub-decree states the list of projects which are likely to need IEIA or/and EIA (see Table 11.2-1).

Table 11.2-1 List of Projects Likely to Need IEIA or/and EIA

No.	Project type / activity	Size / Capacity
A. Industrial		
I. Foods, Drinks, Tobacco		
1	Food processing and canned	³ 500 tons/year
2	All fruit drinks manufacturing	³ 1,500 liters / day
3	Fruit manufacturing	³ 500 tons/year
4	Orange Juice manufacturing	All sizes
5	Wine manufacturing	All sizes
6	Alcohol and Beer brewery	All sizes
7	Water supply	³ 10,000 Users
8	Tobacco manufacturing	³ 10,000 Boxes/day
9	Tobacco leave processing	³ 350 tons/ year
10	Sugar refinery	³ 3,000 tons / year
11	Rice mill and cereal grains	³ 3,000 tons / year
12	Fish, soy bean, chili, tomato sources	³ 500,000 liters/ year
II. Leather tanning, Garment and Textile		
1	Textile and dyeing factory	All sizes
2	Garments, washing, printing, dyeing	All sizes
3	Leather tanning, and glue	All sizes
4	Sponge- rubber factory	All sizes
III. Wooden production		
1	Plywood	³ 100,000 m^3/year(log)
2	Artificial wood	³ 1,000 m^3/year (log)
3	Saw mill	³ 50,000 m^3/year (log)
IV. Paper		
1	Paper factory	All sizes
2	Pulp and paper processing	All sizes
V. Plastic, Rubber and Chemical		
1	Plastic factory	All sizes
2	Tire factory	³ 500 tons /year
3	Rubber factory	³ 1,000 tons /year
4	Battery industry	All sizes

No.	Project type / activity	Size / Capacity
5	Chemical production industries	All sizes
6	Chemical fertilizer plants	³ 10,000 tons /year
7	Pesticide industry	All sizes
8	Paint manufacturing	All sizes
9	Fuel chemical	All sizes
10	Liquid, powder, solid soaps manufacturing	All sizes
VI. Mining production other than metal		
1	Cement industry	All sizes
2	Oil refinery	All sizes
3	Gas factory	All sizes
4	Construction of oil and gas pipeline	³ 2 kilometers
5	Oil and gas separation and storage facilities	³ 1,000,000 liters
6	Fuel stations	³ 20,000 liters
7	Mining	All sizes
8	Glass and bottle factory	All sizes
9	Bricks, roofing tile manufacturing	150,000 pieces /month
10	Flooring tile manufacturing	90,000 pieces/month
11	Calcium carbide plants	All sizes
12	Producing of construction materials (Cement)	900 tons/month
13	Cow oil and motor oil manufacturing	All sizes
14	Petroleum study research	All sizes
VII. Metal industries		
1	Mechanical industries	All sizes
2	Mechanical storage factory	All sizes
3	Mechanical and shipyard enterprise	All sizes
VIII. Metal Processing Industries		
1	Manufacturing of barbed wires and steel net	³ 300 tons/month
2	Steel mill, Iron, Aluminium	All sizes
3	All kind of smelting	All sizes
IX. Other Industries		
1	Waste processing, burning	All sizes
2	Wastewater treatment plants	All sizes
3	Power plants	³ 5 MW
4	Hydropower	³ 1 MW
5	Cotton manufacturing	³ 15 tons/month
6	Animal Food processing	³ 10,000 tons/year
B. Agriculture		
1	Concession forest	³ 10,000 hectares
2	Logging	³ 500 hectares
3	Land covered by forest	³ 500 hectares
4	Agriculture and agro-industrial land	³ 10,000 hectares
5	Flooded and coastal forests	All sizes
6	Irrigation systems	³ 5,000 hectares
7	Drainage systems	³ 5,000 hectares
8	Fishing ports	All sizes
C. Tourism		
1	Tourism areas	³ 50 hectares
2	Golf course	³ 18 holes
D. Infrastructure		
1	Urbanization development	All sizes
2	Industrial zones	All sizes
3	Construction of bridge-roads	³ 30 tons weight
4	Buildings	Height ³ 12 m or floor ³ 8,000 m^2
5	Restaurants	³ 500 Seats

No.	Project type / activity	Size / Capacity
6	Hotels	³ 60 Rooms
7	Hotel adjacent to coastal area	³ 40 Rooms
8	National road construction	³ 100 Kilometers
9	**Railway construction**	**All sizes**
10	Port construction	All sizes
11	Airport construction	All sizes
12	Dredging	³ 50,000 m^3
13	Dumping site	³ 200,000 people

Source: Sub-decree on environmental impact assessment process, MOE

11.3 Sector Plan of Environmental and Social Considerations

From environmental and social consideration viewpoints, existing issues need to be addressed in order to implement the goal of this master plan, i.e., "to develop a human and environmentally friendly public transport system in PPCC to maintain its vitality as the capital city and to support the 2035 urban structure from a transport perspective". Besides, through a series of stakeholder meetings, the expected future urban environment in the Project area was discussed and envisioned as follows:

- Rich and comfortable urban environment by the parks and street trees along sidewalks is provided in the city center.
- In the suburban area, the agricultural land is appropriately managed and cultivated even though its total area has decreased a little. This supports a part of the city's economic production and maintains the urban environment.
- A variety of ecosystems is brought up based on the agricultural land, remaining ponds/lakes and natural greenery.

Keeping these visions in mind, necessary actions for the environment are considered. But first, current environmental issues are summarized as follows:

- Limited urban park in urban area
- Decreasing green areas in the suburban area and on the outskirts of the city
- Increase of CO2 emission due to increasing number of vehicles
- Deterioration of air quality and noise due to increasing number of vehicles
- Anticipating delay in improvement of basic infrastructure including water supply in the suburban area and on the outskirts of the city
- Inappropriate dumping
- Environmental deterioration in surrounding area of open dumping sites
- Limitation of waste water treatment by lagoon system and environmental deterioration near Tra Bek Lake

In order to achieve the three visions, practical measures are proposed in this section.

General:
- To prevent deterioration of air quality and noise
- To mitigate CO2 emissions

City center:
- To secure urban parks and greens
- To improve environment of public transport facilities including sidewalks

Suburban are and outskirts:

- To preserve agricultural land by well-planned suburban developments
- To protect green area including lakes and wetlands for keeping the diversify of the ecosystem

11.3.1 To Prevent Deterioration of Air Quality and Noise

Considering the increasing number of vehicles in the future, it is expected that further deterioration of air quality and noise levels will occur particularly in high-density and congested areas. In addition to introduction of public transport, TDM and a vehicle inspection system, as described in above sections, the measures described below are also important to control noise and emission levels.

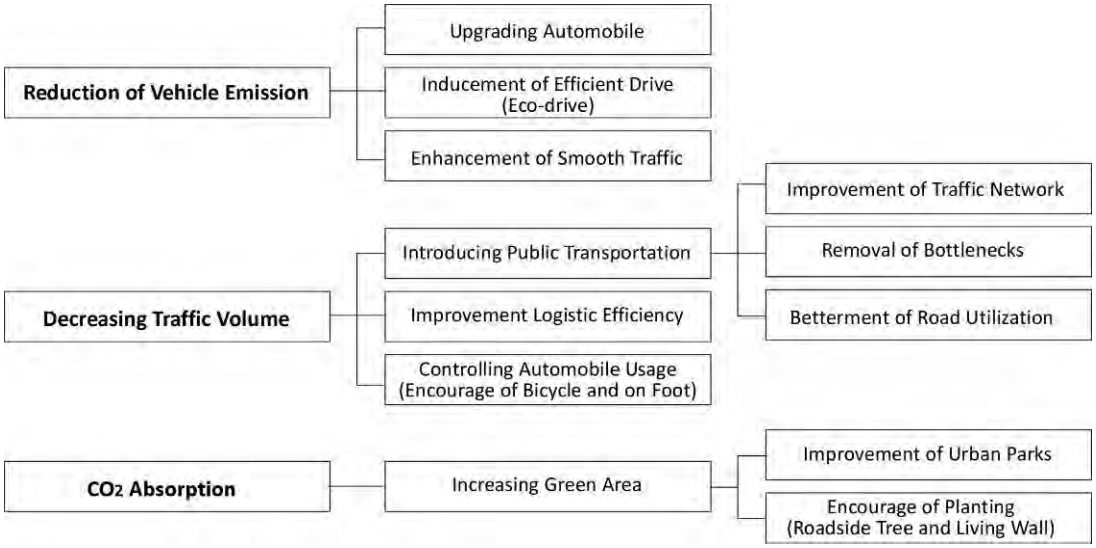
Monitoring of air quality and its data can contribute to understand the existing condition compared to the standards and to be reliable information for traffic control. In addition to the monitoring by MOE at three locations in Phnom Penh, more monitoring points are necessary in order to comprehend air quality appropriately. Consequently, roadside air pollution monitoring stations as shown in the following photos are proposed to be set up where there are likely to be effects of air pollution and record and accumulate data. Installation of such necessary equipment and establishment of a new office that will take charge of monitoring under DOEPP need to be considered.

Source: Ooi Chuo Rikkyo Shita Roadside Air Pollution Monitoring Station, Shinagawa City Local Government

Figure 11.3-1 Roadside Air Pollution Monitoring Station in Japan

11.3.2 To Mitigate CO2 Emissions

In order to mitigate CO2 emissions from vehicle operation, the measures can be categorized into three: 1) reduction of vehicle emission, 2) decreasing traffic volume, and 3) measures for CO2 absorption. The categories are illustrated in the following figure.



Source: PPUTMP Project Team

Figure 11.3-2 Major Mitigation Measures of CO2 Emission

(1) Vehicle Emission Reduction

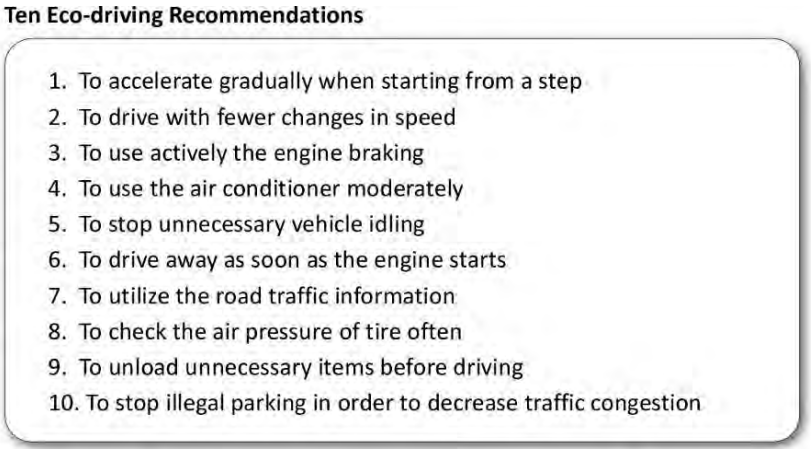
The measures for vehicle emission reduction include mainly three things; a) upgrading automobiles, b) inducing eco-drive and c) enhancing traffic flow.

1) Upgrading Automobiles in Phnom Penh

Automobile manufacturing usually reflects new technologies year by year in terms of low emission and fuel efficiency such as hybrid cars and electric vehicles. To enhance such low-emission vehicles would be an efficient way to reduce CO2 emission. Particularly, incentives to utilize such low-emission vehicles for companies that use many vehicles in their businesses, say, more than 30 cars and trucks, would be effective for CO2 reduction. Furthermore, introducing preferential taxation to purchase low-emission vehicles might also work for increasing the number of such kind of vehicles. On the other hand, the importation of used cars with high-emission engines should be banned or controlled by imposing more taxes.

2) Inducing eco-drive

Dissemination of eco-driving and idling stop practices through brochures, posters and website is important for not only reduction of CO2 vehicle emission but also enhancement of consciousness about global warming and climate change.



Source: Environmental of Tokyo, Tokyo Metropolitan Government in Japan

Figure 11.3-3 Eco-Driving Recommendations

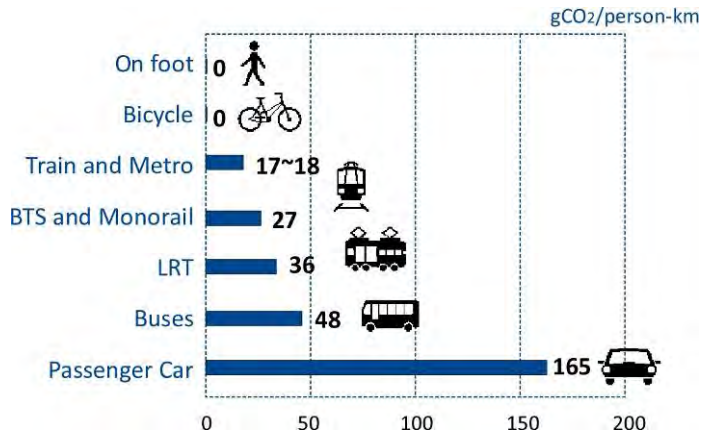
3) Enhancing traffic flow

Smooth traffic means less traffic congestions by improvement of traffic network, removal of bottlenecks, and betterment of road usage. These measures are described in previous chapters.

(2) Decreasing Traffic Volume

The measures for decreasing traffic volume are mostly described in Chapter 7 to Chapter 10 such as introducing public transport and improving logistics efficiency. In this section, attempts are made to explain how to control automobile usage. Controlling automobile usage does not mean to deny people's desire to use their vehicles for any activity. The experience of using non-automobile transport such as public transport, bicycles and by foot is enhanced by providing facilities such as public transport stations that are user-friendly and sidewalks that are clear of parked cars and merchandise so that pedestrians can use them safely.

Additionally advocating citizen awareness is also efficient by dissemination of brochures and posters, and preparation of web-site. The following figure is used for brochure and web-site in order to enhance people's awareness by using CO2 emission by each transport.



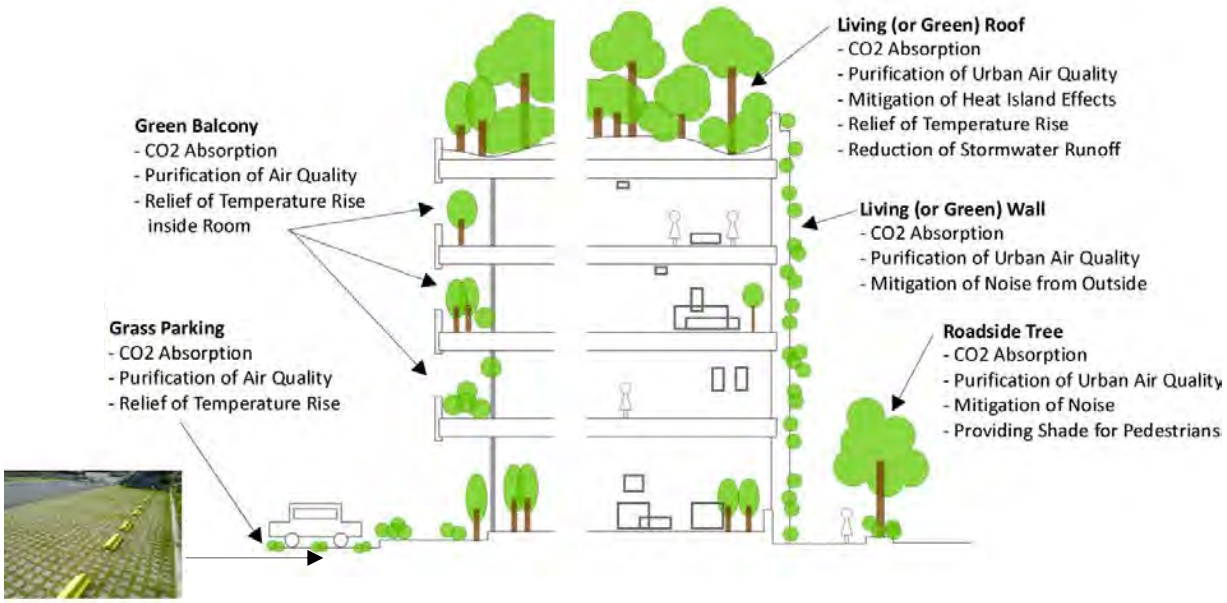
Source: MLIT, Japan modified by PPUTMP Project Team

Figure 11.3-4 Illustration of CO2 Emission by Transport Mode Used to Raise Citizens' Awareness

(3) CO2 Absorption

It is widely known that plants can absorb CO2 and release oxygen by photosynthesis. Planting in the city, i.e., urban afforestation, is expected to contribute to reduction of CO2 emissions especially in high-density areas. In addition to improving urban parks, planting trees and grass on the wall and roof of buildings and car parking, specifically, a living wall (or green wall), a living roof (or green roof) and grass parking, are also useful to having some green in limited spaces. Urban afforestation is not only for CO2 reduction; it has also the following benefits:

- Mitigation of heat island affect
- Protection of buildings from sunlight
- Decrease of radiation heat
- Contribute to air purification
- Reduction of noise



Source: PPUTMP Project Team

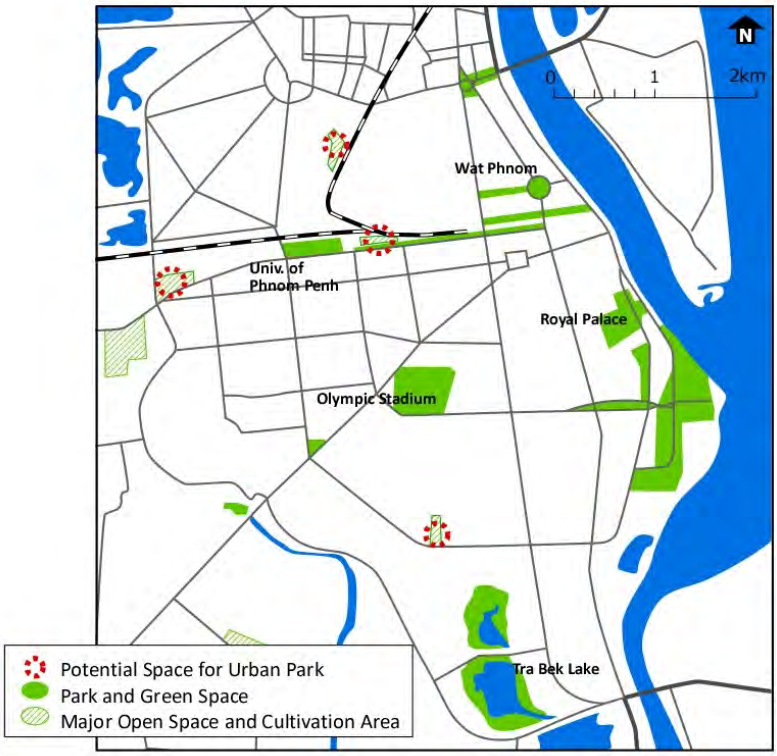
Figure 11.3-5 Ideas for Urban Afforestation

11.3.3 To Secure Urban Parks and Greens

In the central area of Phnom Penh, the urban parks and green area tend to decrease in accordance with the progress of urban development. Urban parks can contribute to not only provide recreation spaces but also be used as evacuation places in case of disasters. As mentioned earlier, it also helps to mitigate heat island effect, to absorb CO2, to promote biodiversity and to reduce storm-water runoff. Therefore, urban parks need to be distributed appropriately depending upon the population and density.

In terms of size of urban parks, 20 m^2/person is recently respected as the standard in major cities[3]. Taking into account the existing condition in the central area of Phnom Penh, efforts for increasing parks and green spaces are necessary. From existing land use viewpoint, limited spaces are vacant. Such open spaces seem to have a potential to be urban parks. Further urban development and redevelopment are strongly recommended to include formulation of parks and green areas.

[3] Wang, X.-J. 2009. Analysis of problems in urban green space system planning in China. Journal of Forestry Research.



Source: PPUTMP Project Team

Figure 11.3-6 Potential Space for Urban Parks in Central Area of Phnom Penh

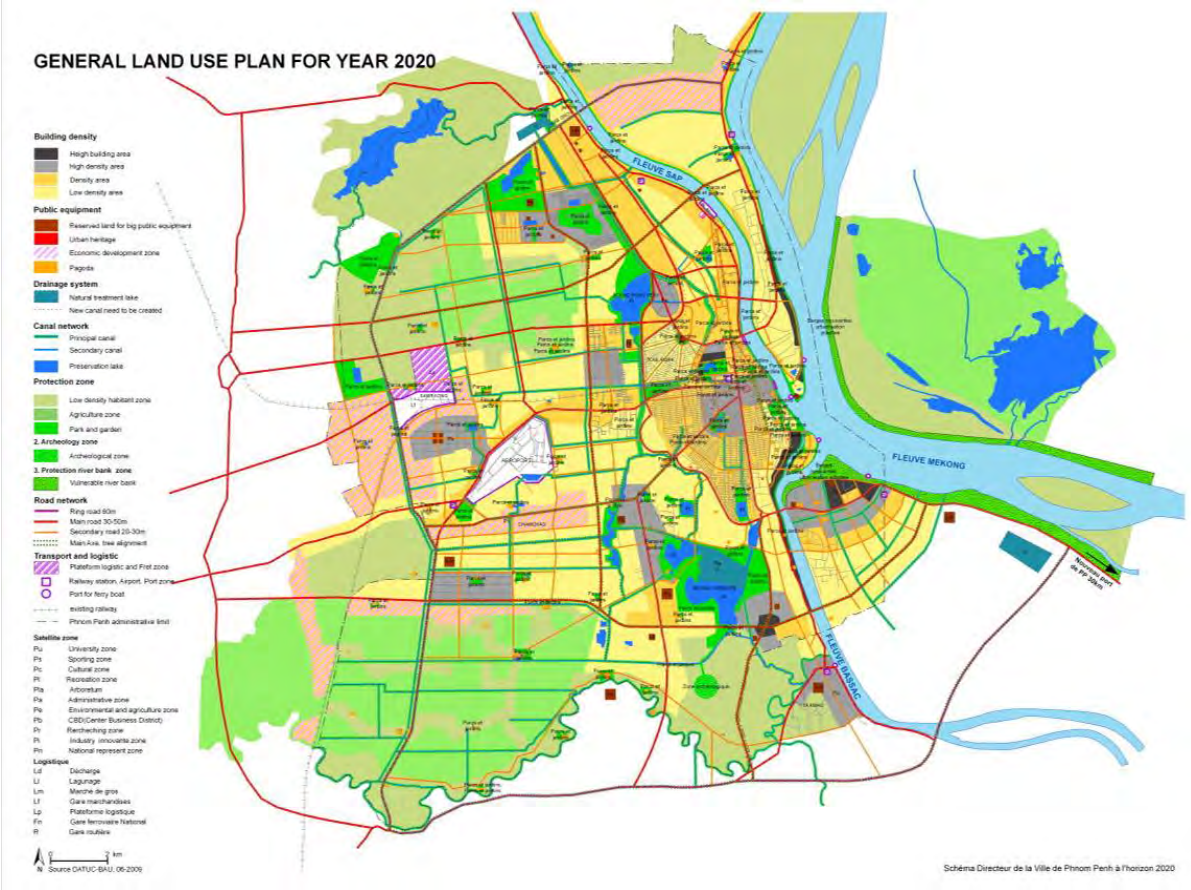
11.3.4 To Improve Environment of Public Transport Facilities Including Sidewalks

In order to enhance the utilization of public transportation, access to the facilities including stations and sidewalks needs to be improved and made user-friendly especially for vulnerable groups including children, elderly persons and expectant mothers. Many sidewalks in Phnom Penh are wide; however, they are used for parking of cars and motorbikes. Moreover, some sidewalks which are bumpy and rather high are not user-friendly at all. Accordingly, control of inappropriate parking and reform of sidewalk are vital. Besides, in some areas, litter on sidewalks and curbs is seen due to lack of service for garbage collection. This may be attributed to insufficient garbage fee collection in the area of low-income households. The possibility of subsidizing such area to have appropriate social services should be considered following a review of welfare services in Phnom Penh. Additionally, planting of roadside trees is recommended in order to provide better landscape and shade from sunlight for pedestrians.

11.3.5 To Preserve Agricultural Land by Well-planned Suburban Developments

With a view to preserve existing agricultural land and green areas, a well-planned development plan and appropriate controls are important. Urban sprawl has been seen in the suburban area and on the outskirts of the city in accordance with urbanization. Further urban development is expected owing to pressure from urban population growth in the future. Since the land use plan does not cover the entire municipal boundaries including newly designated municipal areas, a review of the plan needs to be done immediately. The land use is recommended to provide contrasts of development and preservation areas in order to prevent urban sprawl. This idea induces to formulate population agglomerations in the suburban area and to be basic information for introducing public transportation, making it easy to improve urban infrastructure and to provide services such as water supply, sewage and solid waste

management.



Source: Phnom Penh Municipality

Figure 11.3-7 Future Land Use Plan in Phnom Penh

11.3.6 To Protect Green Area Including Lakes and Wetlands for Keeping Diversity of the Ecosystem

On the outskirts of Phnom Penh Municipality, along IRR, there are still many green areas including a cultivation area, lakes and wetlands. In order to protect the ecosystem and biodiversity in these areas, appropriate development plans and control systems are vital; the same applies for those in the suburban area. On the other hand, open dumping sites and wastewater treatment by means of a lagoon system in Tra Bek Lake rely on this area. Taking into account the increasing urban population in the future, the capacity of such dumping sites and wastewater treatment system is a serious concern. With regard to solid waste management, advocating the use of the "3Rs", namely, recycle, reuse and reduce, and efforts to decrease garbage by DEPP need to continue for the future. The plan of final disposal site is recommended to be reviewed periodically taking into account its impacts on the environment.

11.4 Strategic Environmental Assessment

Strategic Environmental Assessment (SEA) is one of the most appropriate tools for decision-making of plans, programs and projects since it enables environmental impacts to be considered into the decision-making process in the early stage. Additionally, in the process, the information of plans, programs and projects are shared and discussed among the stakeholders in order to reflect their opinions

into the decision-making. Based on such information disclosure process, it enables to achieve consensus from the stakeholders. Thus, SEA is considered as one of the efficient systems for sustainable development.
At this moment, however, there is neither a unified definition nor guideline of SEA because understanding of SEA is diversified. The definition and process of SEA totally rely on the type of plan, program and project. In Cambodia, a SEA system has not yet been prepared.

11.4.1 SEA of PPUTMP

Taking into account the project area and project type of PPUTMP, the Project Team conducted a series of activities as SEA corresponding with the work flow of the Project. The following is the basic approach for undertaking the Project:

a) Identify Problems and Issues on Urban, Transport and Environmental Aspects
Not only urban and transport issues but also environmental issues including air quality, vibration, eco-system, Greenhouse Gas (GHG) and so on were raised and discussed in order to understand current conditions in Phnom Penh.
b) Establish the Basic Direction of the Comprehensive Urban Transport Master Plan
Based on the issues raised in a) above, future vision of Phnom Penh was prepared. Moreover, in order to achieve the vision, an appropriate urban transport master plan was formulated. Both the urban future vision established and basic direction of transport master plan were considered based on the comparative analyses of alternatives.
c) Conduct Stakeholder Meetings
In order to achieve a consensus, at major milestones in the project, stakeholder meetings were conducted for presentation of the progress and discussion with the project stakeholders.
d) Formulation of Implementation Plan and Short- and Medium-Term Action Plans
Based on the longlist of the projects and programs in the urban transport master plan, priority projects have been selected from economic and environmental viewpoints. A priority project selected was examined by pre-feasibility study.
e) Conduct Pre-Feasibility Study (F/S)
In order to avoid serious environmental impacts such as large-scale development in natural area and resettlement, a pre-feasibility study that includes pre-environmental impact assessment by means of setting alternative plans was conducted.
f) Conduct Seminar
Based on the result of the pre-feasibility study, a seminar inviting all counterparts and stakeholders was conducted.
g) Preparation of Rolling Plan by Stakeholders
Based on the master plan and the result of the pre-feasibility study, stakeholders shall review and modify them for the implementation of sustainable development.

11.4.2 Work Flow of SEA

The actual work items related to SEA is summarized in the following Table 11.4-1.

Table 11.4-1 Work Flow of SEA

Approach	Work item	Output
1. Identify problems and issues on urban, transport and environmental aspects		
To review current environmental condition - Review of related reports and document - Interview of related organizations - Sight survey	- To collect data and information related to environment sector - To carry out stakeholder analyses - To do interviews for related organizations	Progress Report Natural environment - Geographical condition - Climate - Natural conservation area Social environment - Population and forecast - Land use - Infrastructure and service
2. Establish basic direction of comprehensive urban transport master plan		
Qualitative evaluation of positive and negative impacts (some factors are evaluated quantitatively)	Formulation of alternatives [Urban structure] - T-shaped Structure - Multi-core Structure - Pear-shaped Structure [Urban Transportation] - Do-nothing - Road Development Oriented - Public Transport Oriented - Public Transport + Demand Management	Evaluation result [Urban structure] - Environmental impact - Transportation impact - Investment cost - Project risk - Suburban development [Transportation] - Urban Transport - Urban Planning - Environment - Economic
3. Conduct 1st stakeholder meeting		
To conduct a Stakeholder Meeting with agenda of urban transport master plan in order to make a consensus	- To invite stakeholder - To make a presentation about the result of evaluation as above	- Selection of alternatives from stakeholders - Minutes of the meeting - Presentation material - List of attendees
4. Formulation of implementation plan and short- and medium-term action plan		
- To prepare action plans (short and medium terms) based on the longlist formulated in the urban transport master plan - To evaluate each action plan	- To list up projects and programs - To prepare a summary of each project and program - To conduct economic analyses (EIRR) of selected projects and programs - To examine environmental impact (IEE) of selected projects and programs - To formulate implementation framework	- Evaluation result of projects and programs for short term in terms of a) Economic efficiency, b) Social impact c) Environmental impacts, and d) Implementation framework - List of medium- and long-term projects and programs - List of priority projects
5. Conduct 2nd stakeholder meeting		
To conduct Stakeholder Meeting with agenda of urban transport master plan in order to make a consensus	- To invite stakeholders - To make a presentation about evaluation results of priority projects and program as above - To explain about PPUTMP	- Consensus on PPUTMP - Selection of priority project by stakeholders - Minutes of the meeting - Presentation material - List of attendees
6. Conduct 3rd stakeholder meeting		
To conduct Stakeholder Meeting with agenda of 1st Public Experience	- To invite stakeholders - To make a presentation about the objectives and plan of 1st public experience - To discuss the contents and plan	- Consensus on 1st public experience in the target area - Minutes of the meeting - Presentation material - List of attendees
7. Conduct 4th stakeholder meetings		
To conduct Stakeholder Meeting with agenda of 2nd Public Experience	- To invite stakeholders - To make a presentation about the objectives and plan of 2nd public experience - To discuss the contents and plan	- Consensus on 2nd public experience in the target area - Minutes of the meeting - Presentation material - List of attendees
8. Conduct pre-feasibility study		
Evaluation of alternatives in F/S projects To conduct Pre-EIA for F/S projects including measurement of noise and air	- To conduct Pre-F/S - To set alternatives (if necessary) for each project	- Evaluation result of alternatives (evaluation factors are forthcoming) - Report on Pre-EIA

Approach	Work item	Output
quality	- To conduct Pre-EIA by sub-contract	
9. Conduct Seminar		
To conduct seminar with agenda of urban transport master plan in order to make a consensus	- To invite counterparts and stakeholders - To make a presentation about result of Pre-F/S	- Consensus on PPUTMP including Pre-F/S - Minutes of the meeting - Presentation material - List of attendees
10. Rolling plan by stakeholders		
In order to implement PPUTMP by 2035, the framework for MP revision by counterparts and stakeholders is prepared	- To discuss framework for rolling plan with counterpart and stakeholders	- Rolling plan for implementation of PPUTMP by 2035

Note: EIRR= Economic Internal Rate of Return, IEE= Initial Environmental Examination,
EIA= Environmental Impact Assessment, MP= Master Plan

Source: PPUTMP Project Team

11.4.3 Stakeholders

Involvement of not only counterparts and implementation bodies but also stakeholders is one of the unique processes in SEA. To sit at the same table with a wide range of organizations could contribute to make nonbiased discussions and to share information about future plans. The stakeholders of this project are determined by the stakeholder analyses. They are mainly selected from the following organizations:

- Commercial organization
- Representative of community (citizens)
- Urban transport related organization
- University, institute and academic federation
- Other organization (including Non-Government Organizations (NGOs))

11.4.4 Stakeholder Meetings and Seminar

As parts of SEA, stakeholder meetings were conducted several times in the project period. The summary of each meeting and seminar is shown below.

1st Stakeholder Meeting

Date:	September 6, 2012
Venue:	Sunway Hotel, Phnom Penh
Main Topic:	The Urban Structure of Phnom Penh for year 2035 ・ Alternatives of Urban Structure ・ Future Vision of Phnom Penh for year 2035
Discussion:	・ Selection of Urban Structure from the 3 Alternatives Provided in the Presentation. ・ Comment from participant on the Future Vision of Phnom Penh for Year 2035. ・ Pedestrian safety and comfort: To consider Pedestrian Flyover Bridge and also green roof for the pedestrian passage.
Attendants:	Counterpart ・ DPWT Central and local government ・ MPWT ・ MOE ・ MPP Commercial organization ・ Cambodia Chamber of Commerce Representative of community (citizens) ・ Sangkat Chrang Chomres Ti 1, Khan Russey keo ・ Sangkat Kork Rorka, Khan PorSenChey ・ Sangkat Phsar Kandal Ti 1, Khan Daun Penh ・ Sangkat PreySar, Khan DongKor

	・ Phsar Thmey 3 Urban transport related organization ・ Cambodia for Confederation Development Association (Tuk-tuk Association) University, institute and academic federation ・ Eastern Asia Society for Transportation Studies ・ Institute of Technology in Cambodia ・ Pannasastra University of Cambodia NGO ・ Handicap International Belgium

2nd Stakeholder Meeting

Date:	August 6, 2013
Venue:	Sunway Hotel, Phnom Penh
Main Topic:	Formulation of the Urban Transport Master Plan in 2035 ・ Evaluation of Urban Transport Master Plan ・ Longlist of Projects ・ Sector Plan
Discussion:	・ Evaluation on proposed urban transport master plan ・ Selection of public transport candidate ・ How to ensure smooth operations of urban public transport
Attendants:	Counterpart ・ DPWT Central and local government ・ MPWT ・ MOE ・ MPP Commercial organization ・ Cambodia Chamber of Commerce Representative of community (citizens) ・ Sangkat Chrang Chomres Ti 1, Khan Russey keo ・ Sangkat Kork Rorka, Khan PorSenChey ・ Sangkat Phsar Kandal Ti 1, Khan Daun Penh ・ Sangkat PreySar, Khan DongKor ・ Phsar Thmey 3 Urban transport related organization ・ Cambodia for Confederation Development Association (Tuk-tuk Association) University, institute and academic federation ・ Eastern Asia Society for Transportation Studies ・ Institute of Technology in Cambodia ・ Pannasastra University of Cambodia NGO ・ Handicap International Belgium

3rd Stakeholder Meeting for 1st Public Experiment

Date:	January 31, 2013
Venue:	MPP Room 3
Main Topic:	・ One-way Road System, Parking and Sidewalk Arrangement in Daun Penh District
Discussion:	・ Responsibility of each stakeholder for this experiment ・ Exact date for roadside resident meeting before the experiment and also the experiment date ・ Presentation of the result of the experiment to MPP
Attendants:	Counterpart ・ DPWT Central and local government ・ MPWT ・ MOE ・ MPP

4th Stakeholder Meeting for 2nd Public Experiment

Date:	January 17, 2014
Venue:	MPP Meeting Room
Main Topic:	・ Final Kick-off Meeting for 2nd Public Experiment on Bus Operation
Discussion:	・ Period of bus operation (February 5, 2014 – March 4, 2014) ・ Setting of bus fare to 1500 Riels/trip for the whole experiment period ・ Improvement of traffic signal at 3 intersections ・ Conduct of traffic count survey from January 21-21, 2014
Attendants:	Counterpart ・ DPWT Central and local government ・ MPWT ・PPCH ・ MOE ・Khan Police Commercial organization ・ Cambodia Chamber of Commerce ・ Edisijuta Parking Company ・ Global Taxi Representative of community (citizens) ・ Daun Penh Deputy Khan Chief ・ Meanchey Deputy Khan Chief ・ Prampi Makara Deputy Khan Chief NGO ・ Handicap International Belgium

Seminar

Date:	August 27, 2014
Venue:	Cambodia Japan Cooperation Center (CJCC)
Main Topic:	Urban Transport Master Plan Seminar for Phnom Penh Citizens
Discussion:	・ Presentation of Urban Transport Master Plan 2035 ・ Questions and Comments from participants on Urban Transport related problems/issues such as parking, sidewalks, infrastructure investment, etc.
Attendants:	Counterpart ・ DPWT Central and local government ・ MPWT ・DOE ・ MOI ・KHAN ・ PPCH ・Commissariat of Municipal Police ・ DOP Embassy ・ French Embassy Commercial organization ・ Cambodia Chamber of Commerce ・ Mitsui & Co ・ Sumitomo Corp ・ AZ Investment Co., Ltd., etc. Representative of community (citizens) ・ Representative citizens from Sangkats Urban transport related organization ・ Cambodia for Confederation Development Association (Tuk-tuk Association) University, institute and academic federation ・ Eastern Asia Society for Transportation Studies ・ Institute of Technology in Cambodia ・ Norton University ・ High Schools Donor ・ World Bank ・ ADB ・ AFD (French Development Agency) NGO ・ Handicap International MEDIA ・ TVK, CTN, CNC and PHNOM PENH POST

12 MASTER PLAN LONGLIST

In this section, the master plan longlist by five sectors that were studied and discussed in this chapter will be presented to clarify the whole projects which comprise the urban transport master plan and to develop the implementation plan to be carried out in Phase 3. However, only three sectors are presented here, namely, public transport, road, and traffic management. The other two sectors (commodity flow and environmental/social considerations) are not included in this section because of the following reasons:

a) The project list of these two sectors is mainly about soft components such as measures to control land use (commodity flow sector: relocation of large-scale factories and commodity flow centers from the urbanized area);

b) Some projects are overlapped with the traffic management sector such as decreasing traffic volume for the mitigation of CO2 emissions in the environmental sector and roadside commodity loading/unloading measures in the commodity flow sector; and

c) Cost of environmental sector's equipment such as roadside air pollution monitoring station is relatively low and will not significantly affect the total investment cost of the master plan.

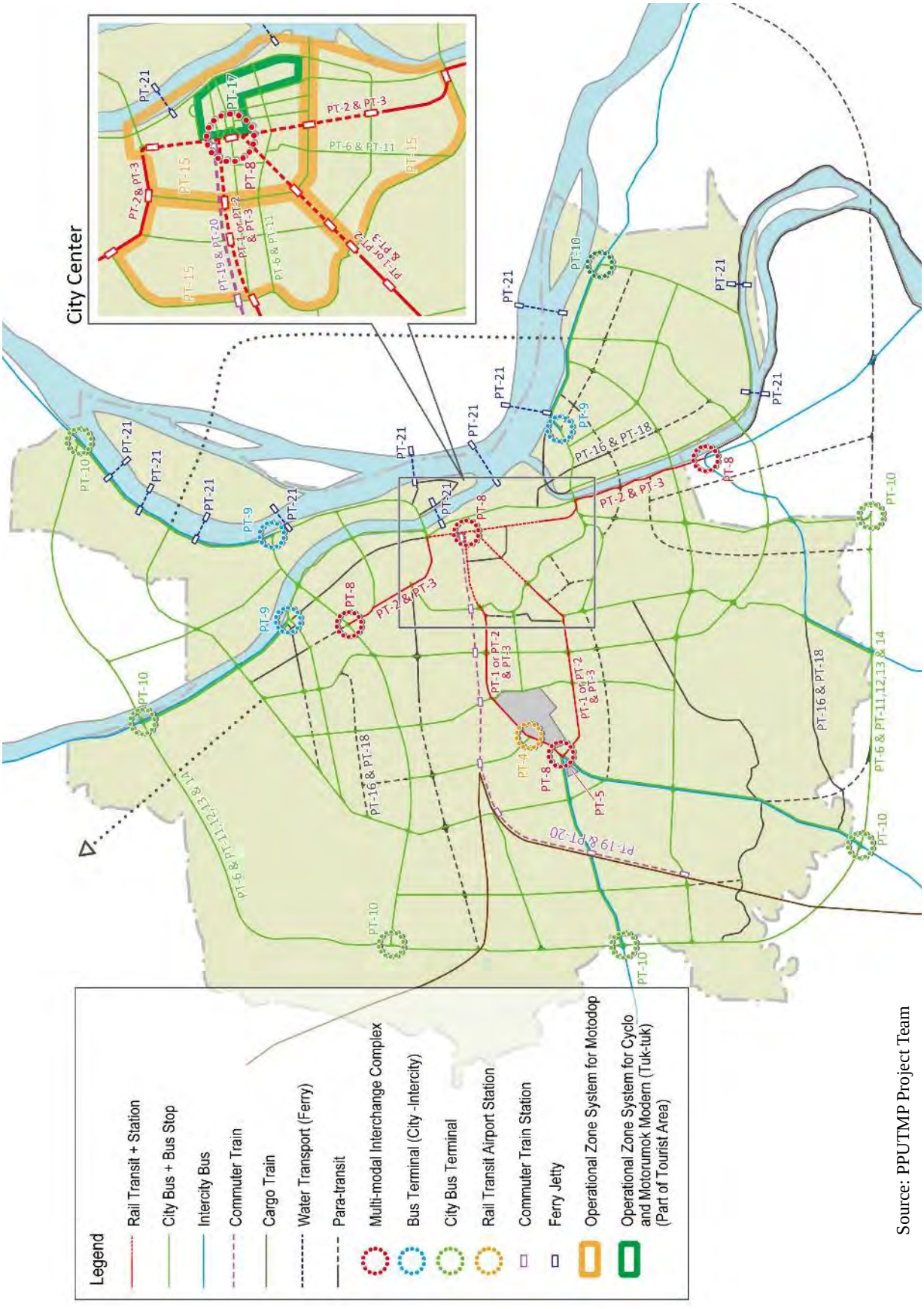
12.1 Public Transport

The outline and location of the public transport projects are shown in Table 12.1-1 and Figure 12.1-1, respectively.

Table 12.1-1 Outline of the Public Transport Projects in the Longlist

Code	Project Name	Project Outline	Quantity	Time Frame
PT - 1	Rail Transit (Phase 1)	Rail Transit (Elevated and partially underground) Chaom Chau - Central Market (CM) (via Russia or Monireth/Veng Sreng)	Total length= 14.0 km	Long term
PT - 2	Rail Transit (Phase 2)	Rail Transit (Elevated and partially underground) Chaom Chau – CM (via Russia or Monireth), GPIC to CM and Takmau to CM	Total length= 30.8 km	Long term
PT – 3	Rail Transit Station		No. of stations= 43	Long term
PT – 4	Rail Transit Airport Station		No. of stations= 1	Long term
PT – 5	Rail Transit Depot		No. of depot= 2	Long-term
PT - 6	Bus Route		Total length= 426 km	Short to Long term (Medium term: 148 km)
PT - 7	Bus depot		No. of depot= 2	Short to Medium term
PT - 8	Multi-modal Interchange Complex	Terminal complex (Rail transit + City bus + Intercity bus)	No. of terminals= 4	Long term
PT - 9	Bus Terminal (Type 1)	City bus + Intercity bus	No. of terminals= 3	Short to Long term
PT - 10	Bus Terminal (Type 2)	City bus terminal	No. of terminals= 7	Short to Long term
PT - 11	Bus stop	Bus stop interval, cc: 300 m and suburban: 500 m	No. of bus stops (Phase 1)= 389 No. of bus stops= 924 (cc: 180 and 744)	Short to Long term Phase 1 (Total: 389, cc: 234 and 155)
PT - 12	BRT	Bus Rapid Transit System (Bus route with more than 6 lanes road)		Medium to Long term
PT - 13	Bus priority measures	Bus priority/exclusive lane (Bus route with more than 4 lanes road)		Short to Long term
PT - 14	Bus location system			Medium to Long term
PT - 15	Restructuring of the para-transit operation (1)	Zone system for Motodop		Short to Medium term
PT - 16	Restructuring of the para-transit operation (2)	Exclusive route system for Motorumok modern (tuk-tuk)		Short to Medium term
PT - 17	Restructuring of the para-transit operation (3)	Zone system for Cyclo		Short to Medium term
PT - 18	Restructuring of the para-transit operation (4)	Improvement of commuter trucks in the suburban area		Short term
PT - 19	Introduction of commuter rail system	Using existing rail system between Central station and PPSEZ station	Total length= 19.3 km	Medium term
PT - 20	Commuter Rail Station		No. of stations= 9	Medium term
PT - 21	Improvement of water transport	Improvement of transfer facilities between water transport and bus	No. of jetties= 11	Medium term

Source: PPUTMP Project Team



Source: PPUTMP Project Team

Figure 12.1-1 Location of Public Transport Projects in the Longlist

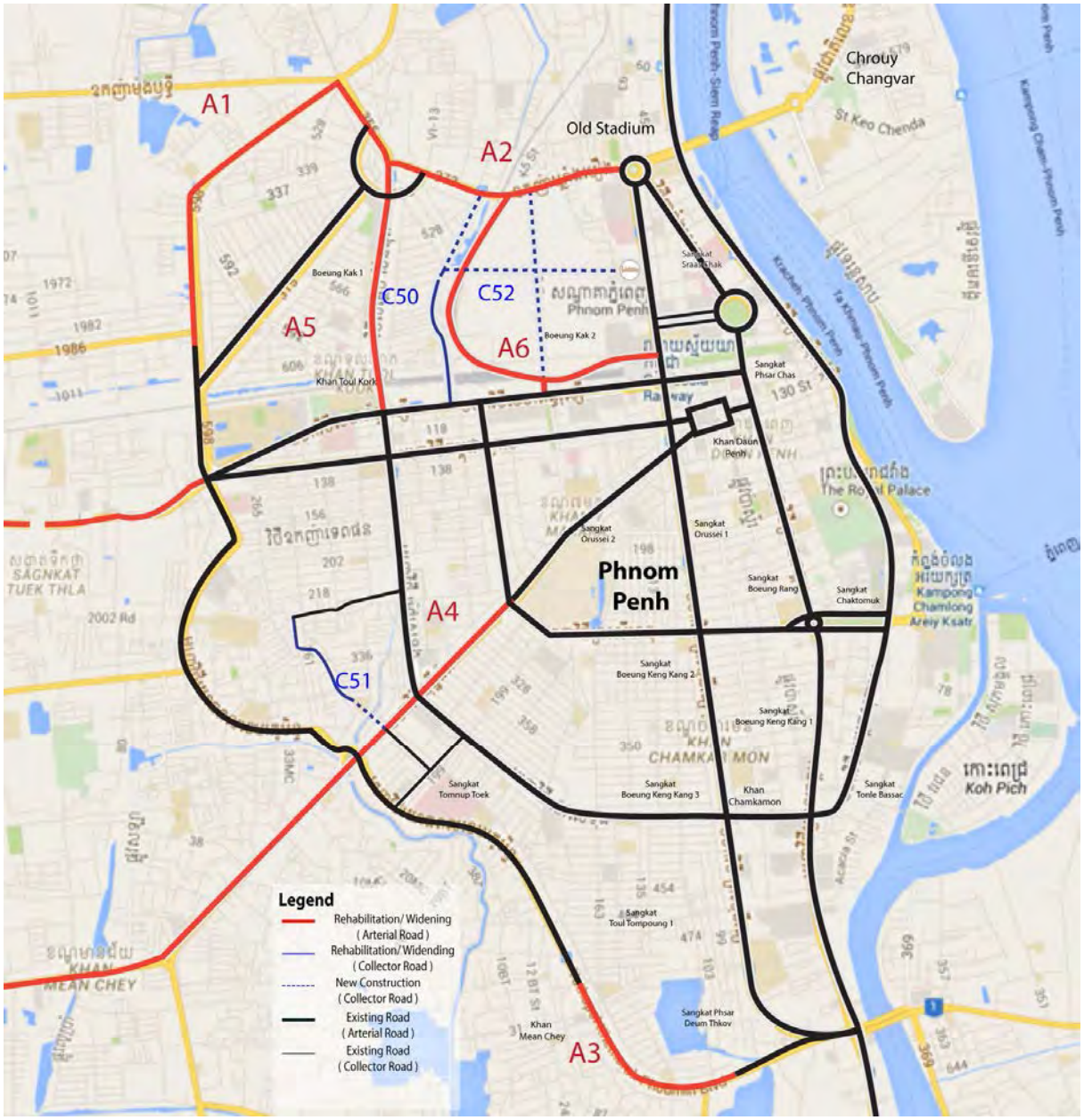
12.2 Road

The road projects proposed in the Master Plan are shown in the table below.

Table 12.2-1 List of Road Project Packages

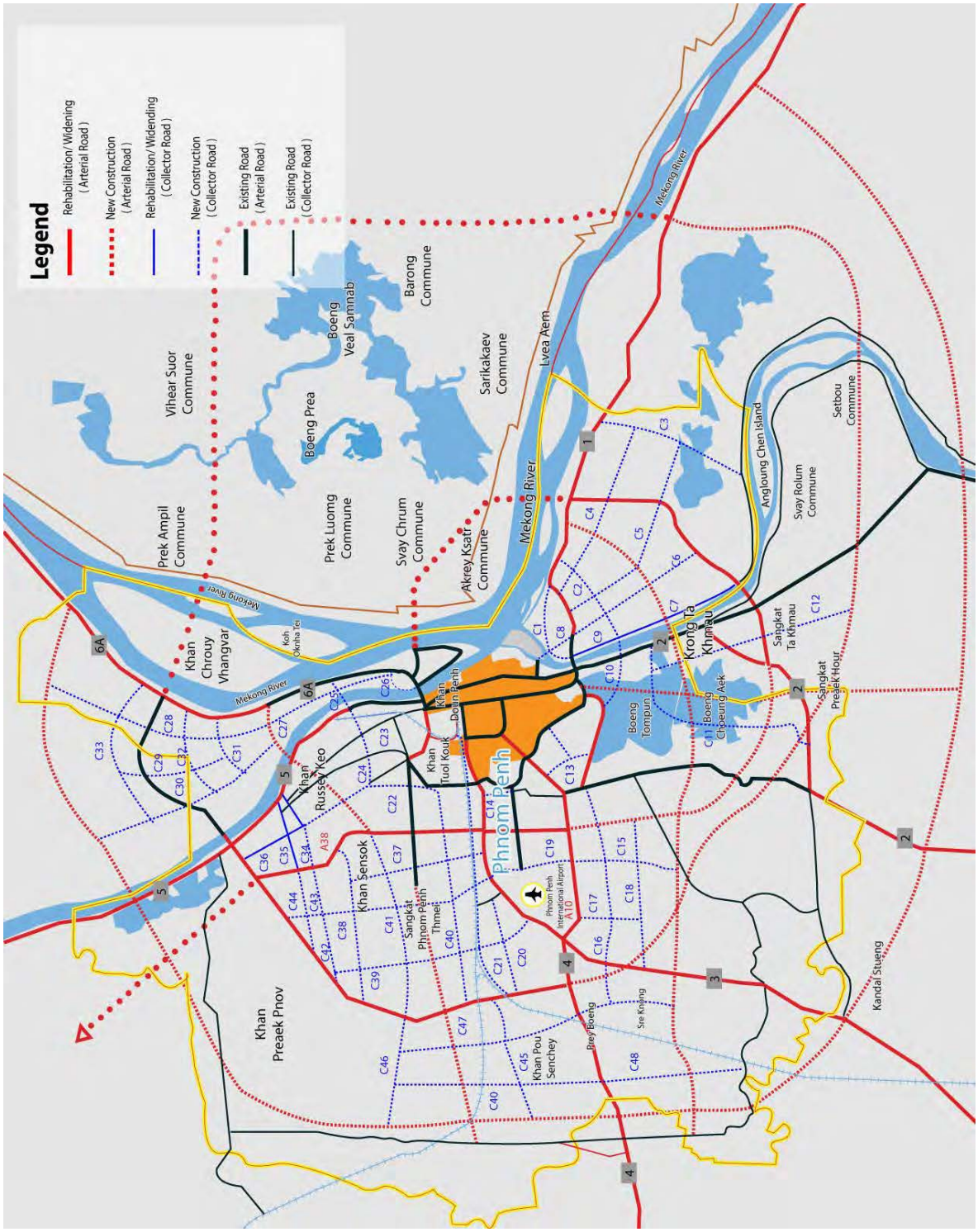
Code	Project Name	Project Components	Total Length (km)
RP-1	Widening and Sidewalk of Arterials in Central Area(IRR, Monireth, Toul Kok)	A1,A2,A3,A4,A5	10.1
RP-2	Boeng Kok Road	A6, C52	6.5
RP-3	Missing Links in Central Area	C50, C51	1.3
RP-4	Widening of NR1, Chabar Ampov - New PP Port	A25,A26	25.3
RP-5	New E-W Arterial Road (NR1 - Cheng Aek Road)	A7,A8	11.5
RP-6	New E-W Arterial Road (Cheng Aek - RR-IV)	A9, A33	16.1
RR-7	New and Widening of RR-II (NR2 - NR5)	A12,A13,A14	20.4
RR-8	Extension of RR-II (NR5-NR6)	A15	2.9
RP-9	RR-III (NR1 - Junction with NR21)	A16	18.5
RP-10	RR-III(NR21 - NR4)	A17,A18	24.5
RR-11	Widening of RR-III(NR4 - 4km section)	A19	4.1
RR-12	Widening of RR-III(4km from NR4 - Preak Pnob Bridge)	A20	10.7
RP-13	RR-IV (NR1 - NR6)	A21,A22,A23,A24	80.8
RP-14	Widening of NR2 (Junction with NR21 - RR-III)	A27, A31	12.1
RP-15	Widening of NR3 (Junction with RR-III - RR-IV)	A32	9.2
RP-16	Widening of Chaom Chao Road	A30	8.4
RP-17	Widening of Russia/NR4 (IRR - RR-IV)	A34, A35	15.2
RP-18	New E-W Arterial in Sen Sok(Toul Kok - RR-IV)	A36, A37	15.9
RP-19	Widening of Hanoi Road (RR-II - RR-III)	A38	4.9
RP-20	Widening of NR5 (Chruoy Changvar Bridge - RR-IV)	A39, A40	15.0
RP-21	Chban Ampov area Development Road package	C2, C6, C7, C9	18.9
RP-22	Mean Chey District Urban Development road package	C3, C4, C5	27.0
RP-23	Mean Chey - Diamond Island Connection Rd package	C1, C8	5.8
RP-24	AZ Green City Development Road package	A28,C10, C11, C12	34.2
RP-25	Chaom Chao South Area Development road package	A29,C15, C16, C17, C18	25.7
RP-26	Russia - Chaom Chao Connection & Boeng Tumpun Access	C13, C14, C19	8.5
RP-27	Samraon Kraom Sub-center Development Road package	C20, C21, C39	15.3
RP-28	Western Peripheral area development roads bw RR-III and RR-IV	C45, C47, C49, C46	31.2
RP-29	Phnom Penh Thmei district Development package(West of Hanoi)	C40, C37, C41	22.5
RP-30	Krang Thnong New Sub-center package	C42, C43, C44, C38	20.8
RP-31	Camko/Grand Phnom Penh Development package	C22, C35, C36	9.8
RP-32	Ruessei Keo, Kilolekh6 area Development roads	C23, C24	9.3
RP-33	Soka, Chruoy Changvar Development roads	C26, C27, C25	9.6
RP-34	Garden City Preak Pnob Development roads	C28, C29, C30, C31, C32, C33	37.5
RP-35	Flyover or Underpass Project in the Central Area(Monivong North, Toul Kok, Monivong South)		1.1
RP-36	Flyover or Underpass Project (Monivong North, Toul Kok, Monivong South, Hanoi/Russia, Hanoi/Chaom Chao, Cheng Aek/Tumnop Thmei, ICs or Flyovers along RR-III and RR-IV)		9.3

Source: PPUTMP Project Team



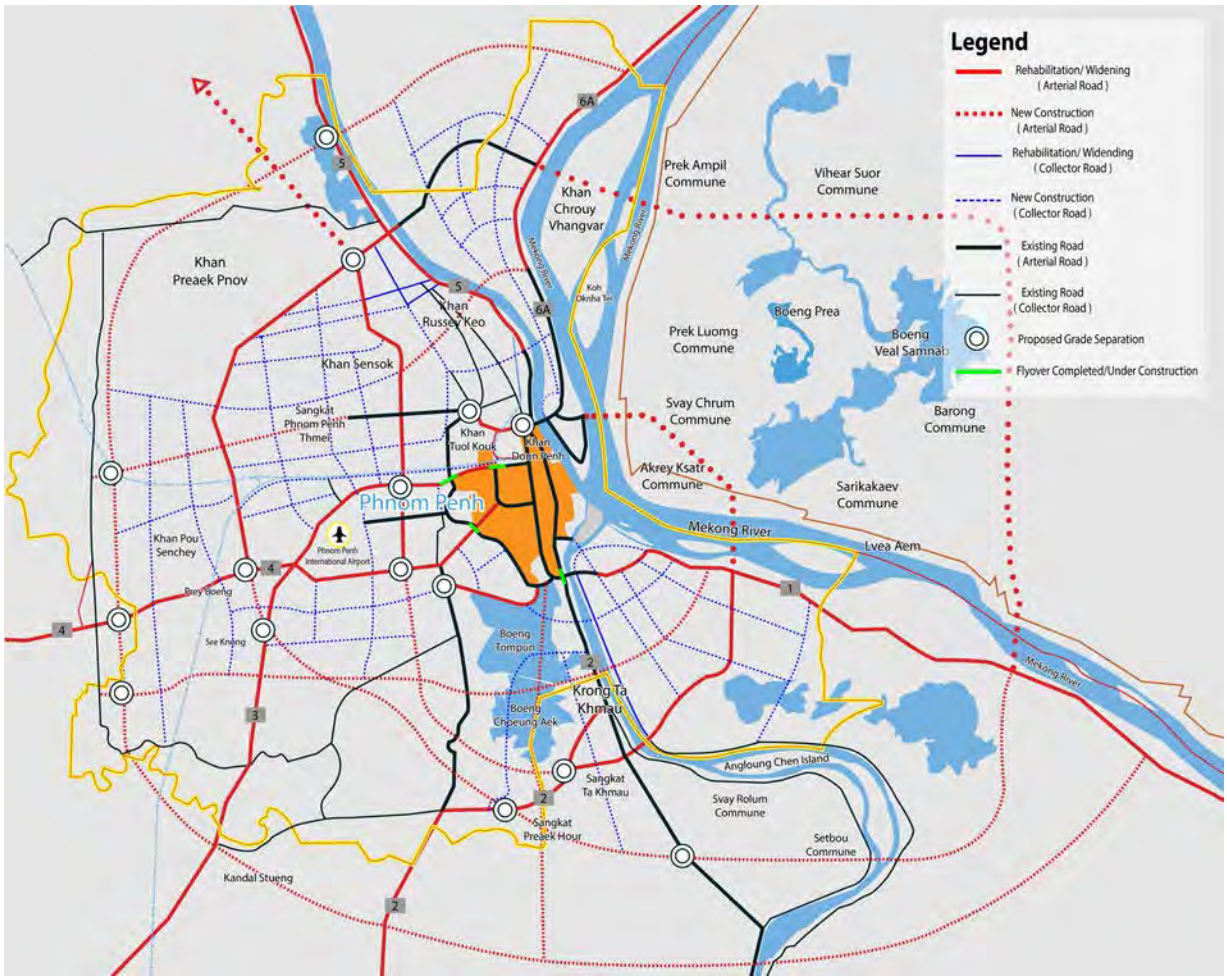
Source: PPUTMP Project Team

Figure 12.2-1 Proposed Road Projects in the Central Area



Source: PPUTMP Project Team

Figure 12.2-2 Proposed Road Projects



Source: PPUTMP Project Team

Figure 12.2-3 Location Map of Proposed Grade-Separated Intersections

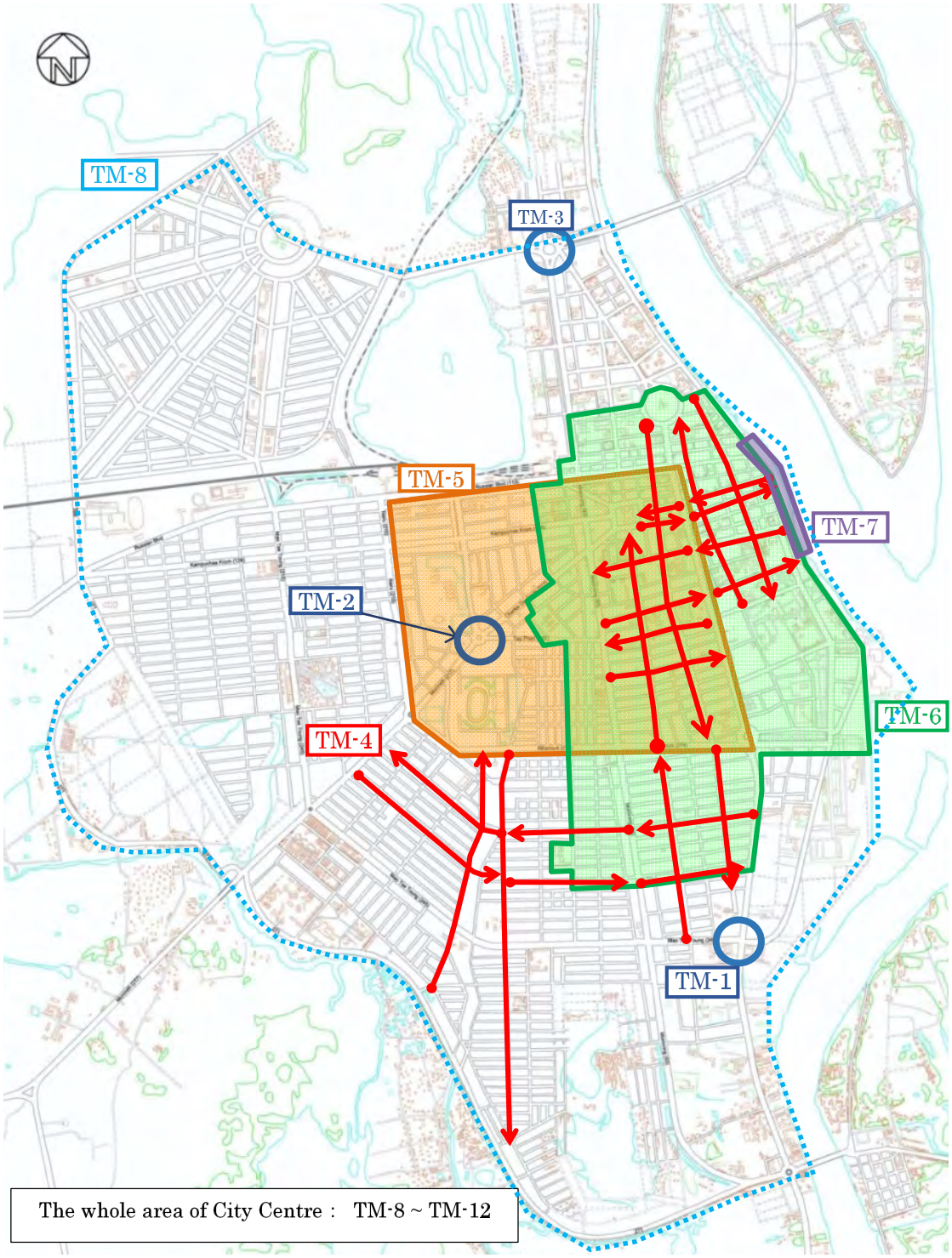
12.3 Traffic Management

The outline and location of the traffic management projects are shown in Table 12.3-1 and Figure 12.3-1, respectively.

Table 12.3-1 Traffic Management Projects in the Longlist

Code		Project Name	Project Outline		Quantity	Time Frame
TM-1		Chamkar Morn Intersection	Smooth traffic flow in the intersection	Signal phasing adjustment	One intersection	Short term
TM-2		Neang Kong Heang Intersection	Smooth traffic flow in the intersection	Revision of traffic regulation	One intersection	Short term
				Signal phasing adjustment	One intersection	
TM-3		Chrouy Changvar Intersection	Smooth traffic flow along IRR	Underpass	Tunnel: 70 m Approach: 200 m	Short term
TM-4		One-way system	Introduction of one-way system		Length: 10.9 km	Short to Medium term
TM-5		Parking measures	Provision of parking space	Off-road parking	M/C: 2,500 Car: 8,600	Short to Long term
				On-road parking	M/C: 7,200 Car: 3,200	
				Parking information system		
TM-6		Development of comfortable pedestrian environment	Vitalization of tourism and city's activities through the development of comfortable pedestrian environment	Dissemination to citizens along the roads		Short to Medium term
				Guide to remove illegal sidewalk parking, etc.		
				Sidewalk widening		
TM-7		Transit mall	Development of pedestrian and public transport-oriented urban space to vitalize the city center and to minimize traffic congestions		Length: 1 km	Medium term
City Center	TM-8	City center traffic signal improvement project for 100 intersections	Effective road space use in the city center	Synchronized traffic signal control	3 intersections along Monivong	Short to Medium term
				Area traffic control system	Initial system covers 100 signals	
				Intelligent traffic signal		
				Traffic surveillance system	Initial system covers 26 intersections (cameras). The system will be installed at TCC together with area traffic control center.	
				Traffic monitoring system using probe vehicles		
				Traffic information system (Variable message sign system)	Initial system covers 8 VMSs (locations).	
				Transit signal priority system		
	TM-9	Park and bus ride	Improvement of traffic and environmental conditions in the city center	Transfer to bus from cars in the suburban area	Suburban bus terminals	Medium to Long term
	TM-10	Mobility management	The mobility management (MM) comprises "soft" measures, which enhance the effectiveness of "hard" measures of traffic planning. The MM tools do not necessarily require large investments measured against their high potential to change mobility behavior. The objective of MM is to reduce single-occupant car use.			Medium to Long term
	TM-11	Driver's education and traffic enforcement	Dissemination of traffic regulation and rules to the citizens for safe, smooth and comfortable urban transport system			Short, Medium to Long term
	TM-12	Preparation of parking space for loading/unloading trucks in the city center	Use of part of car parking space along the trunk roads for truck loading/unloading for trucks during the off-peak period			Short, Medium to Long term

Source: PPUTMP Project Team



Source: PPUTMP Project Team

Figure 12.3-1 Location of Traffic Management Projects

13 ORGANIZATION AND FINANCIAL CONSIDERATIONS

13.1 Proposed Organization

13.1.1 Reorganization of DPWT

When DPWT was reorganized in September 2013, a new division called Public Transport Management Division (PTMD) was created which took over most of the functions previously held by the Transport Office. The roles and responsibilities of PTMD were as follows:

Table 13.1-1 Roles and Responsibilities of PTMD

Item			Action
Institution/ Planning (Administrative & Technical Section)	Institution	Public Transport Guideline	Establishment of guideline Maintaining & revision of guideline
		Establishment of new authority in future	Preparation of new organization's roles and responsibilities
	Policy	Fares	Permission of fares Criteria of decision
		Public transport policy	Preparation of draft Monitoring to transport master plan
	Plan	Annual business plan from operator	Evaluation & preparation of recommendation (Parking/Bus/Taxi)
		Operation report from operator monthly	Review and pointing out to operator (Parking/Bus/Taxi)
	Coordination	Collaborating with other authorities	Attendance of meeting with MPWT, Traffic police and related authorities
Management (Administrative & Public Order Section)	Management	Public transport business	Management of para-transit route Registration of taxi
		Parking business permit to private operator	Criteria of decision (evaluation of proposal) Registration & evaluation of contract Establishment of information system
	Assets (Facility)	Operator facilities (terminal, bus stop, depot etc)	Carry out inspection and make comments
		Parking lot	Inspection of performance (Private) Inventory of parking lot
Services (Technical & Public Order Section)	Service Standard	Operation frequency	Analysis of operation report
		Service hour	Analysis of operation report
		Fares	Interview survey of passengers
	Training	Training program	Preparation of training program on public transport for staff members
	Maintenance	Pedestrian Parking lot Public transport	Survey current situation with photo Survey current situation with photo Monitoring of operation

[Public Transport Guideline]			
	Article	Item	Details
1	Introduction		
2	Business License	➢ Process of approval & licensing	➢ Regulator office (DPWT) Approval (Governor)
		➢ Licensing formality & Evaluation item	
		➢ Duration & Deposit	
		➢ Limitation of additional Income	
		➢ Penalty	
3	Business Plan	➢ Process of approval	
		➢ Annual business plan	➢ Expected revenue, passengers, timetable, fleet size, safety aspect
4	Fares	➢ Process of approval	
		➢ Decision on fare system	
5	Management of City Transport	➢ Selection of routes	➢ Each mode (train, bus, para-transit)
		➢ Maintenance of fleet	
6	Parking Control	➢ Role of concerned party	➢ Management: PTMD (Technical) ➢ Management: DEF (Contract) ➢ Operation : Private
		➢ Control of City Parking	
7	Traffic Safety	➢ Compliance with traffic law	
8	Monitoring System	➢ Operation report	➢ Monthly performance
9	Subsidy	➢ Process of decision and approval	
		➢ Criteria of decision	

Source: PPUTMP Project Team

The Project Team put together a program to strengthen the management and operation capabilities of PTMD after the brainstorming with its staff, as mentioned in section 13.2. The Project Team conducted a training course to explain PTMD's roles and responsibilities and the public transport guideline in September 2013. Due to time constraints, however, it was not possible to hold classroom training continuously after that. However, PTMD did undergo actual training as a main player during the public experiment for the bus operation conducted by the Project Team in February 2014.

The Project Team prepared a Project Design Matrix (PDM) below for strengthening of PTMD[1] in the future and explained it to the Director and Deputy Director of DPWT. The part of PDM can be utilized to get a foothold in Phnom Penh Urban Transport Authority (PPUTA) as well.

[1] PTMD was renamed Public Transport Management Authority (PTMA) with city bus operation as its sole responsibility. As an autonomous agency, PTMA is directly managed by the PPCH Governor, and it is run with collaboration between PPCH (administration/management) and DPWT (operation/maintenance). The mandate of PTMA in the medium term should be clearly outlined to include tackling all public transport issues not only bus operation but also traffic management measures to support public transport.)

"PDM for Strengthening of PTMD"

《Overall Goal》

- Capacity of PTMD is improved regarding implementation arrangements and such aspects as public bus operation and parking management through application of guideline for public transport management, operation
- Furthermore, PPCH shall construct a process for the realization of PPUTA when the railway system is introduced.

《Project Purpose》

- To function sustainably as a regulator for implementation body
- To systematize parking measures, solve traffic jams with the introduction of public transport system and consequently reduce the environmental burdens
- To develop a viable procedure for establishment of PPUTA and to be set forth in the National Strategic Development Plan (NSDP 2019 - 2023)

《Output 1》

- Establishment of policy and guideline for management, operation and service of public transport

《Output 2》

- Establishment and application of information panel for parking system

《Output 3》

- Establishment of sustainable training program for management of public transport

《Output 4》

- Process of creation of Phnom Penh Urban Transport Authority (PPUTA)

《Activity》

1 Establishment of policy and guideline for management and operation of public transport

1-1 Brainstorming of tasks for management of public transport
1-2 Preparation of role and responsibility for each section with matrix through Plan, Do, Check, Action Cycle
1-3 Preparation of guideline for management and operation

2 Establishment and application of information panel for parking system

2-1 Preparation of inventory sheet (Location, Time, Road Width and more items) or map for current condition of parking
2-2 Preparation of sheet (Location, Time, Width of Sidewalk and more items) or map for current condition of pedestrians
2-3 Development of database system for current condition
2-4 Countermeasure of existing parking system (Care of Car and motorcycle parking, clearing sidewalks for walking tourists)
2-5 Method of public announcement

3 Establishment of sustainable training program for management of public transport

3-1 Analysis of existing training program
3-2 Redesign of training items related to public transport
3-3 Implementation of training of trainers
3-4 Preparation of syllabus (Target person, Time frame) and training materials

4 Process of creation of Phnom Penh Urban Transport Authority (PPUTA)

4-1 Set up the Phnom Penh Urban Transport Authority (National Level)/Coordination with related stakeholders

4-2 Establishment of roles and responsibilities for new authority, PPUTA
4-3 Preparation of action plan to set up PPUTA/Preparation of Prakas
4-4 Demarcation of operation body and management body
4-5 Set forth in NSDP (2019 - 2023)

13.1.2 Establishment of Phnom Penh Urban Transport Authority (PPUTA)

(1) Transition to PPUTA

It is very important to establish an independent organization for public transport to enhance the flow of traffic with sustainable and constructive growth in MPP. The Project Team has proposed to set up the Phnom Penh Urban Transport Authority (PPUTA) in response to the issue of related urban transport system under a national level organization.

Establishment of a new organization which shall take responsibility for development planning and implementation of transport in the area of MPP based on existing PTMD roles and responsibilities. PPUTA shall duly conjecture measures for urban transport issues (see Table 13.1-2) with management indicators based on discussion of expected characteristics of public transport.

Table 13.1-2 Urban Transport Related Issues

Administration of Transport Plan	・Identification of concerned parties' roles and responsibilities ・Establishment of regulator to drive the public transport ・Capacity Development
Management and Operation of Public Transport	・Framework of efficient management (approval & licensing and regulatory) ・Secure independence for finance and abolishment of subsidy ・Framework of modernity operation
Implementation Framework	・Development of site acquisition method ・Development of PPP policy ・Capacity Development
Revenue Shortage	・Secure the fund ・Establishment of earmarked funds

Source: PPUTMP Project Team

Before the proposed PPUTA is created, the Project Team suggested setting up a transitional advisory committee to coordinate the urban transport projects. This committee shall prefigure the future framework for transport sector in MPP and describe PPUTA's roles and responsibilities effectively. Moreover, vital for the success of establishment of PPUTA, the feasibility study shall be conducted to specify its roles, status, budget, and nature of resources and manner of obtaining them.

(2) Proposed Structure

The Project Team proposes the structure of PPUTA for future reference as shown in Table 13.1-3. However, it is important to discuss with stakeholders their role and responsibility in PPUTA.

Table 13.1-3 Outline of PPUTA

Item	Content
Status	Autonomous state corporation
Objective	1. Towards a comfortable city street environment ➢ Preparation of public transport policy ➢ Establishment of practical guideline for public transport ➢ Management of traffic 2. Solution for traffic congestion ➢ Tackling parking issues ➢ Overseeing para-transit operation ➢ Management of application for new public transport system 3. Maintenance of city assets ➢ Clearance of walkways (sidewalks) ➢ Inventory of parking lots ➢ Evaluation of private operators
Role and Responsibility	1. Monitoring the Comprehensive Urban Transport Plan (JICA MP) 2. Coordinate the different stakeholders (interministerial) 3. Coordinate transport projects 4. Design the mobility policy framework 5. Better understand urban growth, mobility and transport means 6. Design the transport planning documents 7. Draw up the transport contracts for pay parking, traffic signal, traffic control system, bus stations, ferry station and logistics infrastructure 8. Draw up the tariff policy and the subsidy levels for pay parking price, transport ticket price and reduction policy
Need of Technical Capacity	1. Transport Planning 2. Parking Management 3. Traffic Management 4. Public Transport Design and Management
Process of Creation	1. Sub-Decree creating PPUTA and appointment of Board members 2. Budgets allocation 3. Capacity of human resources 4. Technical assistance from Donors
Organization	1. Administrative division: Policy, guideline, personnel, finance, planning and public relations 2. Facility division: Maintenance of rolling stock or tracks, signal, structure, station and rail 3. Transportation division: Bus or train service, station control, safety management
Consideration of Operation Process	Clarification of operation policy ➢ Shared awareness of operation policy among Authority members 2. Clarification of roles and responsibilities ➢ Achievement of task for each division/staff 3. Draw up business plan ➢ Analysis of current traffic issues ➢ Identification of needs based on public opinion ➢ Set up the goal of PPUTA ➢ Planning of concrete projects such as public transport routes ➢ Collaboration with private sector ➢ Management of public transport ➢ Enhancement of publicity 4. Establishment of monitoring and evaluation system ➢ Evaluation of each project Monitoring of area public transport

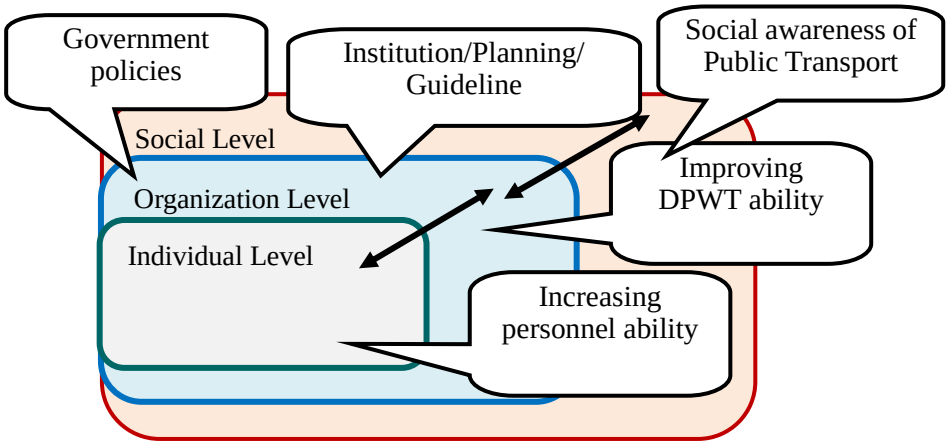
Source: PPUTMP Project Team

13.2 Capacity Development

13.2.1 Background

Capacity Development (CD) refers to the ongoing process of enhancing the problem-solving abilities of organizations by taking into account all the factors at the individual, organizational, and societal levels. Capacity is defined as the ability of organizations to solve problems on their own. Capacity is not simply transferable and its sustainability is largely dependent on the initiative and ownership of the target organization involved.

For example, effective public transport management would not only be limited to the sufficient know-how possessed by PPCH and its staff, but also extends to various other elements. These include a role-sharing mechanism that involves the private sector such as bus operator, communities such as roadside residents, and the government's department in-charge such as an institutional setup that determines the planning and guideline, as well as the policies that set goals of public transport (see Figure 13.2-1).



Source: PPUTMP Project Team

Figure 13.2-1 Concept of Capacity Development

Based on the above, PPCH shall consider the following concept of basic awareness to each target organization or stakeholder to improve:

- Each organization must be developing capacities by themselves.
- Ownership by PPCH is vital.
- Joint efforts with the participation of each organization in PPCH are important.
- A long-term commitment is required.
- Creating a sustainable mechanism after capacity training course.
- Systemic thinking and program approaches.
- A flexible approach responsive to the development needs and conditions.

13.2.2 Evaluation of Capacity Development

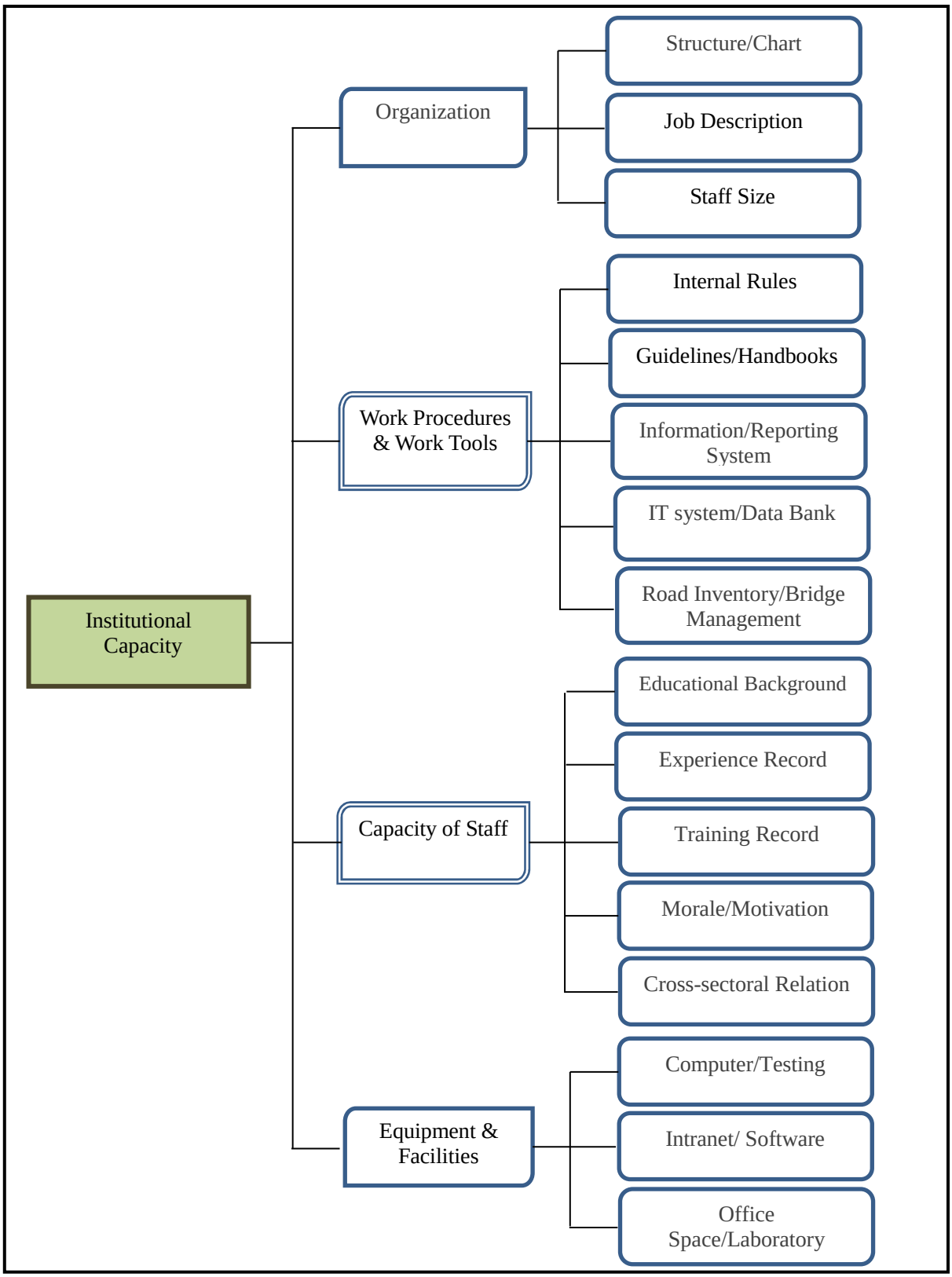
When carrying out a CD program, it is necessary to understand issues from a comprehensive perspective that looks over individual, organizational, and institutional and societal systems respectively as mentioned above, and also determine capacities and the environment, rather than having just a desultory awareness of the focus of cooperation. It is essential that the target organization (DPWT) understands its

own capacities and determine the aims to be achieved. Furthermore, it is also desirable that DPWT recognizes problems it faces and gains a sense of leadership through the process of carrying out assessments with senior evaluators. Capacity Assessment (CA) is basically premised on the assumption that it will gradually turn into assessments led by DPWT management.
Through CA, an understanding of current environment, identification of entry points for training program, and awareness enhancement of proactive attitudes for the target organization can be obtained.

13.2.3 Institutional Capacity

The ability of an organization for accomplishing is usually called 'institutional capacity'. Institutional capacity is influenced by 4 main factors to improve in view of individual, organization and societal levels as shown in Figure 13.2-2. One of the important factors is work procedures and work tools. Work procedures include technical guidelines/handbooks or application of data bank which leads the staff members to actually do the tasks in accordance with prescribed standard procedures. Another important factor of institutional capacity is capacity of staff. Capacity of staff as a group consists of the capacity of the individual staff and combination of them (teamwork). This capacity of an individual staff is influenced by several details of factors such as educational background, experience and morale/motivation. Training is also one of the factors influencing the capacity of staff.

The words 'capacity development' and 'human resources development' (HRD) are often used almost as same meaning with the word 'training'. Particularly, the abbreviation HRD is often used covering a wider concept than 'training'. In this chapter, the word 'training' or 'training course' will be used to mean actions or measures to improve capacity of an individual staff or particular group. More detailed explanation of training is given in the following section.



Source: PPUTMP Project Team

Figure 13.2-2 Factors Influencing Institutional Capacity

13.2.4 Current Practice of Capacity Development Program

(1) Current practice of Capacity Development Program in DPWT

DPWT has not yet undergone the internal training courses, currently. The training course was established by the Ministry of Public Works and Transport (MPWT). DPWT staff members participate in such annual training courses. MPWT has been delivering a training course every year since 2005. The Project has obtained the booklet on this training and translated the essential part of it into English and analyzed these training courses. Although there are several sessions in this training course where engineering subjects are covered, these sessions are considered to cover general topics of each field and not designed to teach practical skill or knowledge of engineering, judging from the time spent on each subject. Therefore, the main objective of this training seems to be strengthening of the general knowledge, as government officials, of middle to upper level managers of MPWT and provincial DPWT offices, and not to strengthen any particular field.

The majority of the participants are senior to middle class managers of MPWT and senior managers of provincial DPWT offices. It is noted that the largest portion of the participants in the first year (2005 - 06) was senior-level managers such as Deputy Directors of MPWT proper and Directors of provincial DPWT offices, and then has been shifting to middle-level managers. This shift is well understandable if the fact that the number of senior-level managers is rather limited is considered. If this training course is delivered every year in a sustainable manner, it is expected that junior-level managers will participate in a few years and even engineer-level staff will start to participate within 10 years. Thus, it is too slow to manage the current traffic flow under vital environment in MPP so that the particular fields of training courses should be established by DPWT as soon as possible.

(2) TOT and Training for PTMD Personnel

1) Introduction

A training of trainers (TOT) was implemented on September 26-27, 2013 as a part of the activities of PPUTMP. The purpose of this TOT was to train the trainers as the first step to grasp the roles and responsibilities for the new division created, the Public Transport Management Division (PTMD). This division is the most important body to involve in the introduction of public transport in MPP so that officials of PTMD should understand these roles and responsibilities to train personnel into this division. After implementation of TOT, the Project also conducted the training course for “Establishment of PTMD and Necessity of Public Transport” to all of PTMD personnel on October 1, 2013. It is indispensable that introduction workshops for the functions of the new division be delivered to all the concerned staff of PTMD in order to make sure that these activities are needed in the daily practices.

2) Report of TOT and Training to PTMD Personnel

The following report summarizes the result of the TOT and training course to PTMD personnel.

2)-1 Outline of the TOT Training and Training to PTMD Personnel

The outline of the TOT and training course to PTMD personnel are as shown in Table 13.2-1 and Table 13.2-2.

Table 13.2-1 Outline of Training of Trainers

Date & Time	September 26-27, 2013; 10:00 - 16:00
Venue	Meeting room 1 of DPWT
Objective	i. To let the trainees of TOT program have experience of delivering lecture, and ii. To grasp the roles and responsibilities for PTMD.
Trainee	6 persons (staff of DPWT)
Trainer	Mr. Kazuo Yumita, JICA expert
Target Level of Achievement	i. Deputy chief of DPWT: Know the roles and responsibilities for PTMD and can refer as necessary in their daily practices ii. Trainees of TOT program: Acquire presentation skill as competent trainers.
Teaching Material	i. Planning of Training Event and Presentation Skill ii. Demarcation of future roles of PTMD and Transport office
Language	Khmer is used for better understanding of all the participants.

Source: PPUTMP Project Team

Table 13.2-2 Outline of Training Course

Date & Time	1 October 2013; 8:20 - 12:00
Venue	Meeting room 1 of DPWT
Objective	i. To introduce PTMD, and ii. To understand the necessity of public transport.
Trainee	9 persons (staff of DPWT)
Trainer	Mr. Kazuo Yumita, JICA expert Mr. Ou Thonsal and Mr. Prom Kampoul, PTMD
Target Level of Achievement	i. PTMD Personnel: Know the roles and responsibilities for PTMD and can refer as necessary in their daily practices
Teaching Material	i. Slide for Demarcation of future roles of PTMD and Transport office ii. Slide for Introduction of Future Transport Plan iii. Slide for Necessity of Public Transport
Language	Khmer is used for better understanding of all the participants.

Source: PPUTMP Project Team

2)-2 Program and Time Schedule

The program and time schedule actually implemented are shown in Table-13.2-3 to Table 13.2-5.

Table 13.2-3 Training of Trainers (TOT) Program, 1st day (September 26th)

Time	Subject	Trainer/ Person in Charge
10:00 - 10:10	Registration	
10:10 - 10:20	Opening address	Director
10:20 - 10:40	Self-introduction	All of participants
10:40 - 11:00	Planning of Training Event	Mr. Yumita

11:00 - 12:00	Brainstorming to figure out role of PTMD in future	All of participants
12:00 - 14:00	Lunch Break	
14:00 - 15:00	Conclusion on the role of PTMD (Routine work & specific assignment)	All of participants
15:00 - 16:00	Preparation of training items for PTMD personnel on October 1	All of participants

Source: PPUTMP Project Team

Table 13.2-4 Training of Trainers (TOT) Program, 2nd day (September 27th)

Time	Subject	Trainer/ Person in Charge
10:00 - 10:10	Registration	
10:10 - 11:00	Review of training items of 1st day	All of participant
11:00 - 12:00	Preparation of training materials on 1st of October	All of participant
12:00 - 14:00	Lunch Break	
14:00 - 14:30	How to present (Speaker's attitude)	Mr. Yumita
14:30 - 15:00	Discussion of current issues (Parking Management)	All of participant
15:00 - 15:30	Evaluation of training	All of participant
15:30 - 15:40	Closing remarks	Mr. Yumita

Source: PPUTMP Project Team

Table 13.2-5 Training Program and Time Schedule (October 1st)

Time	Subject	Trainer/ Person in Charge
8:20 - 8:40	Registration	
8:40 - 9:00	Purpose of Training	Mr. Yumita
9:00 - 9:45	Role of New Organization (PTMD)	Mr. Ou Thonsal
9:45 - 10:30	Introduction of Future Transport Plan	Mr. Koto
10:30 - 10:40	Break	
10:40 - 11:00	Necessity of Public Transport	Mr. Prom Kampoul
11:00 - 11:30	Purpose of the 2nd Public Experiment (Public Bus System)	Mr. Yumita/Mr. Machida
11:20 - 11:50	Explanation of Questionnaires	Mr. Ou Thonsal
11:50 - 12:00	Closing remarks	Director

Source: PPUTMP Project Team

Photo of TOT

Photo of Training

2)-3 Evaluation and Questionnaires

A) Composition of Participants

The level of knowledge and capacity of understanding the lecture may vary depending on the position level of each participant. The composition of position levels of the trainees is as summarized in Table 13.2-6. A total of 16 persons participated as the trainees on October 1, 2013. In the table, it is seen that the majority of the participants were core staff of 'work force'.

However, participants of TOT consist of 3 Deputy Chiefs and 3 staff members. All of them attended this training course on October 1st as well.

Table 13.2-6 Number of Training Participants by Position Level

Position Level	No. of Participants
Deputy Chief	3
Staff	6
Total	9

Source: PPUTMP Project Team

B) Evaluation by the Participants on TOT

To know the evaluation of this TOT by the participants, evaluation sheets were handed out and filled by all the participants at the end of the training. The evaluation sheet was originally prepared in English and was explained to the participants in Khmer. The English version is shown in Table 13.2-7.

Table 13.2-7 Evaluation Sheet

General			
1. Before this Workshop, how much did you know about the role of PTMD?	Very much	Knew partly but not much	Little or very little
	1 person	1 person	4 persons
2. After this training (now), how much do you know about role of PTMD?	Very much	Know some but not much	Little or very little
	2 persons	4 persons	-
3. How much of what you have learned today do you think you will use?	Often	Sometimes	Seldom
	1 person	5 persons	-
4. Was the lecture easy to understand? (Were the lecturers good?)	Good	Average	Poor
	6 persons	-	-
5. Is the work concern easy to implement?	Easy	Generally OK	Difficult to do
	-	6 persons	-
Overall Evaluation			
6. Was the time of lectures too long or too short?	Too long	Just about right	Too short
	-	6 persons	-
7. Do you think this training useful overall?	Very useful	Average	Little useful
	6 persons	-	-

Source: PPUTMP Project Team

(i) Analysis of the evaluation by the participants
Based on the answers given in the above table, the following interpretations may be derived:
- Before the TOT, staff in field had very limited knowledge about roles of PTMD.
- After the Training, understanding of roles was considerably improved.
- All participants evaluated the Training 'useful'.

(ii) Comments by the participants
- Have never seen public transport systems.
- Longer time and continuous workshop are desirable.
- Concrete activities are unknown.
- Action manual is needed for junior staff members.
- Budget allocation to this PTMD is unknown so that the Project Team has to give more support.

C) Questionnaires for the Participants to Answer
After the training on the 1st of October, the participants were asked to answer a set of questions as shown in Table 13.2-8 below.

Table 13.2-8 Questionnaire

Training for
New Organization and Necessity of Public Transport
(Questionnaire)

(All the following questions are with regard to traffic. Please write your answers below.)

1. How do you feel about the current traffic condition in MPP?
2. Which system of public transport do you think is needed in MPP?
3. In case city bus is introduced, which roads are comfortable routes in MPP?
4. What kind of city bus services do you request to use?
5. Until when do you think before public transport such as city bus, BRT, and railway system is introduced?
6. What is your opinion about how to convert to public transport from current traffic modes?
7. When public bus will be introduced in MPP, how are you going to manage such a system?
8. What is your current routine work on a monthly basis?
9. When the new organization, Public Transport Management Division (PTMD), is established, what kind of work do you expect to do?
10. What do you think needs to be reformed for the capacity building in PTMD?

Source: PPUTMP Project Team

D) Conclusion and Recommendation

(i) Conclusion
- The TOT training and training course for PTMD personnel were successfully implemented.
- The knowledge on the role of existing organization was limited before the training.
- After the training, the knowledge on the activities of concern was considerably improved.
- All the participants felt the training was useful.

(ii) Recommendation
- Based on the above facts, it is recommended that similar training be delivered to all PTMD personnel regularly.

- In case of introduction of public transport, PTMD personnel may fall into confusion so that policy, guideline and training program for public transport need to be prepared as soon as possible.
- The Project is supporting this new organization for not only its roles and responsibilities but also its concrete activities for routine and specific works.

13.1.4 Proposed Training Courses for Public Transport Sector

Main focus of the proposed training course is the transport sector and the necessity of training courses shall be recommended by the Project Team written in practical frame. This log frame (logical framework) here considers the CD of DPWT. Table 13.2-9 below shows the log frame of the proposed training courses of transport sector, mainly focusing on public transport field.
It is recommended that the training courses be reviewed again when the nominated key persons start the training courses. The ideas and requests from the practical operations staff (Human Resources Office) are very important to prepare in detail the course design. The course focuses on CD and empowerment of organization that is the foundation of the governmental administration. The expected result has two parts: i) targeting the improvement of individual capability and ii) targeting organizational empowerment.
The courses should be well balanced to provide the target organization with both engineering and administration skills. In other words, DPWT needs human resources with both engineering knowledge and administrative capacity. The Project Team reiterates that even if training courses are successful, dissemination of knowledge to other colleagues is more important, so that DPWT should arrange to organize a harmonized holistic CD plan using practical OJT method.

Table 13.2-9 Log Frame of Capacity Development (Transport Planning)

	Indicator
[Overall Goal] To enhance the capacity for planning and management of environmentally sustainable transportation system based on concept of Green Economy which aims at simultaneous pursuit of preservation and economic development.	1. Monitoring and evaluation of the proposed Urban Transport Plan (PPUTMP) 2. Socio-economic indicators (Production, income, population) 3. Degree of people satisfaction
[Objective] To be able to propose the Action Plan on environmentally sustainable transport in consideration of current status of the country.	1. Development of action plan for short term 2. Regional development plan that utilize the potential factor
[Expected outcome] 1. Participants can review and analyze the current situation and issues of sustainable transportation system. 2. Participants can identify the direction and extension methods of policies, programs, and projects for sustainable transportation system. 3. Participants can draft an action plan. 4. Participants can propose an action plan to related organizations.	1. Monitoring the plan of each sector in PPUTMP 2.1 Regional development plan 2.2 Traffic demand forecast 3. Prioritization of projects 4. Discussion with Directors
[Activities] • Review of current situation of administration system. • Analysis of the national concept of transport network. • Review of initiatives and programs in Greater Mekong Subregion. • Review of transport planning and land use. • Review of city planning nationwide. • Review of public transport planning and Traffic Demand Management (TDM).	[Target Group] Middle ranking officer who have more than 3 years of experience in relevant sector

• Observation of environment and people-friendly transport infrastructure. • Analysis of budget request. • Preparation of action plan.	

Source: PPUTMP Project Team

Table 13.2-10 Log Frame of Capacity Development (Intelligent Transport System (ITS))

	Indicator
[Overall Goal] Traffic demand in Phnom Penh is rapidly increasing, and it is necessary to expand road capacity and enhance safety. However, it is often the case that physical expansion of roads is limited especially in urban areas. ITS assists to enhance the efficiency and safety of existing road network using real-time information. This program aims to enhance the capacity to introduce ITS.	1. Traffic Data 2. Monitoring the traffic flow 3. Degree of people satisfaction
[Objective] To disseminate the knowledge to introduce ITS to DPWT through acquiring the necessary knowledge and technique described below.	1. To conduct the training course
[Expected outcome] 1. To understand the outline and related technology of ITS. 2. To understand the role of the governments to introduce ITS. 3. To propose the action plan through specifying the applicable ITS technology in PPCH. 4. To disseminate the action plan to related officials.	1. Knowledge of ITS under PPCH 2. Strengthening of DPWT is necessary through training courses 3 & 4 Discussion with Directors
[Activities] • Lecture on outline and idea of ITS. • Lecture and site visit on related technology of ITS (Traffic signal control, ETC, VICS, AHS, Road facility control system, Safety driving support, Road management, etc.) • Lecture on ITS administration in other countries (The roles and cooperation among related governmental organizations, the roles and cooperation among the private sector, academic institute and government). • To make the action plan (the participant should pick up one or two applicable technology or knowledge) under the instruction from expert. • To disseminate the action plan and learned knowledge / technology. • Installed or expected to be installed ITS.	[Target Group] Middle ranking officers who have more than 3 years of experience in relevant sector or attended the ITS seminar before

Source: PPUTMP Project Team

Table 13.2-11 Log Frame of Capacity Development (Urban Public Transport)

	Indicator
[Overall Goal] The training aims at enhancing public transport by promoting understanding on advanced countries' system. By acquiring the knowledge on new tasks in the public transport such as environmental issues, utilizing public transport, safety, transport for disabled, transferring system, IC cards, connectivity between different modes, the participants will formulate transport policies for solving	1. Number of passengers who used public transport 2. Monitoring of financial statement

issues and developing urban public transport	
[Objective] To clarify the issues/problems for improving the planning/administrative management of urban public transport currently being tackled in their respective organizations.	1. To conduct the training course
[Expected outcome] 1. To analyze current status and major issues in urban public transport system in PPCH. 2. To acquire comprehensive knowledge on urban public transport system in other countries. 3. To cultivate applied skill for applying the acquired knowledge to PPCH and to deliberate the possibility of application to PPCH. 4. To clarify the issues/problems for improving the planning/administrative management of urban public transport to the respective organizations.	1. Monthly report to Director 2, 3 & 4. Training courses and discussion with Directors
[Activities] • Overview of policy and planning related to urban public transport in other countries (Development of urban transportation facilities and systems, measure for urban public transportation, Procedure of urban transport planning, Environmental problems caused by urban transport and their evaluation, etc.). • Particular subjects of urban public transport planning (Railway policy and situation, Road transport policy and situation, Traffic demand management in city, Metro and bus business in PPCH).	[Target Group] Middle ranking officers who have more than 5 years of experience in relevant sector

Source: PPUTMP Project Team

Table 13.2-12 Log Frame of Capacity Development (Road Administration)

	Indicator
[Overall Goal] To develop the capacity of road administration for the related government officials.	1. Monitoring of PPUTMP 2. Differences between plan and actual development
[Objective] To improve the road planning, construction and maintenance ability of the mid-level official in road sector. To confirm the participant's learning by a presentation based on knowledge acquired through lectures and site visits.	1. Budget for road improvement 2. Average speed, traffic density and transportation cost 3. Number of traffic accidents
[Expected outcome] 1. To understand the process of road planning and points to consider during preparation. 2. To understand the effects of road development and the evaluation method of the project. 3. To understand the process of road structure (mainly bridges) planning and points to consider during preparation. 4. To understand road paving. 5. To understand the new technologies and standards.	1.1 Road planning for short term 1.2 Traffic survey 2. Road inventory 3. Bridge Management System 4. Design standard and specification 5. Participation in the seminar, particularly on the latest method and international standards
[Activities] 【Subject related with Road Network Planning】 • Preparation method of road network planning.	[Target Group] 1. Engineers who graduate in university (civil engineering) or the equivalent

• Observation of other countries' outline of road administration. • Practice of economic analysis, project evaluation and demand forecast. • Practice of disaster prevention plan in the road network. • Site observation. 【Subject related with Road Route Planning】 • Preparation of road route planning. • Review of road related legislation. • Practice of public involvement, environmental impact assessment (EIA). • Inspection of road structure (Bridges, Pavement). • Preparation and management of road construction method and construction machinery. • Practice of road safety. • Management of road maintenance and life cycle cost assessment.	2. A mid-level officer in charge of road planning and expected to be assigned to a lead position in the future

Source: PPUTMP Project Team

Table 13.2-13 Log Frame of Capacity Development (Urban Railway Management)

	Indicator
[Overall Goal] As economy develops, urban railway is introduced to solve issues such as increase of traffic congestion, pollution and energy consumption. For safe and efficient management of the urban railway, there are some issues to be solved.	1. Monitoring of Pre-FS report
[Objective] To propose the improvement plan to establish the management system suitable for PPCH based on the understanding of the issues related to the operation of urban railways and the consideration of their present situations.	1. Implementation plan based on Pre-FS
[Expected outcome] 1. To be able to explain the importance of safe and efficient operation of urban railways. 2. To understand the management system and organization of other countries and to be able to apply that understanding to PPCH. 3. To understand the operation and maintenance methods of other countries' urban railways and to be able to apply that understanding to PPCH. 4. To propose the improvement plan for the management of the urban railways in PPCH organization.	Participation of the seminar and establishment of Phnom Penh Urban Transport Authority (PPUTA)
[Activities] • Lecture on other countries' railway administration and technical standard. • Lecture on participation of privatization and its impact. • Lecture on budget/revenue and expenditure for planning of railway project. • Lecture on railway demand forecast and planning. • Lecture on importance of safety in railway management. • Lecture on lessons and learnings from railway accidents. • Lecture on personnel management and human resource development in railway company (Operator). • Lecture on urban development by operator.	[Target Group] 1. Senior officer in the planning department with planning introduce urban railway

Source: PPUTMP Project Team

13.3 Analysis on Financial Capacity

13.3.1 Project Costs (Tentative)

The budget scale of MPWT, DPWT and PPCC, which take charge of traffic infrastructure development in PPCC, was estimated to be around 500 million USD in 2011 (≒ 1171 × 40% + PPCC + others 33). On the other hand, the total investment of each master plan's alternative is expected to be about 2,500 million USD to 5,500 million USD.

Table 13.3-1 Investment Cost by Alternatives (unit: million USD)

	Road	Bus	BRT or Tram	Tram & Elevated Transit	Elevated Transit	Elevated Transit (partially underground)	Total
Only road(new Case- 5)	2,432	-	-	-	-	-	2,432
Only bus(Alt - 1)	2,432	234	-	-	-	-	2,666
Bus and Tram(Alt - 2)	2,432	234	983	-	-	-	3,649
Bus, Elevated Transit and Tram(Alt - 3)	2,432	234	-	1,729	-	-	4,395
Bus and Elevated Transit(Alt - 4)	2,432	234	-	-	2,263	-	4,929
Bus, Elevated Transit and partially underground (Alt - 5)	2,432	234	-	-	-	2,968	5,634

Note: BRT= Bus Rapid Transit
Source: PPUTMP Project Team

Looking at the relations between investment and capital expenditure estimated for 2015 - 2035, the expenditure rate of minimum cost case for "only road" is 8%, and maximum "partially underground" case is 18%.

*presupposition of trial calculation

: the capital expenditure increases at the same rate of the supposed economic growth rate (6.5% until 2015, later 7.5% until 2035).

: The investment is constant at 2015 prices; however, it increases at the same rate as the supposed economic rate (as above).

: Accordingly, the investment rate against capital expenditure will be constant through maintenance period.

As a reference indicator, looking at the population ratio and Gross Regional Domestic Product (GRDP) ratio of Phnom Penh and those of Tokyo, it is estimated that the population of PPCC will be a little less than around 11% of total population of Cambodia (2008), GRDP is around 30% of Cambodia according to the estimate of 2002 Phnom Penh Master Plan. Looking at the same indicator of Tokyo, the population is 10.3% (as of 2010, 0.103= 13159000/128057000), and GRDP ratio is 17.7% (as of 2010, 0.177= 85221.1/482384.4 billion yen). The public gross fixed capital formation of Tokyo is 7.4% of the national's (as of 2010, 1.174= 1665.4/22228.1 billion yen).

Table 13.3-2 Future Capital Expenditure for Traffic Infrastructure and Investment Cost (unit: million USD)

Year	Future capital expenditure for traffic infrastructure	Only road		Only bus		Bus and Tram		Bus, Elevated Transit and Tram		Bus and Elevated Transit		Bus, Elevated Transit and partially underground	
2011	500	–	–	–	–	–	–	–	–	–	–	–	–
2012	533	–	–	–	–	–	–	–	–	–	–	–	–
2013	567	–	–	–	–	–	–	–	–	–	–	–	–
2014	604	–	–	–	–	–	–	–	–	–	–	–	–
2015	643	51	8%	56	9%	77	12%	92	14%	104	16%	118	18%
2016	691	55	8%	60	9%	82	12%	99	14%	111	16%	127	18%
2017	743	59	8%	65	9%	89	12%	107	14%	120	16%	137	18%
2018	799	64	8%	70	9%	95	12%	115	14%	129	16%	147	18%
2019	859	68	8%	75	9%	102	12%	123	14%	138	16%	158	18%
2020	923	73	8%	80	9%	110	12%	133	14%	149	16%	170	18%
2021	993	79	8%	87	9%	118	12%	143	14%	160	16%	183	18%
2022	1,067	85	8%	93	9%	127	12%	153	14%	172	16%	197	18%
2023	1,147	91	8%	100	9%	137	12%	165	14%	185	16%	211	18%
2024	1,233	98	8%	107	9%	147	12%	177	14%	199	16%	227	18%
2025	1,326	105	8%	116	9%	158	12%	190	14%	214	16%	244	18%
2026	1,425	113	8%	124	9%	170	12%	205	14%	230	16%	263	18%
2027	1,532	122	8%	134	9%	183	12%	220	14%	247	16%	282	18%
2028	1,647	131	8%	144	9%	196	12%	237	14%	265	16%	303	18%
2029	1,770	141	8%	154	9%	211	12%	254	14%	285	16%	326	18%
2030	1,903	151	8%	166	9%	227	12%	273	14%	307	16%	351	18%
2031	2,046	163	8%	178	9%	244	12%	294	14%	330	16%	377	18%
2032	2,199	175	8%	192	9%	262	12%	316	14%	354	16%	405	18%
2033	2,364	188	8%	206	9%	282	12%	340	14%	381	16%	436	18%
2034	2,542	202	8%	222	9%	303	12%	365	14%	410	16%	468	18%
2035	2,732	217	8%	238	9%	326	12%	393	14%	440	16%	503	18%

Source: PPUTMP Project Team

According to the findings at this stage, the investment amount of PPUTMP is supposed to be around 10% ~ 20% of the traffic related budget, which MPWT, DPWT and PPCC have. About the said budget scale, it is important to consider the cost allocation such as PPP and verify the feasibility in financial affairs by using financial analysis, and it is necessary to discuss the validity.
Moreover, about the future revenue, most of the revenue sources of the capital expenditure depend on Grants and Loans from abroad (70% in 2011) in the present situation. Therefore, the improvement of domestic revenue is supposed to be necessary for the implementation of this project.

13.3.2 Current Public Finance

(1) Current Situation of Fixed Capital Formation of Cambodia

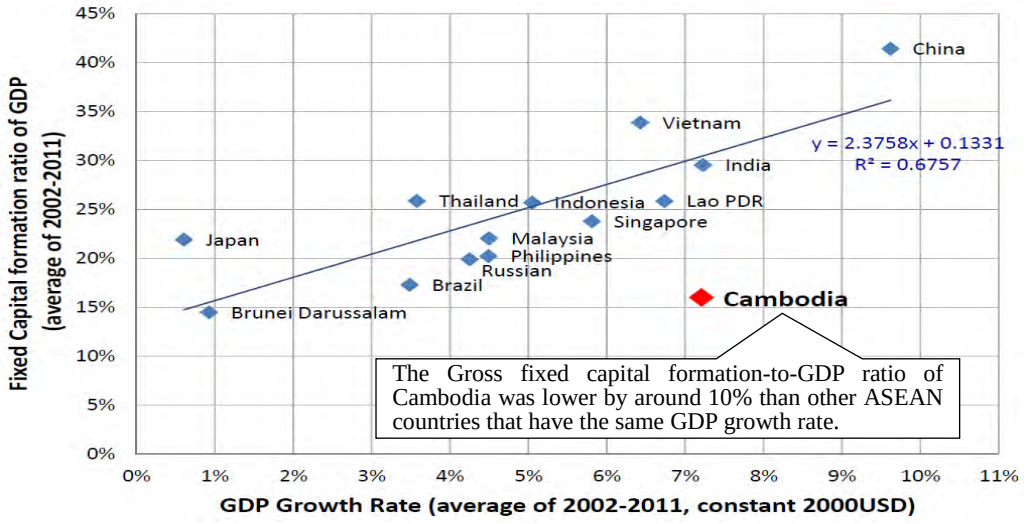
The gross fixed capital formation to Gross Domestic Product (GDP) ratio in the past decade (2002~2011) in Cambodia was 18.4%, which was 3.7% lower than the 22.1% average for the Association of Southeast Asian Nations (ASEAN).

Table 13.3-3 Gross Fixed Capital Formation in Past 10 Years (% of GDP)

Country Name	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Cambodia	**19.0**	**18.7**	**18.3**	**18.9**	**19.3**	**19.8**	**17.3**	**20.1**	**16.2**	**16.0**	**18.4**
Brunei Darussalam	21.2	15.0	13.4	11.4	10.5	13.0	13.7	17.6	15.9	13.4	14.5
Indonesia	19.4	19.5	22.4	23.6	24.1	24.9	27.7	31.1	32.1	32.0	25.7
Lao PDR	18.3	17.8	24.0	23.1	27.1	34.1	32.1	30.3	24.3	27.4	25.8
Malaysia	23.5	22.4	21.0	22.3	22.0	22.4	20.6	22.0	22.3	22.1	22.0
Myanmar	9.8	11.0	11.7	-	-	-	-	-	-	-	10.8
Philippines	20.6	20.7	20.3	19.9	20.1	19.9	19.7	19.0	20.5	21.5	20.2
Singapore	25.5	23.6	23.1	21.1	21.7	22.9	26.5	26.0	24.2	23.4	23.8
Thailand	22.8	24.1	25.9	28.9	28.1	26.4	27.4	24.1	24.7	26.3	25.9
Vietnam	31.1	33.4	33.3	32.9	33.4	38.3	34.6	34.5	35.6	31.9	33.9
ASEAN average	21.1	20.6	21.4	22.5	22.9	24.6	24.4	25.0	24.0	23.8	22.1
Brazil	16.4	15.3	16.1	15.9	16.4	17.4	19.1	18.1	19.5	19.3	17.3
Russian Federation	17.9	18.4	18.4	17.8	18.5	21.0	22.3	22.0	21.8	21.3	19.9
India	23.8	24.6	28.7	30.3	31.3	32.9	32.3	31.6	30.4	29.5	29.5
China	36.3	39.4	40.7	40.1	40.7	39.1	40.8	46.0	45.7	45.5	41.4
BRICs average	23.6	24.4	25.9	26.0	26.7	27.6	28.6	29.4	29.3	28.9	27.0
Japan	22.9	22.5	22.2	22.3	22.7	22.6	22.4	20.8	20.1	20.7	21.9

Note: This is a national total fixed capital formation, not government. Gross fixed capital formation includes roads, railways, schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings and so on.
Source: World development indicators (2012, World Bank)

The relationship between gross fixed capital formation-to-GDP ratio and GDP growth rate is as shown below. The gross fixed capital formation-to-GDP ratio of Cambodia was lower by around 10% than other ASEAN countries that have the same GDP growth rate.

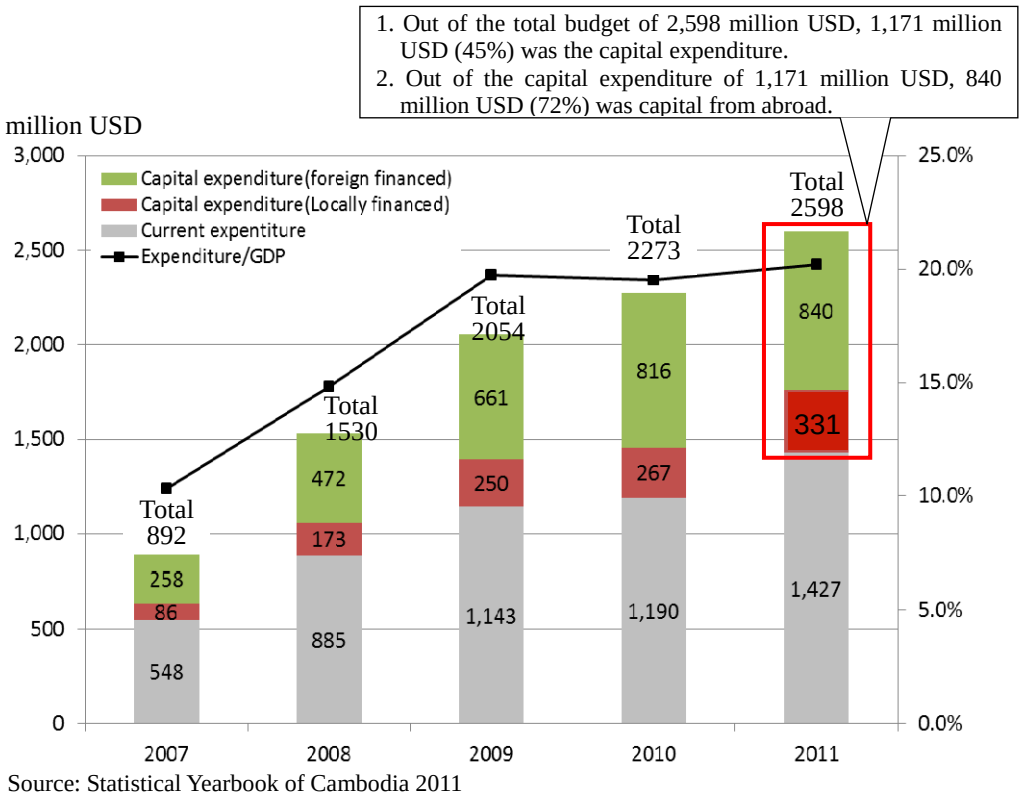


Source: World development indicators (2012, World Bank)

Figure 13.3-1 GDP Growth Rate and Fixed Capital Formation-to-GDP Ratio

(2) Capital Expenditure of Central Government

According to the expenditure situation of fixed capital of the Cambodian government, out of the total expenditure of 2,598 million USD in 2011, 1,171 million USD (45%) was the capital expenditure. In this capital expenditure, 840 million USD (72%) was financed by funds from abroad; 66.6% of the foreign funds (2010) were Grants and the others were Loans.
Also, government spending of Cambodia increased by 2.91 times in the past 5 years from 892 million USD in 2007 to 2,598 million USD in 2011, and GDP rate doubled from 10.3% to 20.2%.



Source: Statistical Yearbook of Cambodia 2011

Figure 13.3-2 Central Government Expenditure and Expenditure-to-GDP Ratio

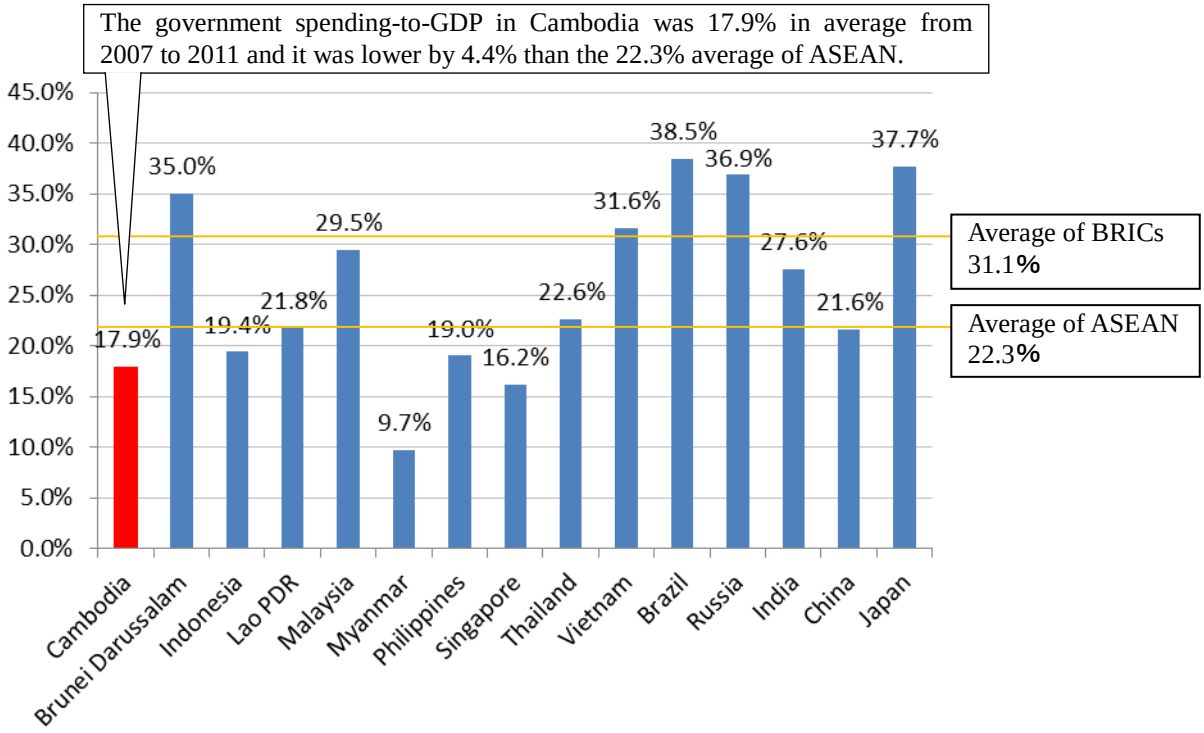
Table 13.3-4 Central Government Real Expenditure

(In millions of USD; unless otherwise indicated)

		2007	2008	2009	2010	2011
Current Expenditure	(A)	548	885	1,143	1,190	1,427
Capital Expenditure	(B=C+D)	344	645	911	1,083	1,171
-locally financed	(C)	86	173	250	267	331
-foreign financed	(D)	258	472	661	816	840
Total Expenditure	(E=A+B)	892	1,530	2,054	2,273	2,598
GDP	(F)	8,631	10,337	10,400	11,634	12,874
Budget/GDP	(E/F)	10.3%	14.8%	19.8%	19.5%	20.2%
Grants in % of GDP		2.2	3.1	4.1	4.8	-
Loans in % of GDP		3.2	2.5	2.5	2.4	-

Source: Statistical Yearbook of Cambodia 2011; State Budget Implementation 2011; Cambodia, More Efficient Government Spending for Strong and Inclusive Growth (2011, WB)

The average ratio of the government spending-to-GDP in Cambodia was 17.9% in the past 5 years, which was 4.4% lower than the 22.3% ASEAN average. However, since the amount of government spending increased rapidly, the GDP ratio in 2011 reached around19.7%.



Source: World Economic Outlook Database, April 2012 (IMF)

Figure 13.3-3 General Government Total Expenditure (% of GDP, average of 2007-2011)

Table 13.3-5 General Central Government Real Expenditure (% of GDP)

Country	2007	2008	2009	2010	2011	Average	Estimates Start After
Cambodia	**14.5%**	**15.6%**	**20.0%**	**19.9%**	**19.7%**	**17.9%**	**2011**
Brunei Darussalam	32.5%	30.1%	38.7%	40.1%	33.7%	35.0%	2011
Indonesia	20.3%	21.3%	18.3%	18.2%	19.0%	19.4%	2010
Lao PDR	18.8%	20.2%	24.6%	23.7%	21.8%	21.8%	2009
Malaysia	27.9%	28.8%	32.4%	28.5%	29.7%	29.5%	2010
Myanmar	9.3%	7.9%	9.8%	11.2%	10.4%	9.7%	2010
Philippines	19.0%	18.6%	20.1%	19.2%	18.1%	19.0%	2011
Singapore	12.1%	17.9%	18.7%	14.7%	17.6%	16.2%	2011
Thailand	21.3%	21.2%	24.0%	23.2%	23.3%	22.6%	2011
Vietnam	30.6%	29.4%	34.5%	33.1%	30.3%	31.6%	2011
ASEAN average	20.6%	21.1%	24.1%	23.2%	22.4%	22.3%	-
Brazil	38.3%	37.7%	38.1%	39.4%	38.8%	38.5%	2011
Russia	33.1%	34.3%	41.4%	39.0%	36.8%	36.9%	2011
India	26.0%	27.5%	29.3%	28.0%	27.1%	27.6%	2010
China	18.9%	20.0%	23.1%	22.5%	23.6%	21.6%	2011
BRICs average	29.1%	29.9%	33.0%	32.2%	31.6%	31.1%	-
Japan	33.3%	35.7%	40.0%	39.0%	40.7%	37.7%	2010

Source: World Economic Outlook Database, April 2012 (IMF)

(3) Capital Expenditure to Infrastructure

1) Main entities of the infrastructure development in Phnom Penh

The infrastructure development in Phnom Penh seems to be almost performed by the following entities:

: MPWT=development of national road
: DPWT=development of road in Phnom Penh
: P P C H=development of road in Phnom Penh

The Role Sharing is not necessarily fixed, so there are some cases such as Friendship Bridge which is under construction by MPWT; on the other hand, the second Monivong Bridge is undertaken by PPCC (DPWT is technical assistant).

2) Budget of MPWT

i) Current Expenditure of MPWT

According to the budget for the different ministries of Cambodia, the total share of current expenditure in 2010 was 1,205.6 million USD and the budget of MPWT was 7.6 million USD (0.63%).

Table 13.3-6 State Budget of Current Expenditure by Ministry-Institution (million USD)

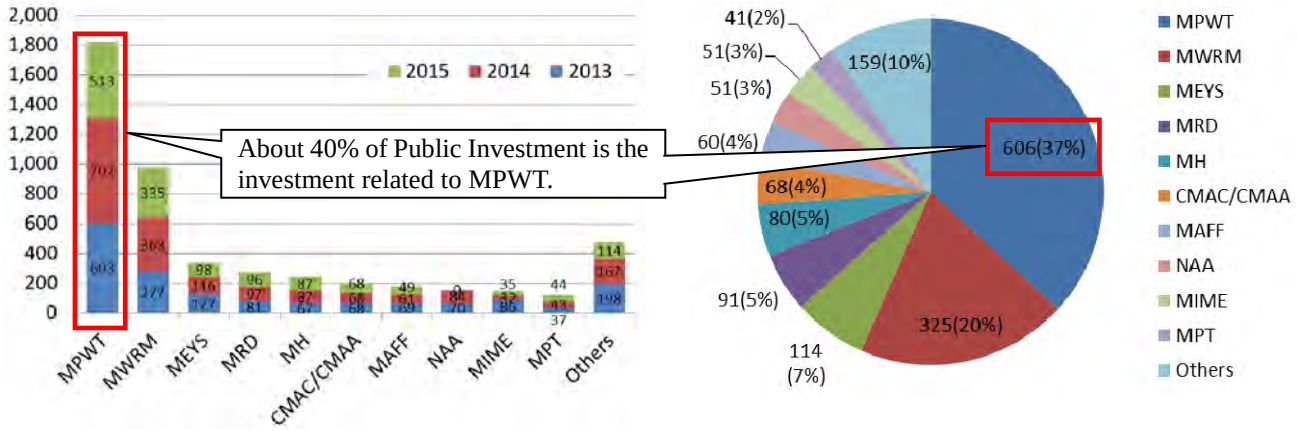
	2006	2007	2008	2009	2010
Total expenditure	578.5	848.4	1,049.8	1,143.2	1,205.6
1. General Administration	103.8	259.4	310.4	318.4	366.5
2. Defense and Security	126.8	139.5	194.6	343.4	290.8
3. Social Administrative	220.1	253.7	271.2	393.7	424.5
4. Economic Administrative	58.4	65.5	100.8	83.8	96.9
-MPWT	**4.2**	**4.9**	**5.7**	**7.2**	**7.6**
-Others	54.2	60.7	95.0	76.6	89.3
official exchange rate	4103	4075	4060	4157	4191

Source: Statistical Yearbook of Cambodia 2011

ii) The capital expenditure of MPWT

According to the Public Investment Programme 3-Year-Rolling 2013 - 2015, MPWT's capital expenditure in 2013 will be 603 million USD and its average in 3 years will be 606 million USD. It is 37% of total public investment.

■Total ■Average（2013 - 2015）



Source: Public Investment Program 3-Year-Rolling 2013-2015 (Ministry of Planning)

Figure 13.3-4 Public Investment Programme 2013 to 2015 by Ministry

Table 13.3-7 Public Investment Programme 2013 to 2015 by Ministry

(unit: million USD)

	2013	2014	2015	Total	Average	%
MPWT	**603**	**702**	**513**	**1,818**	**606**	**36.8%**
MWRM	277	363	335	975	325	19.7%
MEYS	127	116	98	341	114	6.9%
MRD	81	97	96	274	91	5.5%
MH	67	87	87	241	80	4.9%
CMAC/CMAA	68	68	68	203	68	4.1%
MAFF	69	61	49	179	60	3.6%
NAA	70	84	0	153	51	3.1%
MIME	86	32	35	152	51	3.1%
MPT	37	43	44	123	41	2.5%
Others	198	167	114	478	159	9.7%
Total	1,682	1,818	1,439	4,939	1,646	100.0%

Source: Public Investment Programme 3-Year-Rolling 2013 - 2015 (Ministry of Planning)

Also, according to the Public Investment Programme 3-Year-Rolling 2013 - 2015, in 2013 (and it seems to be quite accurate), total investment amount will be 1,682 million USD; and 1,095 million USD of this amount, of which source of fund is already committed, will be depending on foreign funds by 80%.
In 2011, 840 million USD (72%) of the total capital expenditure of 1,171 million USD was foreign capital.

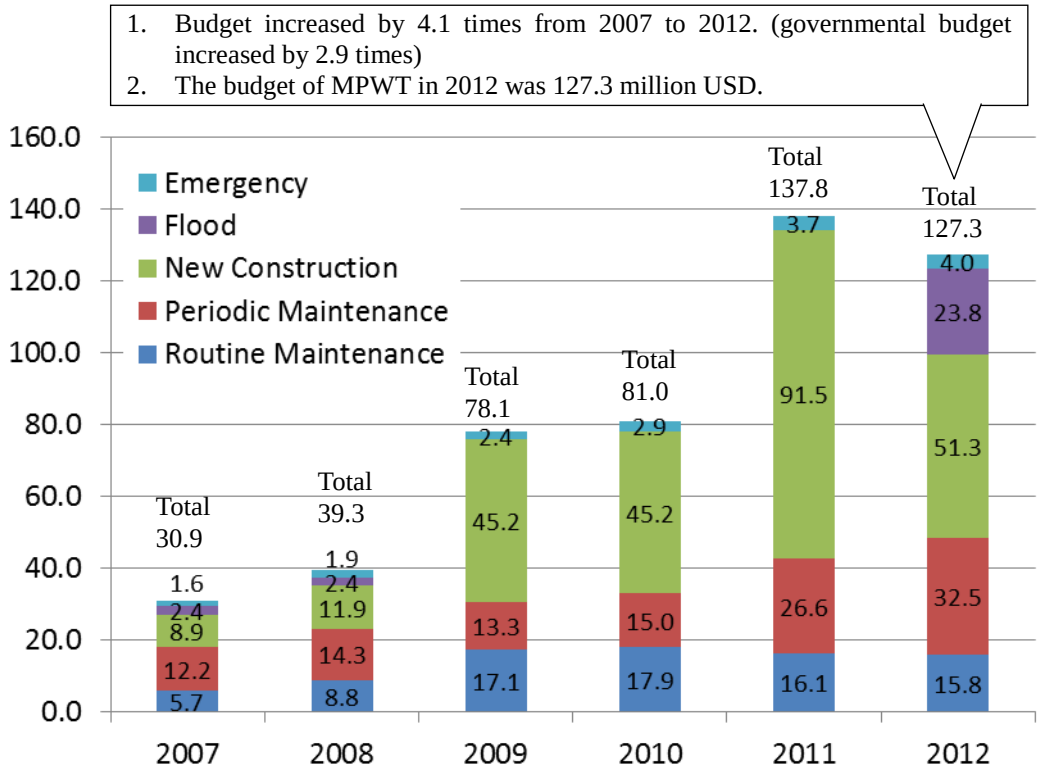
Table 13.3-8 Source of Funds of Public Investment, 2013 to 2015

(unit: million USD)

	Source of Funds		2013		2014		2015	
			Total	MPWT	Total	MPWT	Total	MPWT
On-Going Projects	Committed Funds	RGC	161	19	85	9	127	1
		DPS	755	375	306	209	557	71
	Additional Funds Required		147	0	142		85	
	Total Planned Expenditure		1,063	395	825	218	475	72
Planned Projects	Committed Funds	RGC	62	3	84	10	75	2
		DPS	118	19	209	19	195	4
	Additional Funds Required		440	186	722	454	671	434
	Total Planned Expenditure		619	208	993	483	964	440
Total	Committed Funds	RGC	223	22	169	19	202	3
		DPS	872	395	514	229	752	75
	Additional Funds Required		587	186	864	454	755	434
	Total Planned Expenditure		1,682	603	1,818	702	1,439	512

Note: RGC=Royal Government of Cambodia, DPS=Development Corporation Partners
Source: PUBLIC INVESTMENT PROGRAMME 3-YEAR-ROLLING 2013-2015

Moreover, according to the budget sources of MPWT, MPWT had 127.3 million USD of the national budget (2012) with the breakdown as follows: newly establishment of road was 51.3 million USD (40.3%), periodic maintenance - 32.5 million USD (25.5%), flood measures - 23.8 million USD (18.7%), routine maintenance - 15.8 million USD (12.4%) and emergency action budget was 4.0 million USD (3.1%). The emergency action budget is a budget for immediate action in case that bridges, etc. are destroyed by disasters.
Since the Rolling Plan is the perspective of the national public investment, those elements are included there.



Budget Category		Planned Budget						Total
		2007	2008	2009	2010	2011	2012	
1	Routine Maintenance	5.7	8.8	17.1	17.9	16.1	15.8	83.9
2	Periodic Maintenance	12.2	14.3	13.3	15.0	26.6	32.5	113.9
3	New Construction	8.9	11.9	45.2	45.2	91.5	51.3	254.0
4	Flood Measures	2.4	2.4				23.8	28.6
5	Emergency	1.6	1.9	2.4	2.9	3.7	4.0	16.4
Total		30.9	39.3	78.1	81.0	137.8	127.3	496.7
Exchange rate		4100R	4200R	4200R	4200R	4100R	4000R	-

Note: New Construction in 2011 includes Flood Measures.
Source: MPWT

Figure 13.3-5 Budget Allocation for Road Maintenance (million USD)

3) Budget of DPWT

Although the capital expenditure of DPWT significantly differs each year, it has remained at around 2 million USD in the last 3 years.

Table 13.3-9 Expenditure of DPWT（million USD)

	Source	2007	2008	2009	2010	2011	2012
Maintenance	MPWT	-	-	-	0.1	0.1	0.2
	PPCC	-	-	-	-	-	-
New Construction	MPWT	3.9	1.4	7.8	1.5	2.3	2.1
	PPCC	2.9	11.8	0.7	-	-	-
Total		6.8	13.2	8.4	1.6	2.4	2.3

Source: DPWT

4) Budget of PPCC

The capital expenditure for roads, parks, sewage, etc. in Phnom Penh increased by 1.6 times from 23 million USD in 2007 to 37 million USD in 2011.

Table 13.3-10 Expenditure of PPCC（million USD)

	2007	2008	2009	2010	2011
maintenance	19	31	24	24	28
new construction	3	0	3	11	8
Total	23	31	27	36	37

Source: PPCC

5) Conclusion

From the above, the following are assumed as the budget related to the infrastructure in Phnom Penh:

MPWT＝around 40% of Public Investment Budget (2013 - 2015 average in the Rolling Plan)
DPWT＝around 2.1 million USD (2010 - 2012 average)
PPCH＝around 33 million USD (2009 - 2011 average)

PPUTMP requires a construction cost of 232 million USD in the short term 2014 - 2016 (= about 77 million USD in a single year), 926 million USD in the medium term 2017-2020 (= about 232 million USD in single year) and 3,276 million USD in the long term 2021 - 2035 (= about 218 million USD in a single year).
Furthermore, when the construction cost was arranged by organization, it is found that MPWT needs a budget of 3,032 million USD (= 68% of the total cost) and DPWT needs 1,193 million USD (= 27% of the total cost) in the short and medium terms.

Table13.3-11 Budget of Phnom Penh Urban Traffic Master Plan (million USD)

■Grand Total (= Road + Traffic Management + Public Transport)

	Short Term (14 - 16)	Medium Term (17 - 20)	Long Term (21 - 35)	Total	Total (%)
DPWT	143	295	756	1,193	27%
DPWT	127	219	361	707	16%
PPP	16	76	395	486	11%
MPWT	89	567	2,377	3,032	68%
MPWT	81	526	617	1,224	28%
PPP	8	41	1,759	1,808	41%
PPP*	0	64	144	209	5%
Total	232	926	3,276	4,434	100%

■Public Transport

	Short Term (14 - 16)	Medium Term (17 - 20)	Long Term (21 - 35)	Total	Total (%)
DPWT	3	6	14	23	1%
DPWT	0	1	0	1	0%
PPP	3	5	14	21	1%
MPWT	0	380	1,891	2,271	133%
MPWT	0	380	181	560	33%
PPP	0	0	1,711	1,711	100%
Total	3	385	1,905	2,293	100%

■Road

	Short Term (14 - 16)	Medium Term (17 - 20)	Long Term (21 - 35)	Total	Total (%)
DPWT	107	256	708	1,071	52%
DPWT	94	184	328	606	30%
PPP	13	71	381	465	23%
MPWT	89	187	486	762	37%
MPWT	81	146	437	664	33%
PPP	8	41	49	98	5%
PPP*	0	64	144	209	10%
Total	196	507	1,338	2,041	100%

■Traffic Management

	Short Term (14 - 16)	Medium Term (17 - 20)	Long Term (21 - 35)	Total	Total (%)
DPWT	33	33	33	100.0	100%
DPWT	33.3	33.3	33.3	100.0	100%
PPP				0.0	0%
MPWT	0	0	0	0.0	0%
MPWT				0.0	0%
PPP				0.0	0%
Total	33.3	33.3	33.3	100.0	100%

Note：For PPP with "*", which government ministry or agency is not yet clear at present.
：A cost of railway is included in MPWT.
Source: PPUTMP Project Team

The following table shows a total cost in the short and medium terms, an annual average cost and an estimated annual budget by organization. Regarding the short and medium term budget, it is necessary to raise it urgently.
DPWT and PPCC are estimated to have 40 million USD infrastructure budget annually; however, to execute the projects listed in PPUTMP, DPWT and PPCC are estimated to need 63 million USD annual budget. To raise this amount that is 1.6 times more than the present budget, promoting PPP, securing an original tax source and receiving financial support from central government are needed.
MPWT is estimated to have an annual budget of about 400 - 500 million USD for infrastructure; however, to execute the projects listed in PPUTMP, MPWT is estimated to need an additional budget of about 100 million USD annually. To raise this amount, promoting PPP, using a soft loan, etc. are needed.

Table13.3-12 Total Cost in Short and Medium Terms (2014-2020), Annual Average Cost, and Estimated Annual Budget by Organization（million USD)

Organization	Total cost in 2014－2020 (X)	Annual average cost (Y=X/7)	Estimated annual budget
DPWT(*1)	438	63	About 40
DPWT	346	49	
PPP	91	13	
MPWT	720	103	About 400 ~ 500
MPWT	607	87	
PPP(*2)	113	16	
Total	1,158	165	

Note: *1= A estimated budget of DPWT contains an infrastructure budget of PPCC.
*2= Regarding PPP, if a public sector in charge is unclear, a cost of the PPP is included as a cost of MPWT.
Source: PPUTMP Project Team

14 IMPLEMENTATION PLAN

14.1 Introduction

To materialize the implementation plan of the 2035 Urban Transport Master Plan, the preconditions that include time schedule, project implementation capacity and financial considerations are set up.

14.1.1 Time Frame

The planning period (2014 ~ 2035) is divided in three as follows:

- Short term: 2014 ~ 2016
- Medium term: 2017 ~ 2020
- Long term: 2021 ~ 2035

14.1.2 Project Implementation Body and Personnel

The Phnom Penh City Hall (PPCH), the Department of Public Works and Transport (DPWT), the Ministry of Public Work and Transport (MPWT) and the Private Sector are the infrastructure body and personnel currently working toward the implementation of the master plan in Phnom Penh Capital City (PPCC), but mainly with regards to road project implementation. However, this master plan includes not only road projects but also public transport to be newly introduced and traffic management projects. Therefore, human resources of the public sector (PPCH, DPWT and MPWT) should have the administrative and technical capacities for the implementation of the Urban Transport Master Plan projects with support provided by professional engineers having enough capacity to implement projects in accordance with the proposed implementation schedule.

14.1.3 Expected Budget for Phnom Penh's Infrastructure

The total project cost of the 2035 Urban Transport Master Plan for the next 22 years is about 4,564 million USD (207 million USD/year). Out of this amount, 2,470 million USD (54% of the total), 2,041 million USD (45%) and 53 million USD are earmarked for the sectors of public transport, road, and traffic management, respectively. This means that more than 50% of the project cost will go to new type of infrastructure such as public transport.
On the other hand, previous infrastructure development of the transport sector was only road development, and the annual average cost was only 75 million USD. This amount covered not only road but also flood control and other improvements. Considering these circumstances, it is necessary to look into new types of loan framework and to accelerate the positive participation of the private sectors.

14.2 Cost Estimation

14.2.1 Public Transport Project

(1) Unit Construction Cost

Assumed unit costs for the public transport sector are shown in Table 14.2-1 considering the results of the Preliminary F/S and the 2nd public experiment, and current construction data.

Table 14.2-1 Project Construction Cost for Public Transport

Project Name	Unit Cost	Unit	Remarks
Rail Transit	54.2	Mil.USD/km	Incl. Rail Transit Stations and Depot
Bus System	0.05	Mil.USD/km	Incl. Bus Depot, Bus Terminal, Bus Stop and Bus Priority Measures
Commuter Rail System	2.1	Mil.USD/km	Incl. Commuter Rail Station
Improvement of Water Transport	0.1	Mil.USD/jetty	

Source: PPUTMP Project Team

(2) Public Transport Program Cost

The public transport program cost is estimated as shown in Table 14.2-2.

Table 14.2-2 Public Transport Program Cost

Code	Package Name	Project Components		Quantity	Cost	Finance
		Code	Project Name		(Mil. USD)	
PP-1	Rail Transit (Phase 1)	PT-1	Rail Transit (Phase 1)	14.0km	722.0	Japan Loan
		PT-3	Rail Transit Stations	U/G=2, Elv.=10		
		PT-4	Rail Transit Airport Station	Elv.=1		
		PT-5	Rail Transit Depot	8.0ha	37.0	
PP-2	Rail Transit (Phase 2)	PT-2	Rail Transit (Phase 2)	30.8km	1670.0	MPWT/DPWT/PPP
		PT-3	Rail Transit Stations	U/G+Elv.=30		
PP-3	Bus System (Phase 1)	PT-6	Bus Route	57 km	2.9	DPWT/PPP
		PT-7	Bus Depot			
		PT-9	Bus Terminal (Type 1)			
		PT-10	Bus Terminal (Type 2)			
		PT-11	Bus Stop			
		PT-13	Bus Priority Measures			
PP-4	Bus System (Phase 2)	PT-6	Bus Route	91 km	4.6	DPWT/PPP
		PT-7	Bus Depot			
		PT-9	Bus Terminal (Type 1)			
		PT-10	Bus Terminal (Type 2)			
		PT-11	Bus Stop			
		PT-12	BRT			
		PT-13	Bus Priority Measures			
		PT-14	Bus Location System			
PP-5	Bus System (Phase 3)	PT-6	Bus Route including Feeder to Rail Transit	278 km	13.9	DPWT/PPP
		PT-7	Bus Depot			
		PT-9	Bus Terminal (Type 1)			
		PT-10	Bus Terminal (Type 2)			
		PT-11	Bus Stop			
		PT-12	BRT			
		PT-13	Bus Priority Measures			
		PT-14	Bus Location System			
PP-6	Restructuring of the para-transit operation	PT-15	Restructuring of the para-transit operation (1): Motodop		Soft Components	DPWT
		PT-16	Restructuring of the para-transit operation (2): Motorumok modern (Tuk-tuk)		Soft Components	
		PT-17	Restructuring of the para-transit operation (3): Cyclo		Soft Components	
		PT-18	Restructuring of the para-transit operation (1): Commuter Truck		Soft Components	
PP-7	Commuter Rail System	PT-19	Introduction of Commuter Rail System	19.3km	20	MPWT/PPP
		PT-20	Commuter Rail Station	9 stations		
PP-8	Improvement of Water Transport	PT-21	Improvement of Water Transport	11 Jetties	1.1	DPWT
Total					2,471.4	

Source: PPUTMP Project Team

14.2.2 Road Projects

(1) Unit Construction Cost

Unit construction cost is assumed on the basis of information from international contractors and average cost of past construction records from DPWT.

Road surface is assumed as asphalt concrete type for all the proposed projects.
In the case of arterial roads such as one digit national roads, additional embankment is often required for protecting the road bed from inundation in the rainy season; therefore, the unit cost is likely higher than those for the other roads.
The assumed unit cost is shown in the table below.

Table 14.2-3 Unit Construction Cost

Road Type	Unit Cost (USD/m2)	Remarks
Arterial Roads (New Road)	150	
Arterial Road (Rehabilitation/ Small Scale Widening)	100	incl. sidewalk only
Other Road (New and Widening)	100	
Bridge Construction	1,500	incl. flyover
Underpass	2,500	

Source: PPUTMP Project Team

(2) Land Acquisition Cost

Land acquisition cost is estimated by referring to the land market prices obtained from websites of land developers. Although the proposed road may sometimes affect houses and other properties, the cost is limited only to the land value and excludes the cost for the compensation of the buildings, since this study is still in the master plan stage.

Table 14.2-4 Unit Land Price of Selected District

Name of Selected District	Unit Land Price USD/m2
Boeng Tumpun	100
Stean Mean Chay	250
Sen Sok	20
NR1 South	80
Russei Keo	50
Po Senchey	30
Dang Kao	70
Mean Chey	100

Source: PPUTMP Project Team

(3) Road Project Cost

The road project cost is estimated as shown in Table 14.2-5.

Table 14.2-5 Road Project Cost

Code	Project Name	Project Components	Total Length (km)	Const Cost (million USD)	Land Cost (million USD)	Project Cost (million USD)
RP-1	Widening and Sidewalk of Arterials in Central Area(IRR, Monireth, Toul Kok)	A1,A2,A3,A4,A5	10.1	11.3	9.6	20.8
RP-2	Boeng Kok Road	A6, C52	6.5	12.7	18.0	30.6
RP-3	Missing Links in Central Area	C50, C51	1.3	7.0	4.2	11.2
RP-4	Widening of NR1, Chabar Ampov - New PP Port	A25,A26	25.3	37.2	0.0	37.2
RP-5	New E-W Arterial Road (NR1 - Cheng Aek Road)	A7,A8	11.5	49.2	13.9	63.1
RP-6	New E-W Arterial Road (Cheng Aek - RR-IV)	A9, A33	16.1	46.4	33.3	79.7
RR-7	New and Widening of RR-II (NR2 - NR5)	A12,A13,A14	20.4	52.5	52.0	104.4
RR-8	Extension of RR-II (NR5-NR6)	A15	2.9	31.4	2.7	34.1
RP-9	RR-III (NR1 - Junction with NR21)	A16	18.5	63.8	9.5	73.3
RP-10	RR-III(NR21 - NR4)	A17,A18	24.5	81.0	36.5	117.5
RR-11	Widening of RR-III(NR4 - 4km section)	A19	4.1	13.5	13.5	27.1
RR-12	Widening of RR-III(4km from NR4 - Preak Pnob Bridge)	A20	10.7	18.5	6.2	24.6
RP-13	RR-IV (NR1 - NR6)	A21,A22,A23,A24	80.8	249.8	39.1	288.9
RP-14	Widening of NR2 (Junction with NR21 - RR-III)	A27, A31	12.1	29.6	4.4	34.0
RP-15	Widening of NR3 (Junction with RR-III - RR-IV)	A32	9.2	19.4	1.7	21.0
RP-16	Widening of Chaom Chao Road	A30	8.4	18.8	0.0	18.8
RP-17	Widening of Russia/NR4 (IRR - RR-IV)	A34, A35	15.2	15.5	2.0	17.4
RP-18	New E-W Arterial in Sen Sok(Toul Kok - RR-IV)	A36, A37	15.9	24.1	22.4	46.5
RP-19	Widening of Hanoi Road (RR-II - RR-III)	A38	4.9	8.9	1.8	10.7
RP-20	Widening of NR5 (Chruoy Changvar Bridge - RR-IV)	A39, A40	15.0	26.7	0.1	26.7
RP-21	Chban Ampov area Development Road package	C2, C6, C7, C9	18.9	48.4	14.8	63.2
RP-22	Mean Chey District Urban Development road package	C3, C4, C5	27.0	37.6	23.9	61.5
RP-23	Mean Chey - Diamond Island Connection Rd package	C1, C8	5.8	9.5	12.0	21.5
RP-24	AZ Green City Development Road package	A28,C10, C11, C12	34.2	96.8	40.1	136.9
RP-25	Chaom Chao South Area Development road package	A29,C15, C16, C17, C18	25.7	34.1	28.4	62.5
RP-26	Russia - Chaom Chao Connection & Boeng Tumpun Access	C13, C14, C19	8.5	8.6	13.7	22.4
RP-27	Samraon Kraom Sub-center Development Road package	C20, C21, C39	15.3	23.0	21.5	44.5
RP-28	Western Peripheral area development roads bw RR-III and RR-IV	C45, C47, C49, C46	31.2	45.9	11.5	57.4
RP-29	Phnom Penh Thmei district Development package(West of Hanoi)	C40, C37, C41	22.5	34.6	35.3	69.9
RP-30	Krang Thnong New Sub-center package	C42, C43, C44, C38	20.8	29.5	18.7	48.2
RP-31	Camko/Grand Phnom Penh Development package	C22, C35, C36	9.8	12.5	13.4	25.9
RP-32	Ruessei Keo, Kilolekh6 area Development roads	C23, C24	9.3	9.0	20.7	29.7
RP-33	Soka, Chruoy Changvar Development roads	C26, C27, C25	9.6	15.0	26.0	41.0
RP-34	Garden City Preak Pnob Development roads	C28, C29, C30, C31, C32,	37.5	46.9	25.6	72.5
RP-35	Flyover or Underpass Project in the Central Area(Monivong North, Toul Kok, Monivong South)		1.1	30.8	n.a.	30.8
RP-36	Flyover or Underpass Project (Monivong North, Toul Kok, Monivong South, Hanoi/Russia, Hanoi/Chaom Chao, Cheng Aek/Tumnop Thmei, ICs or Flyovers along RR-III and RR-IV)		9.3	165.5	n.a.	165.5
	Total		599.7	1464.9	576.3	2041.1

Source: PPUTMP Project Team

The total project cost is estimated to be 2,041 million USD at 2013 prices.

14.2.3 Traffic Management Project

(1) Unit Construction Cost

Unit construction costs for the traffic management sector are set in Table 14.2-6 considering current construction data such as sidewalk improvement, result of the public experiments in this project and Japanese examples.

Table 14.2-6 Project Cost

Project Name	Unit Cost	Unit	Remarks
Introduction of the One-way System	12,800	USD/km	
On-road Parking Space	30	USD/unit	
Off-road Parking Space	13,500	USD/unit	
Parking Information System	5,690,000	USD/km	
Improvement of the Sidewalk	25	USD/m2	
Transit Mall Development	25,600	USD/km	
Intersection Improvement	20,000	USD/ Intersection	
Park and Bus/Rail Ride	1,350,000	USD	

Source: PPUTMP Project Team

(2) Traffic Management Program Cost

The traffic management program cost is estimated as shown in Table 14.2-7.

Table 14.2-7 Traffic Management Program Cost

Code	Package Name	Project Components		Quantity	Cost	Finance
		Code	Project Name		(Mil. USD)	
TP-1	One-way System	TM-4	Introduction of the One-way System		0.3	DPWT
TP-2	Parking Measures	TM-5	On-road Parking Space		0.3	DPWT/PPP
			Off-road Parking Space		25.2	
			Parking Information System		5.7	
		TM-12	Parking Space for Cargo Trucks		Including TM-5	
TP-3	Development of Comfortable Pedestrian Environment	TM-6	Dissemination to Citizens along the Roads	Soft component		
			Guide to Move the Illegal On-sidewalk Parking	Soft component		
			Development of the Sidewalk Widening		4.8	Japan Grant/DPWT
TP-4	Transit Mall	TM-7	Transit Mall Development		0.03	DPWT
TP-5	City Center Traffic Signal Upgrading Project for 100 Intersections	TM-8	Synchronized Traffic Signal Control		15.0	Japan Grant
			Area Traffic Control System			
			Intelligent Traffic Signal			
			Traffic Surveillance System			
			Traffic Monitoring System Using Prove Vehicles			
			Traffic Information System (Variable Message Sign System)			
			Transit Signal Priority System			
		TM-1	Chamkar Morn Intersection Improvement		0.02	
		TM-2	Neang Kong Heang Intersection Improvement		0.02	
		TM-6	Development of Sidewalk			
		TM-5	Parking Measures			DPWT/PPP
TP-6	Park and Bus/Rail Ride	TM-9	Park and Bus/Rail Ride		1.4	DPWT/PPP
TP-7	Mobility Management	TM-10	Mobility Management	Soft Component		DPWT
TP-8	Driver's Education and Traffic Enforcement	TM-11	Driver's Education and Traffic Enforcement	Soft Component		DPWT/Traffic Plice
Total					52.8	

Note TM-3 includes in Road Project.

Source: PPUTMP Project Team

14.3 Implementation Plan

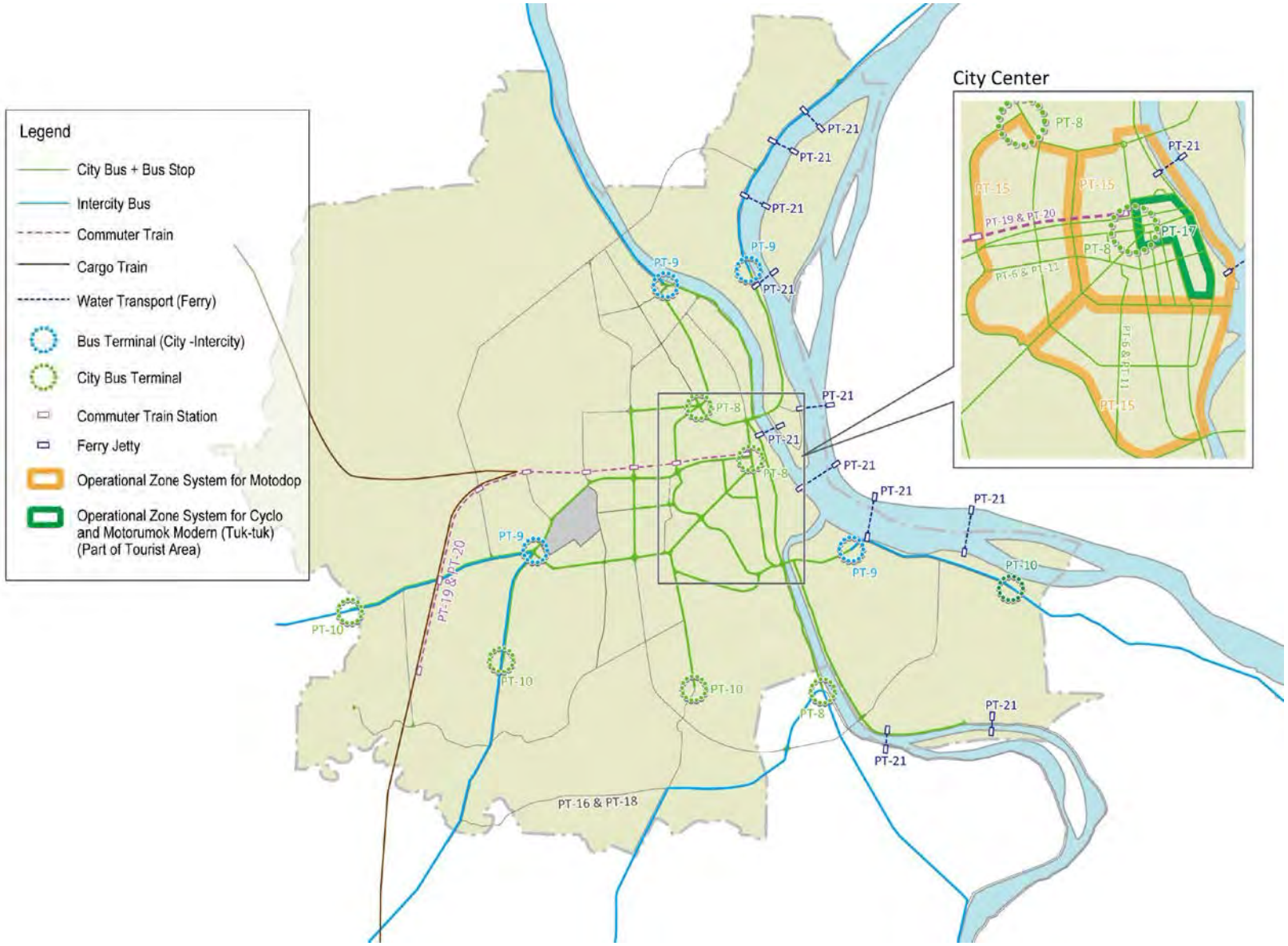
On the basis of the urban transport development policy by staging, the public transport, road and traffic management projects will be implemented with discretion considering that the three sectors are closely related. The basic planning directions of the implementation plan by planning stage and by each sector are as follows.

14.3.1 Public Transport Sector

Short- to Medium-Term Development Policy and projects of the public transport sector are as follows:

a) Completion of the basic bus network including bus priority measures and mode interchange areas such as bus stops and terminals
   Based on the 2nd public experiment results of bus operation, the bus route network should expand to cover the entire city as a trunk public transport system in the medium term. Bus priority measures such as the bus priority lane and development of smooth mode interchange areas such as bus stops and terminals are the important factors to increase the public transport users.
b) Restructuring the para-transit system
   It is necessary to restructure the para-transit system such as the motodop and the motorumok modern (tuk-tuk) to effectively operate the bus system by sharing roles. One of the typical role-sharing of the para-transit is the feeder system of the bus such as introduction of the zone system.
c) Improvement of existing railway line and water transport
   Currently, the existing railway line from central station and PK 9 station is not operating as an urban transport. Considering the rapid urbanization toward the western suburban area, the conversion of this railway line into commuter rail will have a large impact as it will divert traffic along Russian Blvd. and contribute to a favorable urban development around the newly developed train station.
   On the other hand, water transport has an important role in the eastern side of PPCC due to four big rivers that disturb vehicular traffic flow. Therefore, it is necessary to develop an economical and environmentally friendly transport system in the future.

Based on the above discussion, the medium-term plan in the year 2020 of the public transport sector is shown in Figure 14.3-1.



Source: PPUTMP Project Team

Figure 14.3-1 Public Transport System in 2020

14.3.2 Road Sector Implementation Plan

(1) Short- to Medium-Term Development Policy

In the short and medium terms, the main focus will be placed on the following measures in the road sector:

a) Widening/rehabilitation of arterial roads
In order to mitigate traffic congestion in and around the central area, widening and rehabilitation of arterial roads have been proposed. Since the central area is already built up, the widening project will be limited to selected roads, such as Inner Ring Road and Toul Kok Road.
As for the outside of the Central Area, the main radial roads such as Russian, Chaom Chao Road will be widened to cope with the growing traffic demand along E-W corridor. At the same time, the Middle Ring Road (RR-II) is expected to be completed up to NR5 continuously after the section from NR1 to NR2 currently under construction. Furthermore, additional Ring Road (RR-III) proposed by Korea will be started by 2020 according to the Ministry of Public Works and Transport.

b) Support of public transport service
Introduction of new public transport into Phnom Penh is one of the most urgent matters as stated in the urban transport policy.
In the road sector there are two supporting measures: One is to develop the road network for accommodating public transport services, and the other is to provide the sidewalk spaces for the passengers. The widening of above projects is aiming at these purposes as well.

c) Improvement of bottleneck intersections
There are several bottleneck intersections in and around the central area.
Some of them can be improved by applying traffic management measures such as traffic signal installations. For some of them, however, grade separation will be required because of heavy traffic concentration. Accordingly, a flyover or an underpass will be constructed at the intersections.

d) Supporting urban development in the suburban area
The urban development projects mostly undertaken by the private sector are targeting at the residential and some commercial uses; therefore, their development speeds are drastically influenced by the market condition. Some of the large projects are still uncertain when they are put into the actual implementation. Accordingly, the road implementation plan is formulated in accordance with the progress of each urban project.

(2) Short- to Medium-Term projects

As a result, the short- to medium-term projects are proposed as follows (refer to Figure 14.3-2 and Figure14.3-3).

a) Widening/rehabilitation and sidewalk development of arterials in the central area (Inner Ring Road, Monireth and Toul Kok road, etc.)
- Widening from 2 lanes to 4 lanes on the Inner Ring Road
- Rehabilitation of Monireth Blvd. and Toul Kok Road for securing the spaces for bus operation as well as for sidewalks.

b) Widening/rehabilitation of National Roads such as NR1 (Chabar Ampov – New PP port), NR4 (Junction with NR3 - RR-IV), NR5 (Chruroy Changvar Bridge - RR-IV), NR6 (RR-II - RR-IV)
- Above national road sections will be widened to 4-lane roads.

c) Widening of East –West Arterials (Chaom Chao Road, Russia, etc.)
- The surface of Chaom Chao Road is terribly damaged by the large number of heavy

vehicles that use it every day. Therefore, it is proposed that the road be rehabilitated and simultaneously widened to 6 lanes. The sidewalk for both Chaom Chao and Russia will be developed for the convenience of public transport passengers.

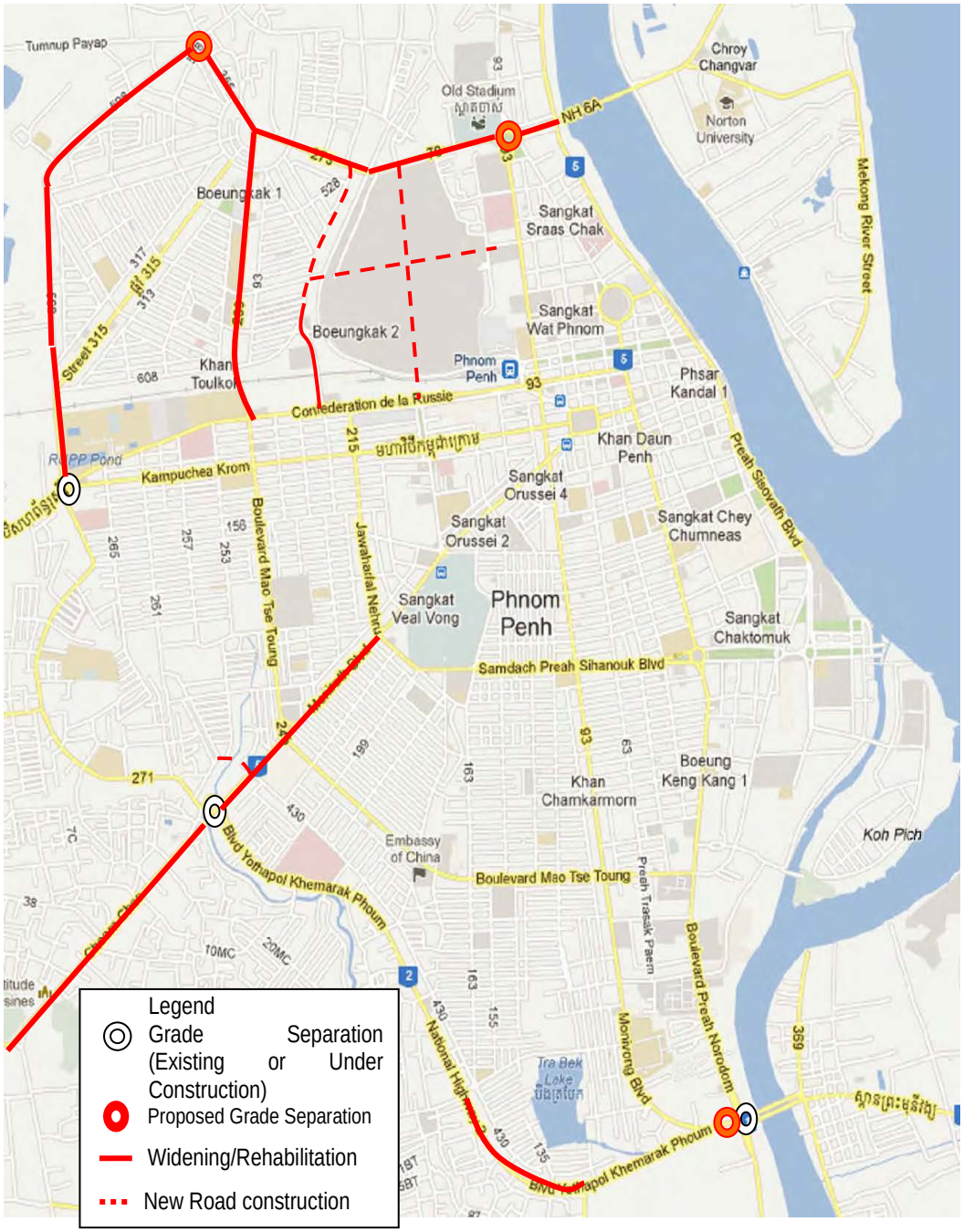
d) Other proposed roads are as follows:
   - Middle Ring Road (RR-II), to complete the connection from NR2 to Chaom Chao Road and NR5 by widening Hanoi Road as stated above
   - Widening of the short stretch of New E-W Road (the section between Toul Kok - Hanoi Road) from 2 lanes to 4 lanes for supporting bus operation along the road.
   - Missing Links in the Central Area
   - Completion of connection roads between Russian and Chaom Chao Road and Boeng Tumpun roads
   - Flyover and underpass projects in the Central Area (Monivong/HunSen Road, Monivong/ St70, St355/Camko road, etc.)

(3) Medium- to Long-Term Projects

Among the road projects proposed in the Master Plan, those that have not been designated in the short- to medium-term projects will be carried out as a medium- to long-term project. The implementation of these projects might be influenced by the surrounding conditions such as the changes in the road development policy including the development pace of expressway network at the national level or the progress of the various urbanization projects scattered over the suburban area of Phnom Penh, which is quite uncertain since they are depending on the future market condition and the eagerness of the private sector.

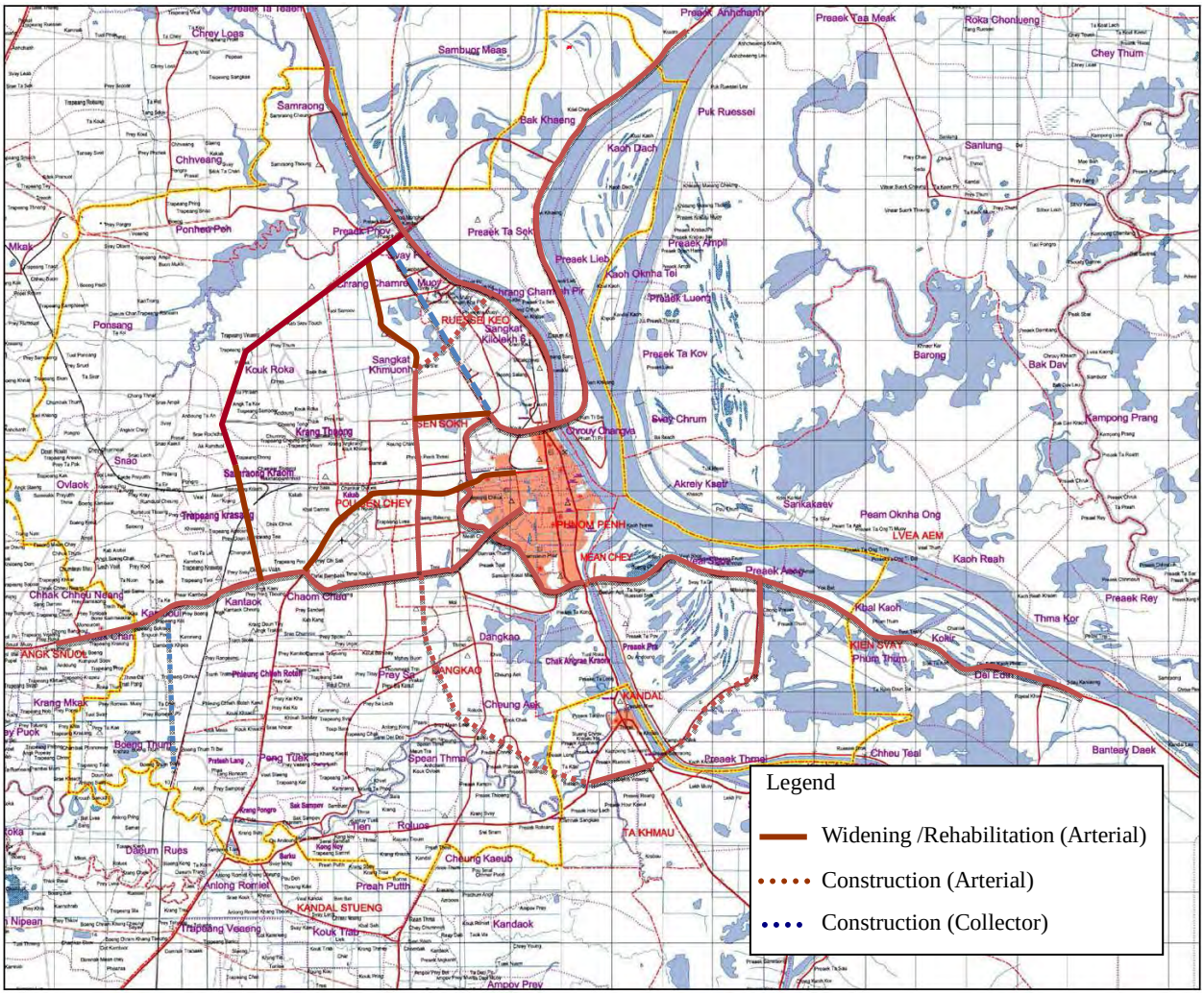
Among others, prominent projects are as follows:

a. Ring Road III (NR1 - NR2 - NR3 - NR4 - NR5)
b. New E-W Arterial Road (NR1 - Cheng Aek Road - RR-II - RR-III - RR-IV)
c. New E-W Arterial Road in Sensok (Toul Kok - RR-IV)
d. Chaom Chao South Area Development Road Package
e. AZ Green City Road Development Package including Hun Sen Boulevard
f. Extension of Ring Road II (NR5 - NR6)
g. Ring Road IV (NR1 - NR2 - NR3 - NR4 - NR5 - NR6)
h. Boeng Kok Road
i. Chban Ampov Area Development Road Package



Source: PPUTMP Project Team

Figure 14.3-2 Road Network in the Central Area Proposed for 2020



Source: PPUTMP Project Team

Figure 14.3-3 Road Network in PPCC Proposed for 2020

14.3.3 Traffic management Sector

Traffic management schemes are mainly for coping with the immediate action; therefore, all programs/projects should be completed before the medium-term period except for development of off-road parking facilities and soft-component such as traffic demand management.

14.3.4 Implementation Schedule

The implementation schedule of the three sectors is tentatively assumed as shown in Table 14.3-1.
The schedule can be rearranged taking into account conditions surrounding each program/project, for example, financial budget, speed of the related projects, difficulties in land acquisition especially road sector and other evaluation factors, etc.

14.3.5 Overall Implementation Plan

Based on the previous discussions, the overall implementation plan is shown below.

Table 14.3-1 Overall Implementation Plan

Public Transport

Code	Package Name	Project Components		Quantity	Cost	Finance	Short	Medium	Long		
		Code	Project Name		(Mil. USD)		2014-2016	2017-2020	2021-2025	2026-2030	2031-2035
PP-1	Rail Transit (Phase 1)	PT-1	Rail Transit (Phase 1)	14.0km	722.0	Japan Loan					
		PT-3	Rail Transit Stations	U/G=2, Elv.=10							
		PT-4	Rail Transit Airport Station	Elv.=1							
		PT-5	Rail Transit Depot	8.0ha	37.0						
PP-2	Rail Transit (Phase 2)	PT-2	Rail Transit (Phase 2)	30.8km	1670.0	MPWT DPWT PPP					
		PT-3	Rail Transit Stations	U/G+Elv.=30							
PP-3	Bus System (Phase 1)	PT-6	Bus Route	57 km	2.9	DPWT PPP					
		PT-7	Bus Depot								
		PT-9	Bus Terminal (Type 1)								
		PT-10	Bus Terminal (Type 2)								
		PT-11	Bus Stop								
		PT-13	Bus Priority Measures								
PP-4	Bus System (Phase 2)	PT-6	Bus Route	91 km	4.6	DPWT PPP					
		PT-7	Bus Depot								
		PT-9	Bus Terminal (Type 1)								
		PT-10	Bus Terminal (Type 2)								
		PT-11	Bus Stop								
		PT-12	BRT								
		PT-13	Bus Priority Measures								
		PT-14	Bus Location System								
PP-5	Bus System (Phase 3)	PT-6	Bus Route including Feeder to Rail Transit	278 km	13.9	DPWT PPP					
		PT-7	Bus Depot								
		PT-9	Bus Terminal (Type 1)								
		PT-10	Bus Terminal (Type 2)								
		PT-11	Bus Stop								
		PT-12	BRT								
		PT-13	Bus Priority Measures								
		PT-14	Bus Location System								
PP-6	Restructuring of the para-transit operation	PT-15	Restructuring of the para-transit operation (1): Motodop		Soft Components	DPWT					
		PT-16	Restructuring of the para-transit operation (2): Motorumok modern (Tuk-tuk)		Soft Components						
		PT-17	Restructuring of the para-transit operation (3): Cyclo		Soft Components						
		PT-18	Restructuring of the para-transit operation (1): Commuter Truck		Soft Components						
PP-7	Commuter Rail System	PT-19	Introduction of Commuter Rail System	19.3km	20	MPWT PPP					
		PT-20	Commuter Rail Station	9 stations							
PP-8	Improvement of Water Transport	PT-21	Improvement of Water Transport	11 Jetties	1.1	DPWT					
Total					2471.4		2.91	215.45	2252.4		

Road

Code	Package Name	Project Components		Project Component	Length	Project Cost	Finance	Short	Medium	Long		
		Code	Project Name			(Mil. USD)		2014-2016	2017-2020	2021-2025	2026-2030	2031-2035
RT-1	Improvement of the City Center Road System	RP-1	Widening and Sidewalk of Arterials in Central Area(IRR, Monireth, Toul Kok)	A1,A2,A3,A4,A5	10.1	20.8						
		RP-2	Boeng Kok Road	A6, C52	6.5	30.6						
		RP-3	Missing Links in Central Area	C50, C51	1.3	11.2						
RT-2	Strengthening the Asian Highway (Radial Road System)	RP-4	Widening of NR1, Chabar Ampov - New PP Port	A25, A26	25.3	37.2						
		RP-17	Widening of Russia/NR4 (IRR - RR-IV)	A34, A35	15.2	17.4						
		RP-20	Widening of NR5 (Chruoy Changvar Bridge - RR-IV)	A39, A40	15.0	26.7						
RT-3	Strengthening the Asian Highway (Ring Road System, RR-II & RR-III)	RP-7	New and Widening of RR-II (NR2 - NR5)	A12,A13,A14	20.4	104.4						
		RP-8	Extension of RR-II (NR5-NR6)	A15	2.9	34.1						
		RP-9	RR-III (NR1 - Junction with NR21)	A16	18.5	73.3						
		RP-10	RR-III(NR21 - NR4)	A17,A18	24.5	117.5						
		RP-11	Widening of RR-III(NR4 - 4km section)	A19	4.1	27.1						
		RP-12	Widening of RR-III(4km from NR4 - Preak Pnob Bridge)	A20	10.7	24.6						
RT-4	Strengthening the Asian Highway (Ring Road System, RR-IV)	RP-13	RR-IV (NR1 - NR6)	A21,A22,A23,A24	80.8	288.9						
RT-5	Southern Radial Arterial Road System Strengthening	RP-14	Widening of NR2 (Junction with NR21 - RR-III)	A27, A31	12.1	34.0						
		RP-15	Widening of NR3 (Junction with RR-III - RR-IV)	A32	9.2	21.0						
RT-6	Southern Suburban Arterial Road Development	RP-5	New E-W Arterial Road (NR1 - Cheng Aek Road)	A7,A8	11.5	63.1						
		RP-6	New E-W Arterial Road (Cheng Aek - RR-IV)	A9, A33	16.1	79.7						
		RP-16	Widening of Chaom Chao Road	A30	8.4	18.8						
RT-7	Northern Suburban Arterial Road Development	RP-18	New E-W Arterial in Sen Sok(Toul Kok - RR-IV)	A36, A37	15.9	46.5						
		RP-19	Widening of Hanoi Road (RR-II - RR-III)	A38	4.9	10.7						
RT-8	Eastern Suburban Area Road System Improvement	RP-21	Chban Ampov area Development Road package	C2, C6, C7, C9	18.9	63.2						
		RP-22	Mean Chey District Urban Development road package	C3, C4, C5	27.0	61.5						
		RP-23	Mean Chey - Diamond Island Connection Rd package	C1, C8	5.8	21.5						
RT-9	Southwestern Suburban Area Road System Improvement	RP-24	AZ Green City Development Road package	A28,C10, C11, C12	34.2	136.9						
		RP-25	Chaom Chao South Area Development road package	A29,C15, C16, C17, C18	25.7	62.5						
		RP-26	Russia - Chaom Chao Connection & Boeng Tumpun Access	C13, C14, C19	8.5	22.4						
RT-10	Northwestern Suburban Area Road System Improvement	RP-27	Samraon Kraom Sub-center Development Road package	C20, C21, C39	15.3	44.5						
		RP-29	Phnom Penh Thmei district Development package(West of Hanoi)	C40, C37, C41	22.5	69.9						
		RP-30	Krang Thnong New Sub-center package	C42, C43, C44, C38	20.8	48.2						
		RP-31	Camko/Grand Phnom Penh Development package	C22, C35, C36	9.8	25.9						
		RP-32	Ruessei Keo, Kilolekh6 area Developmen	C23, C24	9.3	29.7						
RT-11	Chruoy Changvar Area Road System Improvement	RP-33	Soka, Chruoy Changvar Development roa	C26, C27, C25	9.6	41.0						
		RP-34	Garden City Preak Pnob Development roa	C28, C29, C30, C31, C32, C33	37.5	72.5						
RT-12	Western Peripheral Area Road System Improvement	RP-28	Western Peripheral area development roads bw RR-III and RR-IV	C45, C47, C49, C46	31.2	57.4						
RT-13	Flyover/Underpass Project	RP-35	Flyover or Underpass Project in the Central Area(Monivong North, Toul Kok, Monivong South)		1.1	30.8						
		RP-36	Flyover or Underpass Project (Monivong North, Toul Kok, Monivong South, Hanoi/Russia, Hanoi/Chaom Chao, Cheng Aek/Tumnop Thmei, ICs or Flyovers along RR-III and RR-IV)		9.3	165.5						
Total						2,041		195.8	507.1	1338.1		

Traffic Management

Code	Package Name	Project Components		Quantity	Cost	Finance	Short	Medium	Long
		Code	Project Name		(Mil. USD)		2014-2016	2017-2020	2021-2025 / 2026-2030 / 2031-2035
TP-1	One-way System	TM-4	Introduction of the One-way System		0.3	DPWT			
TP-2	Parking Measures	TM-5	On-road Parking Space		0.3	DPWT PPP			
			Off-road Parking Space		25.2				
			Parking Information System		5.7				
		TM-12	Parking Space for Cargo Trucks		Including TM-5				
TP-3	Development of Comfortable Pedestrian Environment	TM-6	Dissemination to Citizens along the Roads	Soft Component					
			Guide to Move the Illegal On-sidewalk Parking	Soft Component					
			Development of the Sidewalk Widening		4.8	Japan Grant DPWT			
TP-4	Transit Mall	TM-7	Transit Mall Development		0.03	DPWT			
TP-5	City Center Traffic Signal Upgrading Project for 100 Intersections	TM-8	Synchronized Traffic Signal Control		15.0	Japan Grant			
			Area Traffic Control System						
			Intelligent Traffic Signal						
			Traffic Surveillance System						
			Traffic Monitoring System Using Prove Vehicles						
			Traffic Information System (Variable Message Sign System)						
			Transit Signal Priority System						
		TM-1	Chamkar Morn Intersection Improvement						
		TM-2	Neang Kong Heang Intersection Improvement						
		TM-6	Development of Sidewalk						
		TM-5	Parking Measures			DPWT PPP			
TP-6	Park and Bus/Rail Ride	TM-9	Park and Bus/Rail Ride		1.4	DPWT PPP			
TP-7	Mobility Management	TM-10	Mobility Management	Soft Component		DPWT			
TP-8	Driver's Education and Traffic Enforcement	TM-11	Driver's Education and Traffic Enforcement	Soft Component		DPWT Traffic Plice			
Total					52.7		3.1	22.6	27.0

Note TM-3 includes in Road Project.

Source: PPUTMP Project Team

14.4 Selection of Priority Programs

14.4.1 Basic consideration for the evaluation of priority programs

(1) In evaluating priority programs, the basic considerations are as follows:
The high priority programs by sector, the programs which need immediate action (details are in Chapter 15 as the Action Plan) and the program which is the most important in the Master Plan (details are in Chapter 16 as the preliminary F/S), are selected through the evaluation of the various factors from the programs by sector, which are discussed in this section.

(2) The evaluation factors are as follows:
1) Is it effective to decrease traffic congestion, which is the fundamental issue for the urban transport? The evaluation looks at either of the following two viewpoints, namely, i) to increase capacity of the transport facility such as road capacity, or ii) to introduce traffic demand management such as introduction of public transport.
2) Does it contribute to the MP's Goal, which is to support the 2035 urban vision and urban structure, and Mission, which is to improve the mobility of the citizens and materialize the urban potential?
3) Does it contribute to the formulation of the urban frame, guide a favorable urban development and support the development of the Mekong Sub-region?
4) In addition, the urgency of the program implementation, its contribution to the road safety and urban environment and its effective use of the existing transport facilities are also evaluated.

(3) Each evaluation item is given points: 'OO' for greatly contribute or large positive impact, and 'O' for contribution or positive impact. The evaluation score is obtained by adding up the number of 'O's'.

14.4.2 Evaluation Results

The evaluation results are tabulated in Table 14.4-1 and explained as follows:

(1) High priority programs by sector

a) Public transport sector
The following three programs have the highest priority in the public transport sector and in all M/P programs. These programs are concerned with the introduction and development of the rail transit.
PP-1 and PP-2 (Rail transit implementation phase 1 and phase 2)
These are large-scale programs introducing rail transit along the major urban transport corridors with the cost of 2,430 million USD, and it will take more than 20 years to complete. The programs' potential will further improve by the introduction of the bus feeder system and development of the mode interchange areas. However, there are still many issues to discuss such as the route, system, implementation body and staging of the development.
PP-7 (Development of the commuter train to operate on the existing railway line)
This program is intended to introduce commuter train service on the existing railway line. The advantages of this program are effective use of the existing transport facilities and low cost, but there are also disadvantages such as low density land use and squatter problems along the railway line.

b) Road sector
Current development progress of the road sector is high because all of the projects proposed in the 2001 M/P on the road sector have been implemented.
The following four programs, which obtained a score of more than 10 points, have a high priority in the road sector:
RP-2 (Development of the radial trunk road system, NR1, NR4, NR5 and NR6)
This is part of the development of the radial-ring trunk road system which forms the urban frame and strengthens the Asian Highway.
RP-3 (Development of the ring trunk road system such as Ring Road II and III)
This is part of the development of the radial-ring trunk road system which forms the urban frame and strengthens the Asian Highway.
RP-6 (Development of the inner city trunk road system: Southern suburban area)
This program aims to guide land use patterns in the southern suburban area where rapid urbanization is ongoing.
RP-7 (Development of the inner city trunk road system: Northern suburban area)
This program aims to guide land use patterns in the northern suburban area where rapid urbanization is ongoing.

c) Traffic management sector
The following three programs have a high priority among the other programs for the traffic management sector.
TP-3 (Improvement of the sidewalk in the city center)
A comfortable sidewalk contributes to the opportunity of re-introducing walking as a mode of transport to citizens, and of increasing the public transport users and the vitality of tourism in Phnom Penh.
TP-5 (100 signalized intersections upgrading)
This program contributes not only in securing smooth traffic flows in the city center but also in performing more effective traffic improvements together with development of related measures such as intersection and sidewalk improvements. It is expected that support will be provided by the Japanese ODA.
TP-7 (Traffic Demand Management)
This program is given the highest priority among the traffic management sector programs. Traffic demand management is one of the traffic countermeasures used to influence and

change the travel needs of people with the eventual aims of reducing traffic congestions, improving traffic safety, saving on fuel consumption and hence reducing vehicle exhaust gases. But changing the citizens' consciousness toward urban transport is one of the most difficult challenges.

(2) Urgent programs (to Short- and medium-term Action Plan)

An evaluation was made of 11 programs for urgent implementation within the short- and medium-term. Programs (excluding soft component) with a score of 12 points are **PP-3 & PP-4 (City bus operation program phase 1 and 2)** from public transport sector and **TP-5 (100 signalized intersections upgrading)** from traffic management sector. These programs need the implementation of the action plan described in Chapter 15 for them to materialize as soon as possible.

(3) The highest priority program among M/P programs (to preliminary F/S)

The program that needs more study in the preliminary F/S is **PP-12 (Development of the rail transit system)** which has the highest priority among the M/P programs.

Table 14.4-1 Selection of Priority Programs

Public Transport

Code	Package Name	Program Cost (Mil. USD)	Decrease of Traffic Congestion: Increase of Capacity of the Transport Facility	Decrease of Traffic Congestion: By Traffic Demand management	Improvement of Mobility to PP Citizens	Contribution to the Urban Vitality: Maintain the Current Urban Vitality	Contribution to the Urban Vitality: Create New Urban Vitality	Contribution to the Smooth Access between Mekong Subregion's Cities	Strengthening the Urban Axis	Effectively Use of the Existing Transport Facility	Contribution to the Road Safety	Emergency to the Phnom Penh City	Contribution to the Urban Environment	Overall Evaluation	Ranking by Sector	Ranking for Short & Medium-term Action Plan	Overall Ranking for Pre F/S
PP-1	Rail Transit (Phase 1)	759.0	OO		OO	OO	OO		OO		OO	O	OO	15	1		1
PP-2	Rail Transit (Phase 2)	1670.0	OO		OO	OO	OO		OO		OO		OO	14	2		2
PP-3	Bus System (Phase 1)	2.9	OO		OO	OO	O				OO	OO	O	12	4	1	5
PP-4	Bus System (Phase 2)	4.6	OO		OO	OO	O				OO	OO	O	12	4	1	5
PP-5	Bus System (Phase 3)	13.9	OO		OO	O	OO				OO		O	10	6		12
PP-6	Restructuring of the para-transit operation	Soft Components	O		O	O	O			OO	O	OO	O	10	6		12
PP-7	Commuter Rail System	20.0	OO		OO	O	OO			OO	OO	O	OO	14	2		2
PP-8	Improvement of Water Transport	1.1	O		O		O			OO		O	O	7	8		21

Road

Code	Package Name	Program Cost (Mil. USD)	Decrease of Traffic Congestion: Increase of Capacity of the Transport Facility	Decrease of Traffic Congestion: By Traffic Demand management	Improvement of Mobility to PP Citizens	Contribution to the Urban Vitality: Maintain the Current Urban Vitality	Contribution to the Urban Vitality: Create New Urban Vitality	Contribution to the Smooth Access between Mekong Subregion's Cities	Strengthening the Urban Axis	Effectively Use of the Existing Transport Facility	Contribution to the Road Safety	Emergency to the Phnom Penh City	Contribution to the Urban Environment	Overall Evaulation	Ranking by Sector	Ranking for Short & Medium-term Action Plan	Overall Ranking for Pre
RP-1	Improvement of the City Center Road System	4.5	O			OO					O	OO	O	7	7	11	21
RP-2	Strengthening the Urban Framework and Asian Highway (Radial Road System)	11.6	OO				OO	OO	OO		O	O	O	11	1		8
RP-3	Strengthening the Urban Framework and Asian Highway (Ring Road System, RR-II & RR-III)	18.1	OO				OO	OO	OO		O	O	O	11	1	4	8
RP-4	Strengthening the Urban Framework and Asian Highway (Ring Road System, RR-IV)	28.9	OO				O	OO	OO		O		O	9	5		15
RP-5	Southern Radial Arterial Road System Strengthening	5.5	OO				O		OO		O		O	7	7		21
RP-6	Southern Suburban Arterial Road Development	13.5	OO			OO	OO		OO		O	O	O	11	1	4	8
RP-7	Northern Suburban Arterial Road Development	14.3	OO				OO		OO		O	OO	O	10	4	7	12
RP-8	Eastern Suburban Area Road System Improvement	12.2	O				OO				O		O	5	10		26
RP-9	Southwestern Suburban Area Road System Improvement	10.1	O				OO				O	O	O	6	9		25
RP-10	Northwestern Suburban Area Road System Improvement	5.7	O				OO				O		O	5	10		26
RP-11	Chruoy Changvar Area Road System Improvement	6.7	O				OO				O		O	5	10		26
RP-12	Western Peripheral Area Road System Improvement	11.5	O				O				O		O	4	13		29
RP-13	Flyover/Underpass Project	8.5	OO			O	OO				O	OO	O	9	5	8	15

Traffic Management

Code	Package Name	Program Cost (Mil. USD)	Decrease of Traffic Congestion: Increase of Capacity of the Transport Facility	Decrease of Traffic Congestion: By Traffic Demand management	Improvement of Mobility to PP Citizens	Contribution to the Urban Vitality: Maintain the Current Urban Vitality	Contribution to the Urban Vitality: Create New Urban Vitality	Contribution to the Smooth Access between Mekong Subregion's Cities	Strengthening the Urban Axis	Effectively Use of the Existing Transport Facility	Contribution to the Road Safety	Emergency to the Phnom Penh City	Contribution to the Urban Environment	Overal Evaluation	Ranking by Sector	Ranking for Short & Medium-term Action Plan	rall Ranking for Pre
TP-1	One-way System	0.3		OO		OO					OO	OO	O	9	4	8	15
TP-2	Parking Measures	31.2		OO		OO					OO	OO	O	9	4	8	15
TP-3	Development of Comfortable Pedestrian Environment	4.8		O	OO	OO					OO	OO	OO	11	3	4	8
TP-4	Transit Mall	0.03		O	OO	OO					OO		OO	9	4		15
TP-5	City Center Traffic Signal Upgrading Project for 100 Intersections	15.0		OO	OO	OO					OO	OO	OO	12	2	1	5
TP-6	Park and Bus/Rail Ride	1.4		OO	O		OO				OO		O	8	7		20
TP-7	Mobility Management	Soft Components		OO	OO	OO	OO				OO	OO	OO	14	1		2
TP-8	Driver's Education and Traffic Enforcement	Soft Components		O							OO	OO	OO	7	8		21

Note OO Has High Impact
O Has Impact
Program needs Urgent Action (Mainly Short- and Medium-term Project)
Some Project in the Program already Started.
Including Sidewalk Improvement
Excluding Soft Component

Pre F/S
Action Plan for City Bus Operation
Action Plan for 100 Traffic Signal Intersections Upgrading

Source: PPUTMP Project Team

15 ACTION PLAN

15.1 Introduction

The action plan in this MP defines the target, action, period and related agencies of the key programs to materialize the 2020 urban transport plan in the medium term.
Selected action plans in this chapter are Action Plan 1: Introduction of City Bus and Action Plan 2: Comprehensive Traffic Management Plan in the City Center (100 signalized intersections upgrading), which are evaluated as urgent programs in section 14.4.
Coordination between Action Plans 1 and 2 is important to materialize more effectively the urban transport plan especially in the city center.

15.2 Action Plan 1: Introduction of City Bus System

To materialize the city bus system as the trunk public transport system in Phnom Penh in medium-term period, the following measures are implemented.

15.2.1 Short- and Medium-term Schedule

The short- and medium-term schedule for the introduction of city bus system is shown in Figure 15.2-1

<table>
<tr><th rowspan="3">Items</th><th rowspan="3">Related Organization</th><th colspan="5">Short-term Planning Period</th><th colspan="4">Medium-term Planning Period</th></tr>
<tr><th colspan="3">2014</th><th rowspan="2">2015</th><th rowspan="2">2016</th><th rowspan="2">2017</th><th rowspan="2">2018</th><th rowspan="2">2019</th><th rowspan="2">2020</th></tr>
<tr><th>Jan-Mar</th><th>Apr-Aug</th><th>Sep-Dec</th></tr>
<tr><td>Public Experiment</td><td>DPWT
PPCH
JICA
Private 1</td><td>1 Bus Route</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Public (Management & Operation)</td><td>PTMD
Private 1</td><td></td><td>1 Bus Route</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Public (Management), Private (Operation)</td><td>PTMA</td><td></td><td></td><td>3 Bus Routes</td><td colspan="2">5 Bus Routes</td><td colspan="4">10 Bus Routes</td></tr>
</table>

Source: PPUTMP Project Team

Figure 15.2-1 Short- and Medium-Term Schedule for the Introduction of City Bus System

15.2.2 Implementation Goal for Short- and Medium-term Plan

The implementation goal for the city bus system is as follows:

- Implement 5 bus routes until 2016 (Short-term period)
- Implement 10 bus routes until 2020 (Medium-term period)

15.2.3 Measures to action

The following are measures PTMA is expected to implement according to a time schedule:

- To add another route (making it three routes) to the bus operation at the end of 2014.
- To develop the bus operation manual until the end of 2014.
- To develop the bus operation plan to extend the bus route in the future until the end of 2015
- To increase the bus operation routes from three to five routes at the end of 2016.
- To increase the bus operation routes from four to ten routes at the end of 2020.
- To develop the restructuring plan of the para-transit such as the motodop and the motorumok modern (tuk-tuk) to prepare the service area of them until 2020.

15.2.4 Long-term Goal

The bus system will be restructured to play the role as the feeder system of rail transit along the urban transport corridors and as the trunk public transport system in the suburban area after the introduction of the rail transit in the long term.

15.3 Action Plan 2: Comprehensive Traffic Management Plan in the City Center

The following comprehensive traffic management measures will be implemented for securing the smooth flow of traffic in the city center with effective use of the limited urban transport space.

15.3.1 Short- and Medium-term Schedule

The short- and medium-term schedule of the Action Plan 2 is shown in Figure 15.3-1.

Items	Related Organization	Implementing Organization	Short-term Planning Period			Medium-term Planning Period			
			2014	2015	2016	2017	2018	2019	2020
Traffic Signal Upgrading	Traffic Signal Upgrading	JICA & DPWT							
	Intersection Improvement	JICA & DPWT							
	Sidewalk Improvement (Major Roads)	DPWT							
Sidewalk Improvement (Secondary Roads)		DPWT							
Introducing One-way System		DPWT							
Parking Measures	Major Roads	DPWT							
	Secondary Roads	DPWT							
	Off-road Parking, etc.	DPWT							
Driver's Education and Traffic Enforcement		NRSC & Traffic Police							

Source: PPUTMP Project Team

Figure 15.3-1 Short- and Medium-Term Schedule of the Action Plan 2

15.3.2 Conduct of the 100 signalized Intersections Upgrading for Securing the Smooth Traffic Flow in the City Center

(1) Implementation Goal for Short- and Medium-term Plan

The following is the implementation goal for the short term and medium term

- 70% of 100 signalized intersections will be improved until 2016
- 100 signalized intersections will be improved until 2017
- Sidewalks will be improved along the trunk roads including near improved intersections by the 100 signalized intersections upgrading project from 2017 to 2018

(2) Current problems and issues

- There are 69 signalized intersections in the city. But many of them operate individually. Therefore, it cannot cope with the serious traffic congestions in the city.
- Phnom Penh City requested a Japan Grant for the 100 signalized intersections upgrading in July 2013, and it was approved. Preparatory Work for this Project commenced in April 2014; and detailed design is planned to start in mid-2014.
- It is necessary to improve the intersection by the installation of road marking and traffic sign and sidewalk improvement for the effective traffic management in the city.

(3) Measures to action

The following are planned to be implemented for a comprehensive traffic management in the city center:

- To complete the detailed design by JICA until 2015 and start the intersection improvement project from 2016 in cooperation with DPWT.
- To complete the improvement of 100 signalized intersections based on the plan to introduce the traffic control system by JICA until the end of 2017 in cooperation with DPWT.
- To materialize the comfortable and public transport friendly pedestrian environment by introducing the public-oriented sidewalk improvement by the private sector.
- To improve 58,600 m sidewalk together with the signalized intersection improvement by the collaboration between DPWT and JICA.

(4) Long-term Goal

The following are the long-term goals:

- To install new traffic signals as required (considering the change of traffic volume in the city center)
- To install new traffic signals at intersections of newly developed urban area in the suburban area.

15.3.3 Additional introduction of One-way System

(1) Implementation Goal for Short- and Medium-term Plan

One-way roads will increase to 21 km from 2017 to 2019 in the short- and medium-term plan.

(2) Current problems and issues

- Currently, there are designated one-way roads with four sections (2 pairs and 4.8 km).
- It is expected that with the expansion of one-way system in the future based on positive impact to the citizens in the 1st public experiment, a one-way system near riverside (1 pair and 1.3 km) was introduced.
- One of the issues that will have to be attended to is strengthening the traffic enforcement of the one-way system against violators such as private cars and Motorumok Modern (tuk-tuk).

(3) Measures to action

The following measures will be carried out in line with the comprehensive traffic management in the city center:

- DPWT will develop the implementation plan for the newly introduced one-way system until 2017.
- DPWT will expand the section of one-way roads from 6.1 km to 21.2 km until 2019.
- For the smooth introduction of the one-way system, it is necessary to consider how to clearly explain this to citizens.
- DPWT will conduct the enforcement of the one-way system against such traffic violators as private cars and Motorumok Modern (tuk-tuk) in collaboration with traffic police until 2019.

15.3.4 Improvement of the Sidewalk Environment for Secondary Roads

(1) Implementation Goal for Short- and Medium-term Plan

For the short- and medium-term plan for secondary roads, the goal is to complete the sidewalk improvement until 2020.

(2) Current problems and issues

- Current sidewalk conditions make it difficult, if not impossible, for pedestrians to use because of illegal on-sidewalk parking and encroaching vendors, even though the sidewalk width is relatively wide. As a result, pedestrians are forced to walk on the carriageway putting them at risk

of accidents.

- For tourists, who often move around the city on foot walking becomes difficult because of the uneven sidewalks and lack of charm of the urban scenery.
- It is necessary to develop comfortable sidewalks for pedestrians together with intersection improvement and introduction of one-way system.

(3) Measures to action

The plan calls for DPWT to undertake the following in line with the comprehensive traffic management in the city center:

- To prepare the sidewalk development plan for secondary roads until 2018.
- To complete the sidewalk improvement until 2020.

15.3.5 Implementation of the Parking Measures

(1) Implementation Goal for Short- and Medium-term Plan

The goals for parking in the short-term and medium term are as follows:

- To provide on-road parking space for 7,200 motorcycles and for 3,200 cars until 2020 (expected public transport modal share is 10%).
- To provide off-road parking space for 800 motorcycles and for 2,700 cars until 2020 (expected public transport modal share is 10%)

(2) Current problems and issues

- Currently, 12,000 and 6,000 additional parking spaces for motorcycles and cars, respectively, are needed in the city centre.
- It is necessary to develop comprehensive parking measures including soft components such as traffic demand management (bus operation) and introduction of one-way system (secure the on-road parking space) because of the limited urban space.

(3) Measures to action

The following measures need to be put into action to address the parking problem:

- DPWT will develop the Parking Plan at the end of 2018.
- DPWT will provide on-road parking space for 7,200 motorcycles and 3,200 cars in the end of 2020.
- Parking lots for the trunk road will use the part of 5.0 m sidewalk space and DPWT will conduct the marking and strengthening of enforcement against illegal parking in cooperation with traffic police. Parking lots for secondary roads will be provided together with introduction of one-way system.
- DPWT will provide off-road parking space for 800 motorcycles and 2,700 cars in the end of 2020.
- For the development of the off-road parking facilities, DPWT will establish a compulsory parking provision in buildings ordinance and introduce the subsidy system for the private sector's participation to the parking business.

(4) Long-term Goal

The long-term goal is to complete the parking measures until 2035 by conducting traffic demand management including upgrading the public transport system and accelerating the development of off-road parking facilities by introducing the private sector's participation.

16 PRELIMINARY FEASIBILTY STUDY

16.1 Introduction

The rail transit system that runs along the major transport corridor that connects the city center and the northern/southern and western suburban areas is selected as the priority project in the Master Plan. The preliminary feasibility study (F/S) for this priority project is conducted in Phase 3 of the Master Plan.

Prior to the preparation of the preliminary F/S, the following factors should be considered:

(i) Target Public Transport Corridor and Selection of the Route

The target corridor of the preliminary F/S is selected from among the three main alternative public transport corridors, namely: (1) South-north transport corridor along Monivong Blvd., (2) East-west transport corridor along Russian Blvd., and (3) Southwest transport corridor along Charles de Gaulle and Monireth Blvd. Selection of the priority corridor is mainly based on the evaluation of the estimated passenger demand and the corridor characteristics.

(ii) Physical Space Adopted for Transit System Introduction

Although the space for the system introduction (right-of-way) can be secured solely by exclusive land acquisition, it is practically inadaptable because of the huge acquisition cost involved. Therefore, it is deemed better to utilize the available public space, such as existing/planned transport space (road or railway), for introducing the proposed railway transit system.

(iii) Type of Infrastructure

A transit system needs fixed infrastructure to build its track structures, stations and others. Although these infrastructure can be built as surface facilities, this would be difficult since the focus area consists of developed urban areas with heavy traffic. Thus, it is basically assumed that the infrastructure of the public transport system should be developed as an elevated or underground type, except for at-grade sections where conditions can allow it.

(iv) Public Transport System

Based on the Master Plan which was analyzed in the study's second phase, a medium-capacity rail transit system with a capacity of 4,000 to 7,000 passengers/hour/direction and found in many parts of the world, is going to be selected as the target public transport system for the transport corridor considering the transport system’s specifications and Phnom Penh’s urban and transport characteristics.

(v) Construction and Operation Method

How to effectively use private sector participation is the key to the construction and operation method for the proposed public transport system, considering the economic conditions in Cambodia and examples in other cities in Southeast Asia.

16.2 Analysis and Screening on Target Public Transport Corridor

16.2.1 Target Public Transport Corridor

An examination of the expected demand and corridor characteristics (see Table 16.2-1) was made on the abovementioned public corridors, namely: (1) South-north corridor that passes through Monivong Blvd., consisting of three sub-corridors, (2) East-west corridor passing through Russian Blvd., and (3) Southwest corridor passing through Monireth Blvd., which had been elaborated in the master plan study. As a result, alternatives (2) East-west corridor and (3) Southwest corridor were selected for further analysis because of the following reasons (see Figure 16.2-1):

(i) Relatively high passenger demand is expected, i.e. around 72,500 to 81,600 trips/day in 2035;

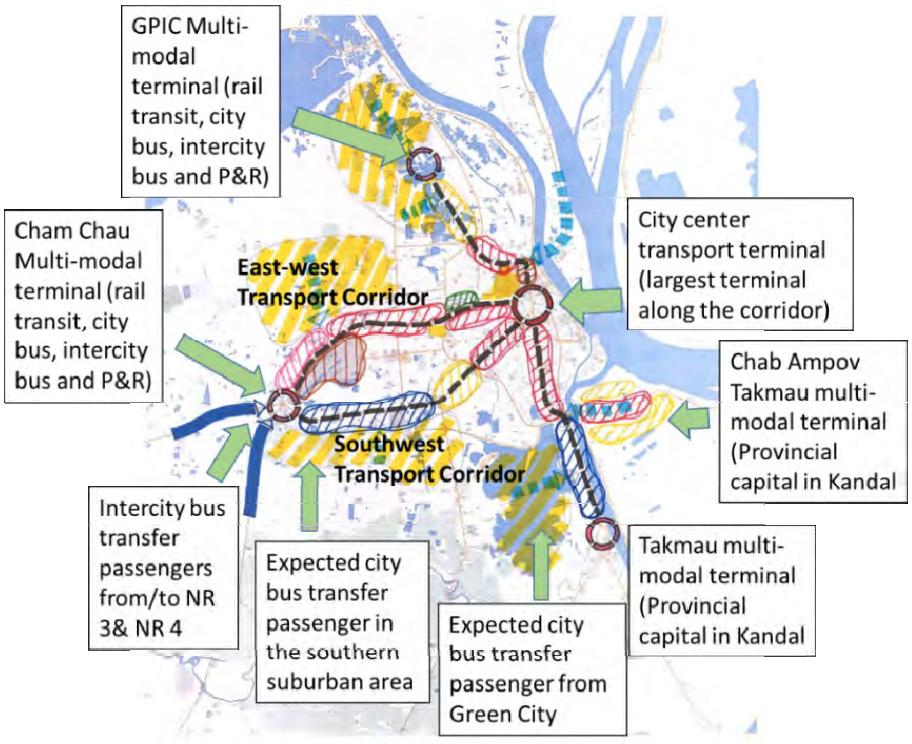
(ii) The routes connect between the urban the central district and western fringe area where urbanization is in progress;

(iii) The routes connect with several intense traffic generation nodes, i.e. Phnom Penh airport, train depot and bus terminal facilities (future plan);

(iv) A large-scale development plan is underway by the private sector in the central district, e.g., Boeng Kak lake development plan;

(v) Various land use patterns are seen along the corridors; and

(vi) It is possible to collect future transport demand by the bus feeder network from the south and north sectors where area development will be expected in the future.



Source: PPUTMP Project Team

Figure 16.2-1 Corridor Characteristics

From these alternative corridors, several physical route alternatives were prepared and the necessary analysis was conducted.

Table 16.2-1 Summary of Corridor Analysis

Corridor Name			Route Name	Description
1	1	South-North Corridor (North)	Monivong-Rd 271-Rd 598	・Major institutional and educational zone in the city center
				・Large-scale residential development (Camko City and GPIC) on-going in the northern suburban area
				・Expect transfer passengers from intercity buses from NR 5 and NR 6
				・Expect transfer passengers from city buses from northwestern area
				・Expect an acceleration of residential development along the corridor (Degree of change of the urban development→Large)
	2	South-North Corridor (South)	Monivong-NR 2	・Largest commercial zone in the city center
				・Currently, industrial areas such as factories locate in the suburban area along the corridor (commuting demand from factory workers)
				・Southern terminal of this corridor -> Thakmau, provincial capital of Kandal.
				・Expect traffic demand to/from Chab Ampav area and intercity bus transfer passengers to/from NR 1
				・Large-scale urban development on-going in the western side of the corridor (Green City Development)
				・Industrial zone may turn to corridor type commercial zone in the future (Degree of change of the urban development -> Small)
	3	South-North Corridor (Central)	Monivong	・Northern part of the city center along the corridor -> institutional and educational zones
				・Southern part of the city center along the corridor -> the largest commercial zone in Phnom Pneh
				・Degree of change of the urban development in the future -> Small
2		East-West Corridor	Russia Russia-Kampuchea Krom Russia-Railway	・Institutional and educational zone in the city center
				・Current and new corridor commercial zone in the suburban area
				・Large-scale mode interchange area (airport) located along the corridor
				・Future large-scale mode interchange area (bus terminal) located at the western end of the corridor (Cham Chau Roundabout)
				・Expect bus tranfer passengers from the northern part of Russia Blvd.
				・New corridor type of commercial development already developed in the suburban area -> not much change in land use pattern along the corridor (Degree of change of the urban development -> Small)
3		Southeast Corridor	CDG-Monireth-Veng Sreng St	・Largest commercial zone in the city
				・Steng Minh Chey area locates in the corridor center; one of the largest traffic generated zones in the city
				・Many factories found along the suburban area; many residential developments on-going
				・Factories to relocate to the Outer Ring Road area to avoid a mix of residential and industrial zones in the dense urban area in the future
				・Expect city bus transfer passengers to/from future housing development in the southwestern area
				・Existing factories to relocate to Outer Ring Road in the future (Degree of change of the urban development along the corridor -> Large)

Source: PPUTMP Project Team

16.2.2 Screening of Alternatives

(1) Requirement of Optimum Route

The optimum route was selected from several alternative routes along the east-west transport corridor including Russian Blvd., Kampuchea Krom Blvd., and the Railway Line, which were evaluated in Section 16.2.1 considering the geometric design, land use, type of infrastructure, and urban environmental aspects.

(2) Formulation of Alternatives to be Examined

Several routes can be evaluated from the East-west and Southwest transport corridors. There are basically three routes, namely: the Russian Blvd. route, the Railway route, and the Charles de Gaulle-Monireth-Veng Sreng Blvd. route, which may be subdivided into two alternatives considering the following criteria:

(i) Cost: To minimize cost (although minimizing cost and considering the environment are not always compatible; therefore, a different alternative for this can be proposed);

(ii) Urban environment: To consider Phnom Penh's urban environment especially its urban scenery with a low skyline;

(iii) Passenger demand potential: To select densely populated areas along the route; and

(iv) Maximizing use of the existing transport facility: To use the existing railway tracks.

A summary of the characteristics of the four alternative routes is given below and shown in Figures 16.2-2 and 16.2-3.

Alternative 1: This route is divided into two: the section from Central Market to the Ministry of Defence (2.2 km) is underground, and the section from the Ministry of Defense to depot (11.8 km) is elevated.

There are no problems about maintaining the urban scenery and future route expansion. Even the cost is not too high because the length of the underground section is short.

Alternative 2: This route is divided into three sections: the section from Central Railway Station to PK 9 Station (8.3 km) uses the existing railway tracks, the section from PK 9 Station to Pochentong Airport (1.5 km) uses the airport access road, then from the airport to the Depot uses Russian Blvd. and National Road No. 4 (4.4 km).

The advantages of this alternative are the effective use of the existing railway facility and the maintenance of the urban scenery. However, its disadvantages are less passenger demand and no extension of the system in the future.

Alternative 3-1: This route is divided into four sections: the section from Olympic Stadium to after Stung Minh Chey Intersection along Charles de Gaulle and Monireth Blvd. (underground), the section from Stung Minh Chey Intersection to Cham Chau Roundabout along Veng Sreng Blvd. (elevated), then it goes to the airport. All the sections totaling 12.0 km are mainly elevated.

This route has advantages in terms of urban scenery and future route expansion but has a cost disadvantage.

Alternative 3-2: This route is divided into three sections: the section from Central Market to Cham Chau Roundabout along Charles de Gaulle, Monireth Blvd. and Veng Sreng Blvd. (elevated), then goes to the airport, and from the airport to the Depot using Russian Blvd. and NR4. All the sections totalling 16.3 km are elevated.

This route has disadvantages in terms of urban scenery and future route expansion.

(3) Evaluation of Alternatives

The optimum route for the preliminary F/S is selected from the abovementioned alternatives based on the evaluation of a set of nine criteria items described below. Each evaluation item is given points: 3 for good, 2 for fair, and 1 for worse. However, since cost is the most important item for route evaluation, its assigned points is doubled.

(i) Cost

Cost has a big impact for the implementation of the preliminary F/S, and so it is the only evaluation item which points are multiplied by 2.

(ii) Passenger Demand in 2035

The route with the highest passenger demand is the Russian Blvd. route with 3 points, followed by the Charles de Gaulle-Monireth-Veng Sreng Blvd. route with 2 points, and the route along the railway line with 1 point.

(iii) Existing Land Use Along the Route

The alternative routes have various land uses. Both the Russian Blvd. route and the Charles de Gaulle-Monireth-Veng Sreng Blvd. route are given 3 points each. On the other hand, land use of the alternative route along the railway tracks is mainly agriculture in the suburban area and is, therefore, given 1 point.

(iv) Accessibility to Pochentong Airport

Alternatives 3-1 and 3-2 need a longer trip from the airport to the City center (2 points) while the other alternatives are more accessible to the airport and are, therefore, given 3 points each.

(v) Future Urban Development along the Route

There are many ongoing development projects along the Russian Blvd. route such as the Booyoung Development and the Boung Kak Lake Development (3 points). Also, the Charles de Gaulle-Monireth-Veng Sreng Blvd. route has a future potential as a relocation area for factories (3 points). On the other hand, the Russian Blvd.-Kampuchea Krom Blvd. route has 2 points. There is no development along the railway line route, especially the western suburban area (1 point).

(vi) Possibility of Future Expansion of the System

The alternative routes terminating at Central Market and Central Railway Station have 1 point each, and the alternatives with a possibility of future extension have 3 points each.

(vii) Urban Environment (Pertaining to the Urban Scenery)

Alternative routes with at-grade or underground sections are given the highest point (3 points) for maintaining the urban scenery, and alternatives with elevated sections are given the lowest point (1 point).

(viii) Issues of VIP Traffic

Russian Blvd. is the dedicated road for VIPs and, therefore, there is an opinion that ordinary people are not allowed to use the elevated facilities above the King or other VIPs. Alternative routes using Russian Blvd. are given 1 point, and the others have 3 points.

(ix) Issues of Land Acquisition

Alternative routes needing land acquisition are given lower points (large area: 1 point; small area: 2 points) than alternatives with no land acquisition issue (3 points).

(4) Evaluation Result

Based on the overall evaluation, alternative route 1 (Russian Blvd. route) gets the highest points (see Table 16.2-2) but still needs further discussions especially on the issue of the VIP traffic.

Source: PPUTMP Project Team

Figure 16.2-2 Alternative Routes for East-West and Southwest Transport Corridors

Source: PPUTMP Project Team

Figure 16.2-3 Characteristics of Alternative Routes

Table 16.2-2 Comparative Evaluation of Alternative Routes

Items		Alternative 1	Alternative 2	Alternative 3-1	Alternative 3-2
		Russia Blvd. route	Railway - Russia route	CDG - Monireth - Veng Sreng Blvd. route	
		Monivong Blvd.- MRD (Russia, underground) MRD - Depot (Russia, elevated)	Central Station - Depot (Railway line and Russian Blvd. Elevated)	Olympic Studiam - Monireth (CDG and Monireth, Elevated) Monireth - Airport (Monireth, Veng Sreng and Russia, Elevated)	Central Market - Depot (CDG, Monireth, Veng Sreng and Russia, Elevated)
Length of elevated and underground section (km)	Elevated Section	11.8	14.2	12.0	16.3
	Underground Section	2.2	0.9	0.9	0.9
	Total	14.0	15.1	12.9	17.2
Cost (Million USD)		759	645	586	733
		2	**4**	**6**	**2**
2035 Passenger Demand (Passengers/Day)		81,600	72,500	75,000	79,000
		3	**1**	**1**	**2**
Land use along the route		**3**	**1**	**3**	**3**
Accessibility to the airport		**3**	**3**	**1**	**1**
Future development along the route		**3**	**1**	**3**	**3**
Future Extension		**3**	**1**	**3**	**1**
Urban environment (urban scenery)		**3**	**3**	**2**	**1**
Issue to the VIP Traffic		**1**	**3**	**3**	**3**
Issue of ROW		**3**	**2**	**1**	**3**
Overall Evaluation		**24**	**19**	**23**	**19**

Source: PPUTMP Project Team

17. CONCLUSION AND RECOMMENDATIONS
17.1 Conclusion

■A Quick Look at the Master Plan (Outline of the Master Plan)

The Urban Transport Master Plan proposed in this project was based on the analysis of current transport characteristics including person trip survey and the future vision formulated through the discussion with stakeholders.

A two-fold approach to urban transport planning adopted, namely: (1) reorientation of transport mode from private to public, and (2) introduction of traffic demand management, which tries to give balance between the increases in demand and supply within the limitations of urban land and financing.

Considering this approach, the road system, which forms the urban framework, was formulated comprising a radial-ring trunk road network system, and the road network was developed to cope with the urban development in the suburban area.

Meanwhile, in the city center, in order to maximize the transport space, comprehensive traffic management measures were introduced, and these included traffic signals system improvement, one-way system, parking measures and pedestrian environment improvement.

The abovementioned plans and development are in support of the public transport system comprising rail transit and its feeder bus system, which is intended to spur the creation of the new Phnom Penh, offering convenience to better appreciate the charm of the city. And the restructuring of the existing public transport systems such as para-transit, railway and water transport together with the abovementioned new public transport system can trigger a shift in modal choice from private to public transport and create a comfortable and vital urban environment with high mobility.

The commodity transport system was also developed as it is an important infrastructure supporting the economic activities and daily life of the citizens in Phnom Penh. Furthermore, an appropriate urban transport-related organization and financial system was formulated for sustainability.

Twenty-nine programs, integrated from 68 projects, are proposed, and the total project cost is about 4,564 million USD. Of this amount, 2,470 million USD (54% of the total), 2,041 million USD (45%) and 53 million USD are earmarked for public transport, road, and traffic management sectors, respectively.

The economic internal rate of return (EIRR) is 18% and it can be judged that the master plan investment is feasible to Cambodia, based on the 30% of total trips shifting to public transport mainly from such private modes as cars and motorcycles. This is a big challenge for Phnom Penh but it also promises big gains in the creation of a better Phnom Penh.

On the other hand, previous infrastructure development of the transport sector was only road development, and the annual average cost was only 75 million USD. This amount covered not only roads but also flood control and other infrastructure improvements. Considering these circumstances, it is necessary to look into new types of loan framework and to accelerate the positive participation of the private sector.

■Projects Recommendations and Other Trials and Actions

Two public experiments were implemented from the two themes of the main urban transport issues, which are (1) reorientation from private to public transport: introduction of city bus operation, and (2) maximize the use of limited urban space: implementation of comprehensive traffic management plan including one-way system expansion. After the public experiments, things moved quickly and smoothly for (1) the city bus operation managed by PTMA and (2) preparatory survey for development of traffic management system in Phnom Penh by JICA.

On the other hand, master plan formulation by back-casting with stakeholder participation was also examined. Back-casting is a method of setting the future vision with the participation of relevant people considering various alternatives. Then, that future vision or plan will be implemented through careful thought and analysis. The development of the 2035 future vision in Phnom Penh is a product of collaborative work of back-casting and shared vision among the stakeholders.

This master plan project also supports the urban transport-related business opportunities for Cambodian and Japanese private sector through the meetings with stakeholders and with the Japanese Business Association of Cambodia (JBAC). City bus operation and the traffic management system project are already materialized and the development of rail transit system is also expected in the near future.

17.2 Recommendations

■Priority Project Recommendation (Short and Medium-term Action Plans and pre F/S)

・Action Plans

Two proposed short and medium-term action plans have already started. However, there are two key issues to address in order to attain the 2020 goal and these pertain to bus operation and traffic management.

With regards to bus operation, there should be capacity development for PTMA staff to ensure the efficient running of the bus. In addition, a way must be found for the effective participation of the private sector in the bus operation to cope with the increase in bus routes to 10. covering 148 km, before the year 2020.

As for traffic management, there should be a comprehensive plan that includes developing on-road parking measures for local roads and improving the sidewalk circumstances together with that of 100 signalized intersections as soon as possible. One idea is to start with citizen participation in one pilot road, say Street 240, as a model road in Phnom Penh.

・Pre-feasibility Study

A pre-feasibility study (pre-F/S) was conducted for the rail transit, which was proposed as the future trunk public transport in Phnom Penh and recommended as the highest priority project in the master plan. In pre-F/S, the Project Team studied the preliminary route alternatives (3 alternatives were proposed and evaluated but the final route has yet to be decided due to the many discussions still to be held among stakeholders regarding the rail transit system), passenger demand, project cost, economic and financial analysis and concept of the implementing organization. For the materialization of the rail transit system, it is necessary to conduct a feasibility study (this is

a more detailed study than the pre-F/S) to determine the final route alignment, produce a detailed passenger demand, analyze the economic/financial impacts and decide on the implementing organization as soon as possible after completion of this master plan. The urgency of this matter is owed to the increasing traffic demand every day and the implementing period, which is more than 5 years after the feasibility study.

▪Government Approval of the Master Plan

For the materialization of the 2035 Urban Transport MP in the Capital City, the cooperation of not only PPCH but also MPWT (on the government side) is necessary. Therefore, the official approval of the government is the precondition for the urban transport master plan's materialization.

The Urban Master Plan in 2020 for PPCH which was completed in 2009 funded by the French government has been undergoing the process of government approval for almost 5 years now through consultation with NCLMUP, and its final approval is expected soon. And the recommendation from NCLMUP is to proceed with the formulation of the 2035 Urban Master Plan, which entails updating of the 2020 Urban Master Plan, after the government approval of the 2020MP. With this recommendation from the government, PPCH planned the formulation of an integrated 2035 Urban Master Plan including the 2035 Urban Transport Master Plan supported by JICA. Then, PPCH will submit and request the government approval of Phnom Penh's 2035 Comprehensive Urban Master Plan.

■ Secure the Right-of-way of the Trunk Road Network

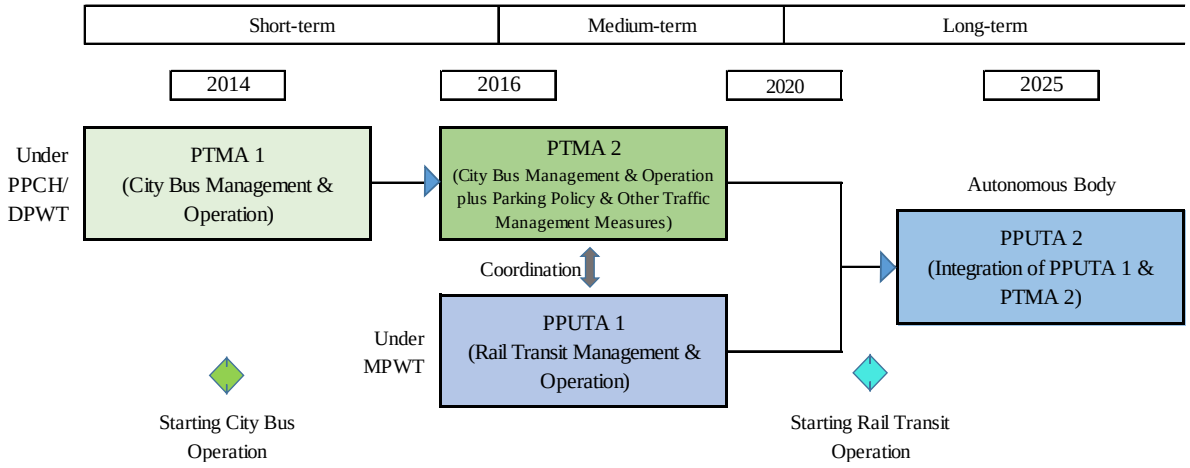
The radial-ring trunk road network forms the physical framework in PPCC. Therefore, it is essential to secure the right-of-way of trunk roads for the PPUTMP completion as soon as possible, even though it will take time to proceed with the road improvement/construction.

▪Establishment of Urban Transport-related Organization

City bus operation was introduced and started in 2014, and the Public Transport Management Authority (PTMA) has been created as the management agency of the city bus operation. However, having a newly created agency is not enough; PTMA should be given a mandate to implement the traffic management measures such as parking measures and sidewalk improvement, which are directly related to having a smooth bus operation. However, PTMA's management/operation capacity is still poor, and the participation of the private sector is necessary to cope with the 2020 bus route network plan. The key to sustaining the bus operation lies in strengthening the bus operation capability of PTMA and the timing of the private sector's participation.

On the other hand, a new organization called the Phnom Penh Urban Transport Authority (PPUTA) is being proposed to manage the rail transit; however, it is advisable that MPWT handle this in the meantime because the current railway department will have to be restructured and its management/operating capabilities strengthened for the new transit system, and besides, only a government entity can apply for a foreign loan. It is also advisable that PTMA and PPUTA be merged as an autonomous urban transport management agency after the transit system starts operating.

The Project Team has recommended the following responsibilities and process of merger of PTMA and PPUTA.



Note: Public Transport Management Authority (PTMA) and Phnom Penh Urban Transport Authority (PPUTA)

Source: PPUTMP Project Team

Figure 17.2-1 Recommended Responsibilities and Process of Merger of PTMA and PPUTA

▪Necessity of Master Plan Monitoring and Rollout by Stakeholder Participation

It is necessary to continue the activity of the stakeholder group that was organized during the master plan study and request its participation in checking the progress of the master plan implementation in collaboration with PPCH. At the same time, it is important to maximize the use of the stakeholder group and activities to raise citizen awareness of modal shift from private to public transport using the mobility management scheme.

To flexibly respond to the unstable socio-economic circumstances in Phnom Penh, it is necessary to periodically revisit the plan to fill the gap between current conditions and plan. Therefore, it is essential that plans are rolled out every 5 or 10 years and PDCA (Plan -> Do -> check -> Action->) is conducted to secure the sustainability of implementation of the urban transport plan.