1.6 Traffic Accidents

In this section, some traffic accident analyses are carried out after processing data that can be obtained from the central police office.

1.6.1 Traffic Accident Data

Traffic accident investigations in Phnom Penh city are undertaken by the Municipal Police and records of these investigation are kept in 8 Police Offices. Investigations and record keeping are done by the central police office and 7 other district offices for each of their respective jurisdiction areas. Simple statistical data from the 7 district offices are reported to the central office. There is no suitable data for accident analysis at the present moment. There is also no data base built up for the traffic accidents. All the data recording and processing are done manually.

1.6.2 Traffic Accident Characteristics (1)

This section describes the characteristics of traffic accidents in Phnom Penh based on the traffic accident data for the entire city in 1997-1999.

(1) Trend in Annual Total Accidents, 1997-1999

Table 8-6-1 and Figure 8-6-1 show the total accidents reported for the three year period of 1997-1999. In 1997, there were 429 cases of reported accidents. This annual total increased by 34% to 578 cases by 1998. In 1999, the total cases reported were 472, which amounted to a 10% increase compared to 1997 but a fall of 18% from 1998.

(2) Number of Injuries and Fatalities

Table 1.6.1 and Figure 1.6.1 and 1.6.2 show the number of accidents and the number of fatalities, serious injuries and minor injuries from 1997-1999. Based on these figures, the following observations can be made:

1) Fatalities
   - The number of fatalities is increasing very rapidly every year. In 1999, there were 133 fatalities. In spite of the decrease in total accidents from 1998 to 1999, the number of fatalities has increase sharply. In other words, taking the fatalities for 1997 as 1.0, the ratio for 1998 is 1.34 and by 1999, this ratio has increased to 1.58. This means that there was an increase of 58% in fatalities in 1999 compared to 1997.

Table 1.6.1: Accident Variation in Year in Phnom Penh

Category		1997	1998	1999
Total Number of Accidents (Ratio)		429 (1.00)	576 (1.34)	472 (1.10)
Fatality	Nos. of Fatalities (Ratio) [Average fatality/accident]	84 (1.00) [0.20]	108 (1.29) [0.19]	133 (1.58) [0.28]
Serious Injury	Nos. of Serious Injury (Ratio) [average injury/accident]	335 (1.00) [0.78]	457 (1.36) [0.79]	419 (1.25) [0.89]
Minor Injury	Nos. of Minor Injury (Ratio) [average injury/accident]	250 (1.00) [0.58]	307 (1.23) [0.53]	281 (1.12) [0.60]

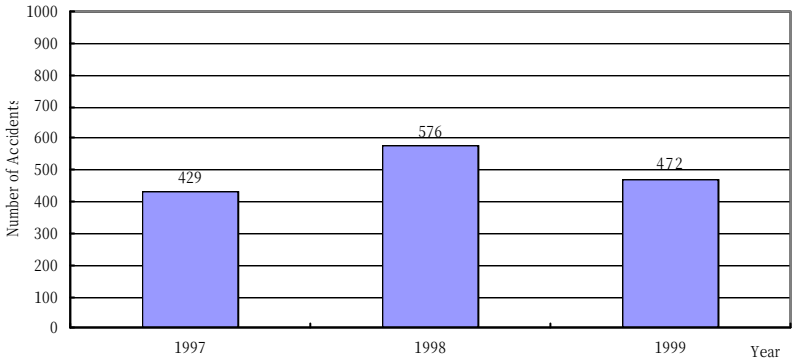


Figure 1.6.1: Total Number of Accidents, 1997-1999

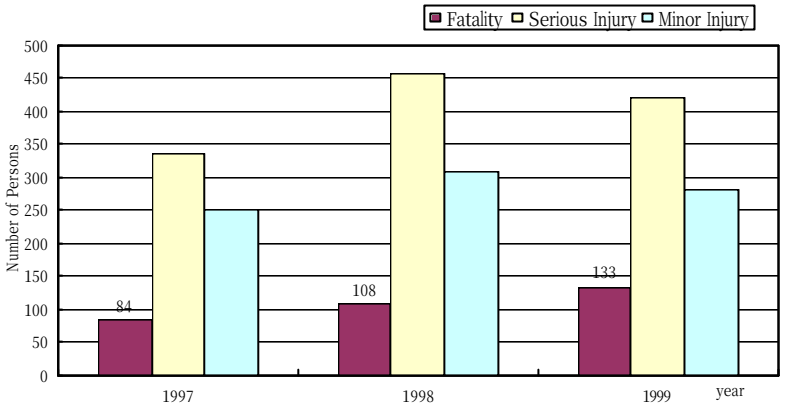


Figure 1.6.2: Numbers of Fatalities and Injuries, 1997-1999

- Examined from another perspective, in 1999, for every accident reported, there was an average of 0.28 fatality. This means that for every 3~4 cases of accidents, there is one person killed. (There are cases where in one accident, there are several fatalities).
- Fatality rates in Japanese cities with a similar population size of about one million, such as Kawasaki City and Hiroshima City are only 3.9 and 6.3 respectively. Comparing these rates, the City of Phnom Penh has a fatality rate of 2 to 3 times that of the Japanese cities. The traffic accidents and fatalities in Phnom Penh will continue to increase in the future.

2) Number of injuries

The yearly fluctuations of number of injuries have the same trend as that of the yearly total number of accidents from 1997-1999. For serious injuries, the ratio has increased from 1.0 in 1997 to 1.36 in 1998 and then to 1.25 in 1999. For minor injuries, the ratios were 1.0 to 1.23 and 1.12 respectively for 1997, 1998 and 1999.

Looking at these ratios, it is clear the increases in serious injuries are higher than the minor injuries.

In 1999, therefore, for every traffic accident, there was 0.9 person who suffered serious injuries and 0.6 minor injuries. In other words, for every accident, there was 1.5 person who suffered injuries.

3) Proportion shares between fatalities and injuries

Table 1.6.2 and Figure 1.6.3 show the proportion shares of fatalities, serious injuries and minor injuries. From these figures, the proportion share of fatalities is increasing every year. On the other hand the proportion share of minor injuries is decreasing. This implies that increasingly, traffic accidents in Phnom Penh are producing more deaths and serious injuries than minor injuries.

Table 1.6.2: Percentage share of Fatalities and Injuries

	1997		1998		1999	
	Number	Percent	Number	Percent	Number	Percent
Fatal	84	12.6%	108	12.4%	133	16.0%
Serious Injury	335	50.1%	457	52.4%	419	50.3%
Minor Injury	250	37.4%	307	35.2%	281	33.7%
TOTAL	669	100%	872	100%	833	100%

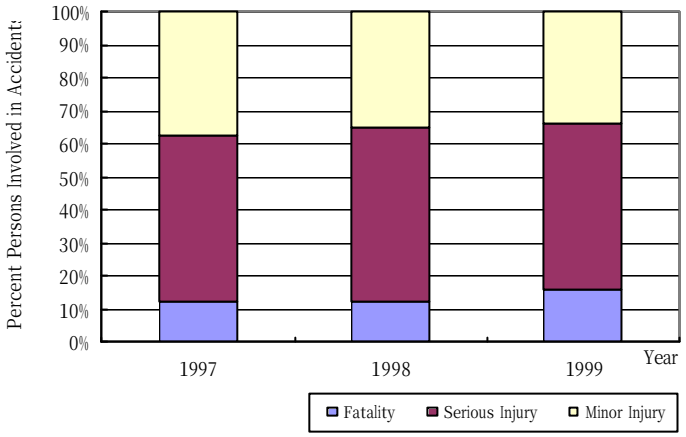


Figure 1.6.3: Percentage share of Persons in Fatal Accident and Injury by Year

(3) Accidents by Type of Vehicles

Table 1.6.3 and Figure 1.6.4 show the number of traffic accident in 1999 by types of vehicles involved. Based on these figures, the following observations are made:

- Accidents involving collision between motorcycles are the major type of accidents, accounting for 36% of the total, followed by accidents between 4 wheelers and motorcycles which account for 34%. These two types of accidents together accounted for 70% of the total number of accidents.
- Accidents involving collision between 4 wheelers accounted for only 10% and between motorcycle and pedestrian, 9%.
- Accidents between 4 wheelers and pedestrians accounted for 6% of the total.

From these data, the following conclusions are made regarding the various types of vehicles involved in accidents:

- Accidents that involved motorcycles accounted for 80.3% of the total 472 accidents (379 accidents). Although motorcycle traffic may be higher than the other vehicular traffic, but this high rate of involvement is alarming. To reduce the total number of traffic accidents, traffic safety measures regarding motorcycles must be implemented diligently.
- Accidents involving 4 wheelers were 249 cases or 52.7% of the total. Although this rate is not as high as motorcycle, but the figure implies that out of every 2 accidents, there is one that involves 4 wheelers.
- Accidents involving pedestrians amounted to 249 cases or representing 14.8% of the total.
- Accidents involving bicycles accounted for only 2.1% of the total which is even smaller than the figure involving pedestrians.
- Accidents involving motorcycle and motor-remok warrant special concerns. Despite of the low traffic volume of motor-remok in the city, a share of 2.1% is considered very high.

Table 1.6.3: Accidents by Type of Vehicles

Collision by Types of Vehicles	Number of Accidents	Percentage share
Car & Car	46	9.7%
Car & Motorcycle	158	33.5%
Car & Pedestrian	29	6.1%
Motorcycle & Motorcycle	166	35.2%
Motorcycle & Pedestrian	41	8.7%
Car & Bicycle	6	1.3%
Car & Cyclo	1	0.2%
Car & Motor remok	2	0.4%
Motorcycle & Motor remok	10	2.1%
Motorcycle & Bicycle	4	0.8%
Non collision accidents	2	0.4%
Car & Objects	7	1.5%
TOTAL	472	100.0%

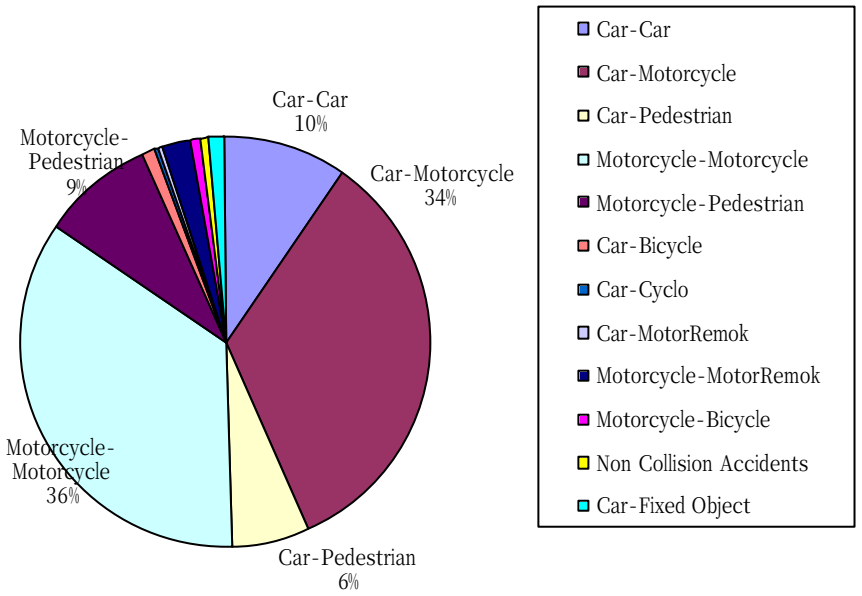


Figure 1.6.4: Percentage Share of Accidents by Types of Vehicles

(4) Causes of traffic accidents

Table 1.6.4 and Figure 1.6.5 show the number of traffic accidents and their percentage share by causes in 1999. Causes of accidents were determined by traffic policemen who investigated these accidents on site.

From these analyses, the following observations are made:

- Out of the total 472 accidents, 261 were due to various violations of traffic rules, comprising about 55.3% to the total. If those accidents caused by speeding which make up 15.3% are included, a total of 333 cases would represent 70.6% of the total number of accidents.
- Accidents caused by drunken driving were also many, 97 cases in all, and represents a share of 20.6%.
- Accidents caused by under-aged motorcycle drivers (15 years and below) were 16 cases in number or 3.4% of the total.
- There were also 16 cases of accidents or 3.4% caused by 4wheel drivers who drove without licenses.

From this scenario, it is clear that enforcement by the police needs to be further strengthened on such offenses as drunken driving, driving without license, under-aged drivers and so forth, in order that the number of accidents can be reduced. Enforcement on these types of violations, unlike enforcement on over speeding, is relatively easy and requires no sophisticated equipment but its effects on reduction of accidents can be substantial.

Table 1.6.4: Number of Accidents by Causes in 1999

Causes of accidents	Number of cases	Percent share
Drunken driving	97	20.6%
Over speeding	72	15.3%
Under-aged drivers	16	3.4%
Driving without license	16	3.4%
Violation of traffic law	261	55.3%
Violation of safe driving	3	0.6%
Caused by fixed objects	7	1.5%
TOTAL	472	100.0%

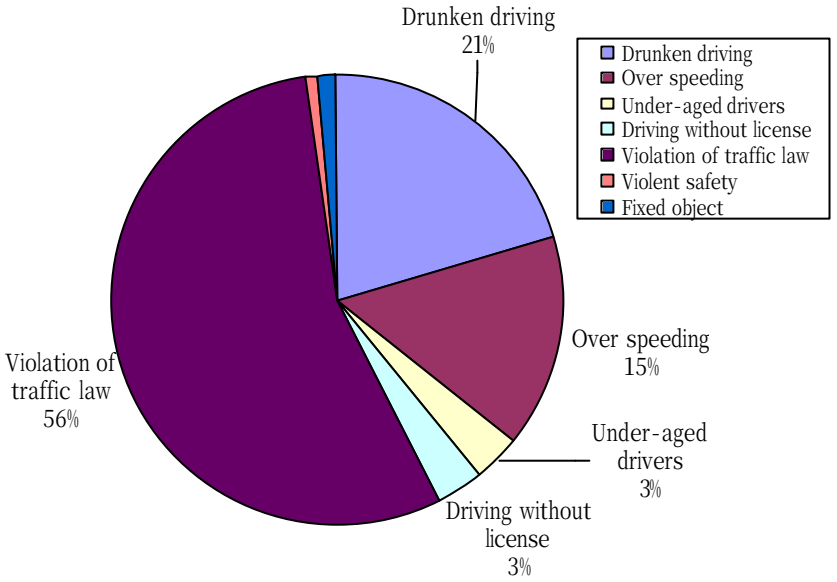


Figure 1.6.4: Percentage Share of Accidents by Types of Vehicles

(5) Traffic accidents by road categories and structures

Table 1.6.5 and Figure 1.6.6 show the number of accident cases in 1999 occurring in the city center and city outskirts. Accidents in the city center are further categorized by types of road structures while those in the outskirts are analyzed by different national routes.

From these two analyses, the following points are made:

- Of the total number of accidents, 68.9% of them occurred in the city center while the remaining 31.1% occurred in the outskirts.
- Many accidents have occurred on National Route No.2, (15.5% of the total) as well as No.1 (5.9% of the total).
- For those occurring in the city center, most of them were along district road sections (35.6% of the total), followed by local streets (10.4%).
- 17.2% of the total accidents have occurred at intersections and 4.2% at roundabouts.

Table 1.6.5: Number of Accidents by Location in 1999

Category	Location	Number of accidents	Percent share to total
Outskirts on National Routes	National Route No.1	28	5.9%
	National Route No.2	73	15.5%
	National Route No.3	10	2.1%
	National Route No.4	15	3.2%
	National Route No.5	8	1.7%
	National Route No.6A	13	2.8%
Sub-Total		(147)	(31.1%)
City Center	District roads	168	35.6%
	Local streets	49	10.4%
	Roundabouts	20	4.2%
	Intersections	81	17.2%
	Bridges	2	0.4%
	Dilapidated roads	5	1.1%
Sub-Total		(325)	(68.9%)
TOTAL		472	100.0%

Note: the data are only in Phnom Penh City

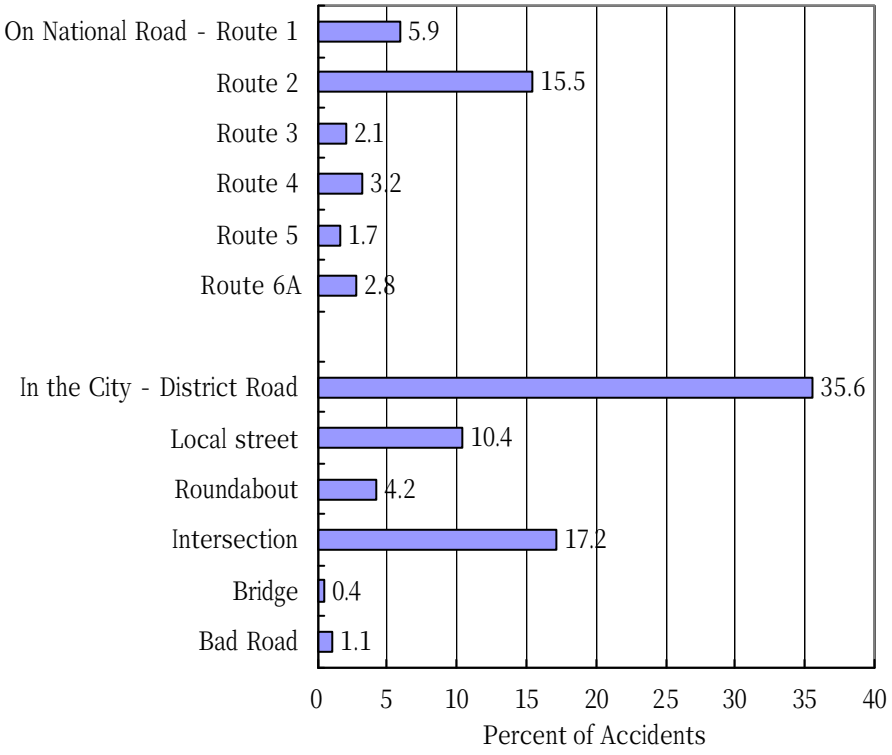


Figure1.6.6: Percent Share of Accidents by Location

1.6.3 Traffic Accident Characteristics (2)

The previous section describes the various analyses on traffic accidents using data from 1997-1999 for the city of Phnom Penh. In this section, more analyses are outlined using traffic accident data gathered by the central office of the Municipal Traffic Police, mainly on major or serious traffic accidents (fatal and serious injuries). In 1998 there were a total of 74 reported cases of serious accidents while there were 84 cases in 1999. The objectives of these analyses are to draw attentions to any particular patterns of occurrence, such a particular month, day or hour or location so that effective enforcement program can be planned to counter these accidents.

(1) Monthly Pattern

In both 1998 and 1999, many serious accidents have occurred in the month of January. (see Figure 1.6.7) Except for the month of April where there was a significant difference between 1998 and 1999 figures, there is no other outstanding pattern for the rest of the other months.

(2) Day of Week Pattern

Figure 1.6.8 indicates the occurrence of traffic accidents by different days of the week for both 1998 and 1999. Traffic accidents on Sundays and Wednesdays were high for both years. Many accidents also occurred on Saturdays in 1998 and Fridays in 1999. From this analysis, it is clear that weekends are days where many accidents occur while midweek (Wednesday) is another to watch out for.

(3) Time of Day Pattern

There were some differences between the time of day pattern of traffic accident occurrences in 1998 and 1999. (see Figure 1.6.9).

In 1998, more accidents happened between 16:00 to midnight 02:00 hours. Accidents in other hours of the day were significantly less. The hours of 20:00 to 02:00 hours was the most outstanding period where many accidents have occurred (more than 20%). In 1999, however, more accidents have occurred between the hours of 14:00 to 24:00 of the day, particularly between 14:00~16:00 hours and 20:00~22:00 hours.

(4) Major Accident Locations

Figure 1.6.10 shows the location of major accidents as reported to the central traffic police office in 1998 and 1999. By plotting the locations on a road map, it can be clearly seen that most serious accidents occurred along the major trunk roads. Accident occurrences by roads are given in Table 1.6.6 below.

Table 1.6.6: Number of Serious Traffic Accidents by Major Trunk Routes

Road Name	Fatal accident	Serious accident	Total
Blvd.Monivong	16 (4)	17 (2)	33 (6)
Blvd.URSS	6 (1)	16 (2)	22 (3)
Blvd.Norodom	7 (4)	9 (1)	16 (5)
Blvd.Mao Tse Toung	1	5 (1)	6 (1)
Blvd.Sihanouk	4 (2)	4	8 (2)
Blvd.Sothirous	5	2	7

Note: Figures in ( ) are accidents at intersections with other streets, which are also shown for the crossing streets.

From the above figures, the number of serious traffic accidents occurred at some of the main intersections in the city center are given in Table 8.6.7.

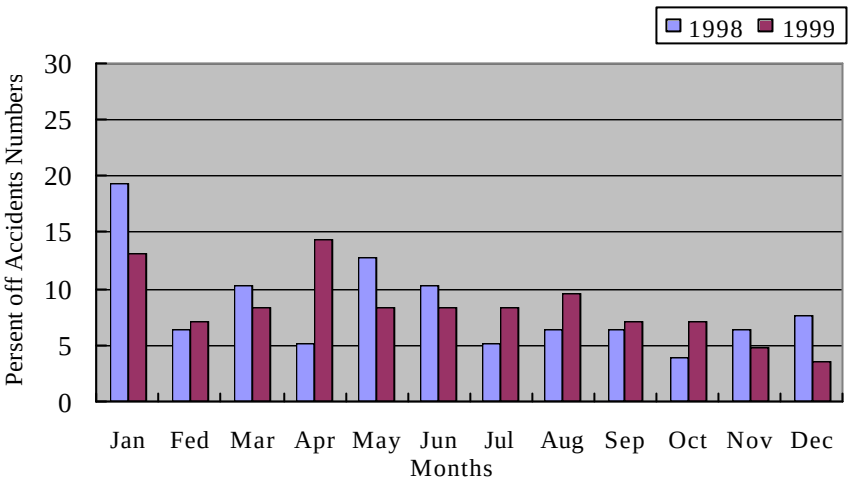


Figure 1.6.7: Accident Variation in Months

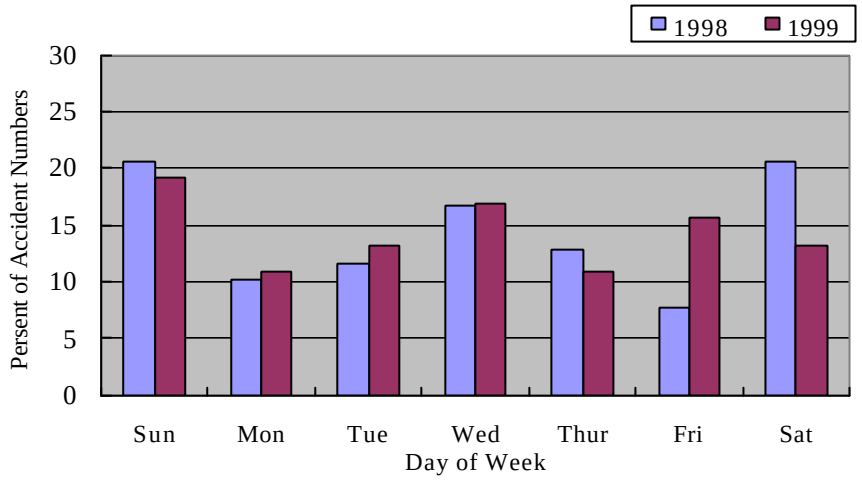


Figure 1.6.8: Accident Variation in Day of Week

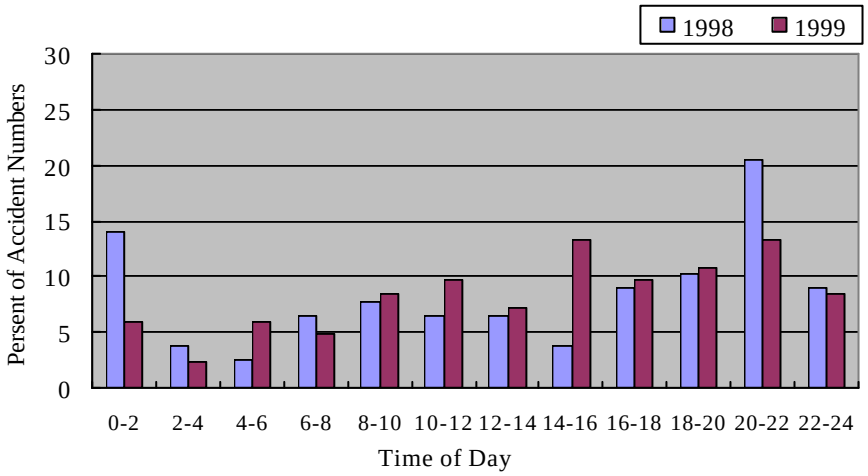


Figure 1.6.9: Accident Variation in Time of Day

Table 1.6.7: Serious Traffic Accident by Intersections in City Center

Intersection Name	Fatal accident	Serious accident	Total
Blvd.Monivong and .NR No.2 / Blvd.Norodom	3	0	3
Blvd.Monivong and Blvd.URSS	1	2	3
Blvd.URSS /271 and 598	0	5	5
Blvd.Monivong and90 Rue	1	2	3

(5) Common Types of Collisions in Phnom Penh

There were a total of 28 cases of serious traffic accidents that have occurred on the major trunk roads in 1999 reported to the central police office. Analyzing the types of collisions of these accidents (see Figure 8.6.11), head-on collision between two vehicles stood out as the major type of accident (total 8 cases and 2 were fatal). Next type of collision that was serious was rear-end collision (total 5 cases, 4 were fatal). The other main type of collision was with pedestrians (total 3 cases, 2 were fatal and one with serious injuries).

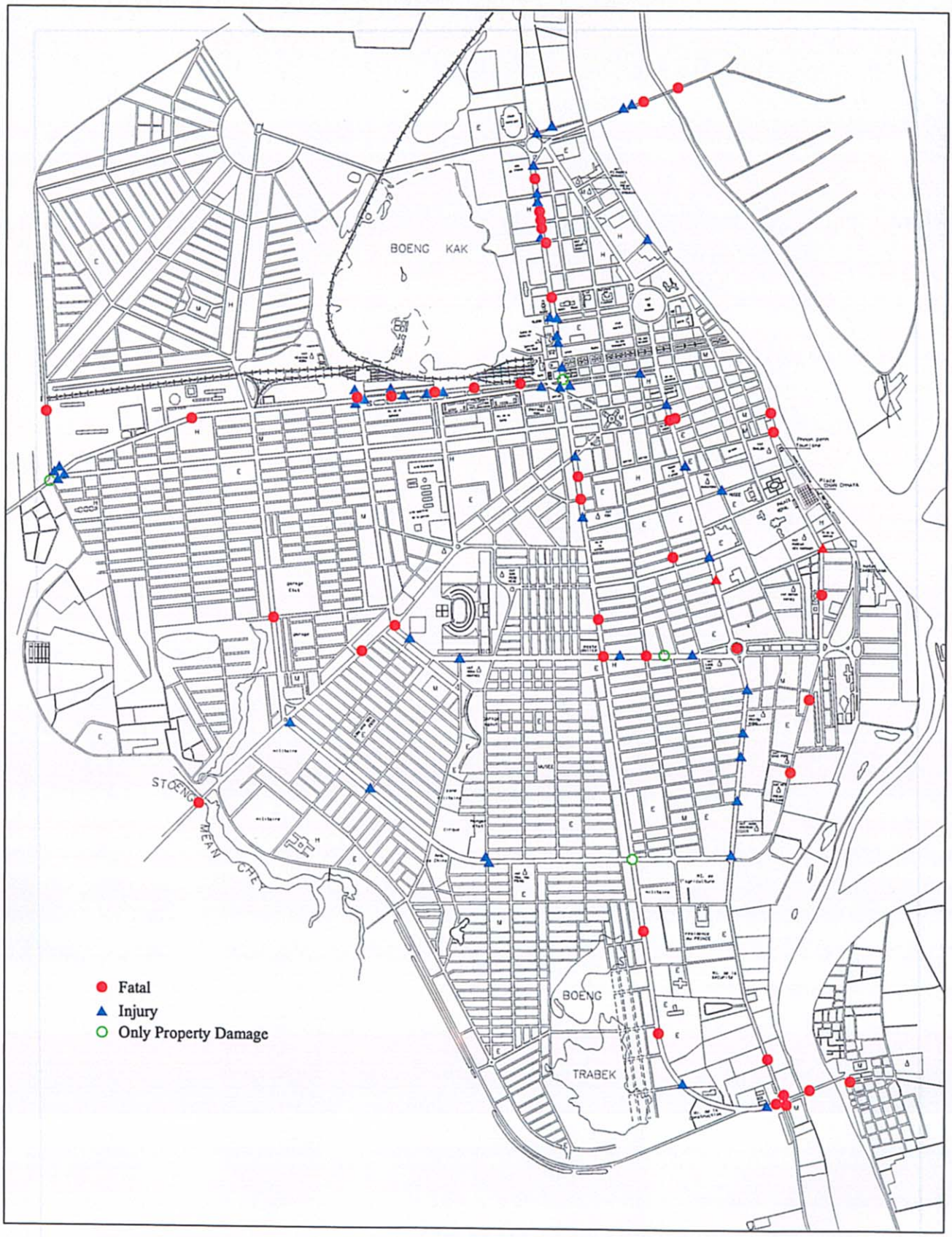
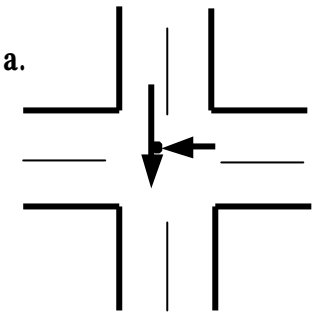
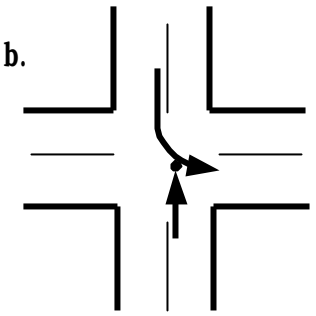


Figure 1-6-10: Road Map Showing Locations of Serious Accidents

1. At Intersection :

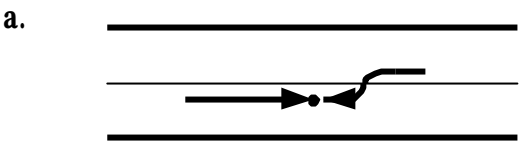


Right Angle Collision (2cases with 1 fatality)



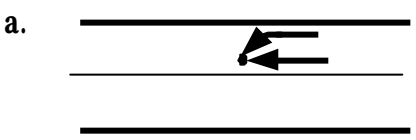
Left Turning Collision (3cases with no fatality)

2.Head-On collision :

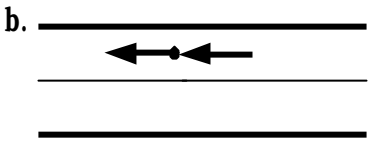


Head-On Collision (8 cases with 2 fatalities)

3. Side Swipe Collision and Rear-End Collision

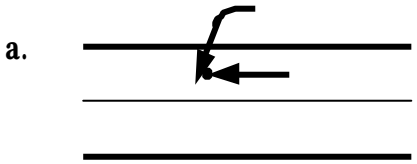


Side-Swipe Collision (2 cases with 0 fatality)

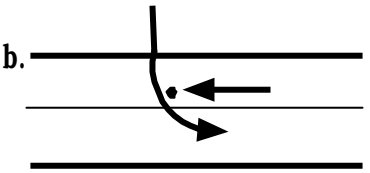


Rear-End Collision (5 cases 4 fatalities)

4. From Side Road and Parking Lot:

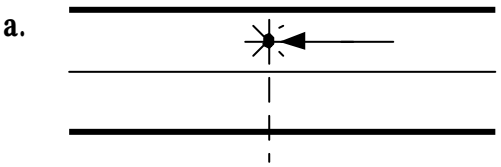


Crossing Collision (1 cases with 0 fatality)



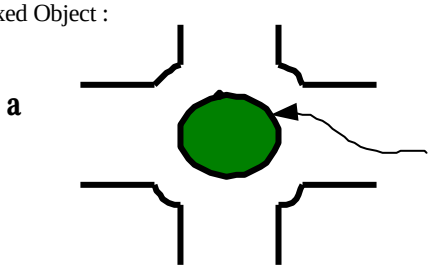
Crossing Collision (2 cases with 0 fatality)

5. Pedestrian :



Collision to Pedestrian (3 cases with 2 fatalities)

6. Fixed Object :



Collision to Fixed Object (2 cases with 2 fatalities

Figure 1.6.11: Type of Collisions on Main Trunk Roads in City Center

1.7 Traffic Signals

1.7.1 Signalized Intersections

As previously mentioned in section 1.3, there are presently 20 signalized intersections in the CBD area bounded by the ring road of Blvd.Mao Tse Tong. Although there were 33 signalized intersections just two years ago, but since then, signals at 13 of them had been removed due to the diminishing effects of signal control. These 13 intersections are now non-signalized.

One of the reasons for the signal removal was the short distance interval between signalized intersections. Red phase queuing vehicles tend to extend to the upstream intersection resulting in a total blockage of this intersection. (Signals of these intersections are not coordinated).

1.7.2 Traffic Control Methods at Signalized Intersections

The following traffic control methods are employed at signalized intersections:

(1) Traffic Control During Normal Situation

Under normal traffic situation, traffic control at the signalized intersections is based on the functions as provided by the traffic signals.

(2) Traffic Control During Abnormal Situations

When severe traffic congestion or an accident occurs in a signalized intersection, a traffic policeman from the nearest police station will carried out the appropriate traffic control. Under such a situation, traffic from all approaches are forbid to further enter the intersection, vehicles under gridlock situation in the intersection or accident vehicles are then removed. Under such a circumstance, the policeman will just ignore the signals when carrying out the control.

(3) Traffic Control During Power Outage

When there is a power outage, the signals are not functioning. Under this situation, if there is a traffic policeman nearby, he will control the traffic at the intersection manually. If there is no policeman around, the intersection has to be operated as a non-signalized intersection.

Power supply situation in Phnom Penh is very poor. Conditions may differ between areas, several power outage a day is not uncommon.

(4) Signal Control During Midnight

There are three types of signal controls that are commonly used during the night time at the signalized intersections.

- using the same signal parameters as those during the day time for a 2-phase signal control,
- using blinking red and yellow signals,
- signal control is shut down by cutting off the power supply.

The type of control deployed at any intersection depends on its night time traffic situation. In Phnom Penh, the blinking red and yellow signals are deployed at present with priority given by each intersecting road.

1.7.3 Signal Installation

Signal heads and poles are imported from Singapore and these are installed based on standards used in Singapore.

(1) Signal Indication

Both the 20 cm and 30 cm lenses are used for vehicle signal heads. For the vertical arrangement of 3 lenses on straight pedestal poles, 20 cm lenses are used. The 30 cm lenses are used for heads mounted on overhead poles with lenses arranged in the horizontal direction. Rectangular lenses with 20 cm width are used for pedestrian signals using pedestrian symbols.

The signal sequence deployed for the vehicle signals is 'Green→Yellow→Red→Green→…..' The 'all red' phase is not used. The pedestrian signals used the simple sequence of 'Green→Red→Green ….' In this country, right turn is allowed at all times, even during the red signal phase.

(2) Signal Head Location

Two types of signal head and poles are used for vehicle signals, while only one type is deployed for pedestrian signals.

- Arm-type signal pole, installed to mount signal heads above the roadway on the far side of the intersection approach, with one signal head for each traffic lane.
- Pedestal type vertical pole, installed on the near side of the intersection approach on both the right and left hand sides of the pedestrian crossing, carrying three signal heads each.
- The pedestrian signal heads are also mounted on the pedestal pole, two signal heads each on both sides of the pedestrian crossing for each approach.

(3) Laying of Cables

Power supply cables and the signal cables are all buried under the road surface using conduits for preserving the aesthetic of the town.

1.7.4 Signal Functions and Equipment

(1) Signal Controller

Signal controller is installed at one corner of each signalized intersection, from which all the signal functions are controlled.
All the signal controllers used in Phnom Penh are manufactured by the Department of Public Works and Transport of the MPP by one of its technicians. All the controllers are electric mechanism type of controllers, each with one motor and several relay mechanisms.

However, this form of controller is incapable of signal synchronization and the parameters are all fixed. It is also difficult to revise the signal parameters.

(2) Functions of Signal Controller

1) Vehicle signals

- Signal control deploys the simple 2-phase signal control, together with the pedestrian signals. The 3 or 4-phase signal controls to accommodate left and right turning vehicles cannot be handled by the existing signal controllers.
- Signal cycle, split times and other signal parameters are all fixed. Therefore signal control that can response to varying traffic demand cannot be executed.
- The existing signal controller is not capable of synchronizing or coordinating signals at one intersection with those of the adjoining signalized intersection. For this reason, all the signalized intersections works as stand-along type of signal control. When the distance between two signalized intersections is too short, signal control becomes ineffective and congestion is common.
- As long as this type of signal controller is used, the following types of control cannot be deployed:
  - Time of day control,
  - Actuated control using vehicle detectors,
  - Coordinated control,
  - Centralized area control.

2) Pedestrian signals

The timings for the pedestrian signals coincide with those for the vehicle signals. In other words, when the signal for vehicles turns green, so is the pedestrian signal. When the vehicle signal turns from green to yellow, the pedestrian signal changes from green to red.

In general, the green times for the vehicle signals and pedestrian signals should be different. The green time for the pedestrian signal is normally set to be shorter than the green time for the vehicle signal. This arrangement is to ensure that there is sufficient time for the pedestrians already in the intersection to clear the crossing before the vehicle signal changes. However, the signal control timing design used in Phnom Penh is such that both vehicles and pedestrians must clear the intersection during the yellow timing. For the vehicles, the present yellow timing is sufficient for them to clear the intersection but it is just too short for pedestrians. This create complex situations where pedestrians who are in the midst of crossing may suddenly have to face the lateral start-up traffic head-on.

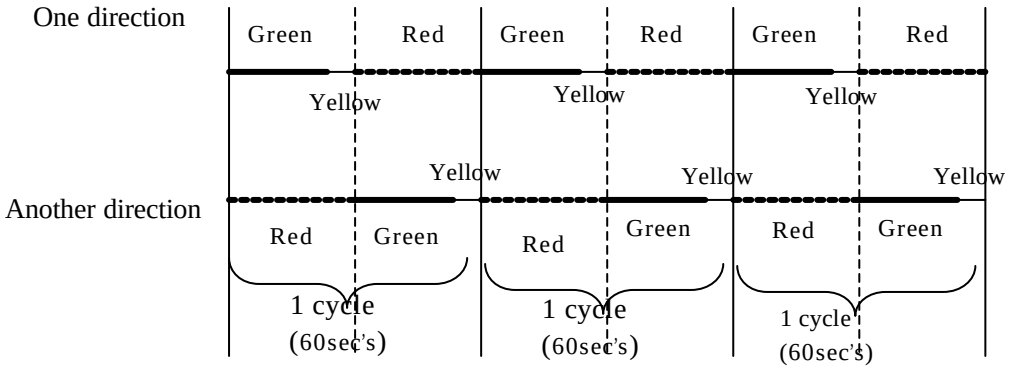
3) Existing signal parameters

All the present signalized intersections use the same fixed time signal parameters. This is then displayed as the signal parameters setting. There are only two items in the parameters, namely signal cycle time and split times.

- Phasing …….. 2 phases
- Cycle time ……. 60 seconds
- Split

	Phase	For Vehicles	For Pedestrian
One direction	Green	25sec's	25sec's
	Yellow	5sec's	
	Red	30sec's	35sec's
Another direction	Green	25sec's	25sec's
	Yellow	5sec's	
	Red	30sec's	35sec's

- Signal diagram



The following three observations can be made on the existing signal parameters:

- All signalized intersections are given the same fixed signal parameters, it is therefore difficult for the signals to response to various different traffic demand situations.
- Timing for one direction is exactly the same as for the opposing direction, indicating that the timing does not take into account the different traffic demand by direction. Fortunately, since most of these signals are installed at intersections with two major cross roads, no particular problem has occurred.
- Offset parameter is not setup to enable coordination of the set parameter of one intersection with those of the next intersection.

1.7.5 Traffic Control Device Related to Signalization

In signalizing an intersection, installing the signal equipment alone is not sufficient to ensure problem free traffic control. Appropriate traffic control devices especially pavement markings and traffic signs must also be installed at the same time.

(1) Pavement Markings

The present pavement markings at signalized intersection have not actually been authorized but are based on some temporary design standards.
The followings are the major markings deployed:

- Central dividing line …… yellow line marking
- Lane dividing line …… white line marking
- Stop line …….. white line marking
- Pedestrian crossing …….. zebra line markings

Thermal plastic material with good durability is used for these markings. However, the followings are some suggestions for improving the existing markings:

- Where left turn prohibition is enforced, there is no such left turn prohibition marking,
- The existing pavement markings are often covered with mud during the dry season, making them difficult to be seen. Most of the white markings appear to be yellow.
- Probably due to poor marking maintenance, worn out markings can be seen in many places.

(2) Traffic Signs

Left turn prohibition traffic signs are deployed at signalized intersections where such movement is prohibited. However, only one sign is installed on the right hand side pedestrian walkway. For this reason, many drivers have failed to notice this traffic sign.
At intersections where left turn is prohibited, considerations are needed for improving the installation of traffic signs as well as provision of pavement markings.

(3) Safety Islands

Safety island is not provided at the existing signalized intersections. This provision is closely related to the intersection configuration. There is no particular need for this facility at the moment.

1.7.6 Other Signal Control Facility

Signal control is only used for traffic control at signalized intersections in the city of Phnom Penh. Signals are also needed at various road sections for pedestrian crossings and reversible lanes. In the near future, signalization of pedestrian crossings will be particularly needed to ensure the safety of pedestrians.

1.7.7 Major Issues in the Near Future

The existing situation of signal control and various observations are as described above. Several major issues that required attention in the near future are summarized below:

1) Left turning vehicles often disrupt the smooth through traffic flow from the same direction as well as from the opposing direction. For this reason, it is very essential to install exclusive left turn lane at intersections, as well as adding left turn signal phasing to the existing signal control phasing design.
2) Signal parameters should be improved from the present fixed type to variable type of parameters, so that the signals can response to actual traffic demand to a certain extent. (such as considering the use of 'time of day' control).
3) Improve on the maintenance and management of pavement markings to ensure better visibility.
4) Ensure the workings of traffic signals during power outage.

These issues are to form the major topics to be addressed in the future.

1.8 Traffic Signs and Road Markings

This section describes the current conditions of installations of two of the most important traffic safety devices, namely traffic signs and road markings.

1.8.1 Traffic Signs

(1) Definition

A traffic sign is an important traffic control device mounted either on a fixed or portable support. A special message is conveyed to drivers by means of word or symbol for the purpose of regulating, warning or guiding traffic. Signs are essential were special regulations are applied at specific places or at specific times only; or where hazards are not self-evident. They also provide information on highway routes, directions, destination and points of interest. (from "Fundamentals of Traffic Engineering -13th Edition" by Institute of Transportation Studies, University of California at Berkeley)

(2) Installation standards of traffic signs in Cambodia

The Ministry of Public Works and Transport in Cambodia had prepared the required design standards on traffic signs (including shape, color, size, message, lettering, etc). and the design standards had been approved in 1996.

The next step is to study and decide on the standards for installation, such as location, supports, height, material, reflection, lighting and others. Traffic signs are installed in Phnom Penh based on this on-going standardization process; thus they are not strictly being authorized yet. References were made on standards on traffic signs used in France, Australia, Singapore and other countries. The standards when finally adopted by Cambodia thus will be an internationally acceptable one.

A: last some big, clear, easy-to-read road signs for Phnom Penh's ever-increasing throng of cars and motorbikes. The signs, in Khmer and English, all appear to be sponsored by one of the city's numerous mobile-telephone companies.

Of special interests are the traffic signs for the unique on-street parking regulation on even and odd-day of the month along a major road in the city. For regulating this unique parking control, the Ministry of Public Works and Transport has come up with its own unique design and message in conveying this information to the public. This is shown in Figure 1.3.6 in Section 1.3.2.

(3) Installation conditions of traffic signs

A large number of traffic signs have already been installed in the city. Most of them are regulatory and guidance signs. Recently, many guide signs were put up around the city by the authority. Besides all these are the signs indicating names of streets put up at the corners of intersections.

One obvious problem with the traffic sign installation is the height of some of these signs, which is lower than the average height of pedestrians. Pedestrians are in danger of hitting their heads on many of the signs installed near the corners of intersections. Furthermore, many directional, destination or points of interest signs were erected perpendicularly on the pedestrian sidewalks. Some of these signs are a hindrance to pedestrian traffic.

(4) Building a database on traffic signs installation

Traffic management facilities along Blvd. Monivong (about 6 km in length) were improved when this important road underwent road upgrading works in 1999. At that time, traffic signs were designed and installed.

A computer database was constructed (using AUTOCAD Program) to store all the installation data in a personal computer. Contents of this database include the types of traffic signs and their installation locations on city maps. Lists of these traffic signs and locations are also included. From now on as roads get improved, new data will be added on to this useful database.

Figure 1.8.1 shows an example of this signs database of a road section.

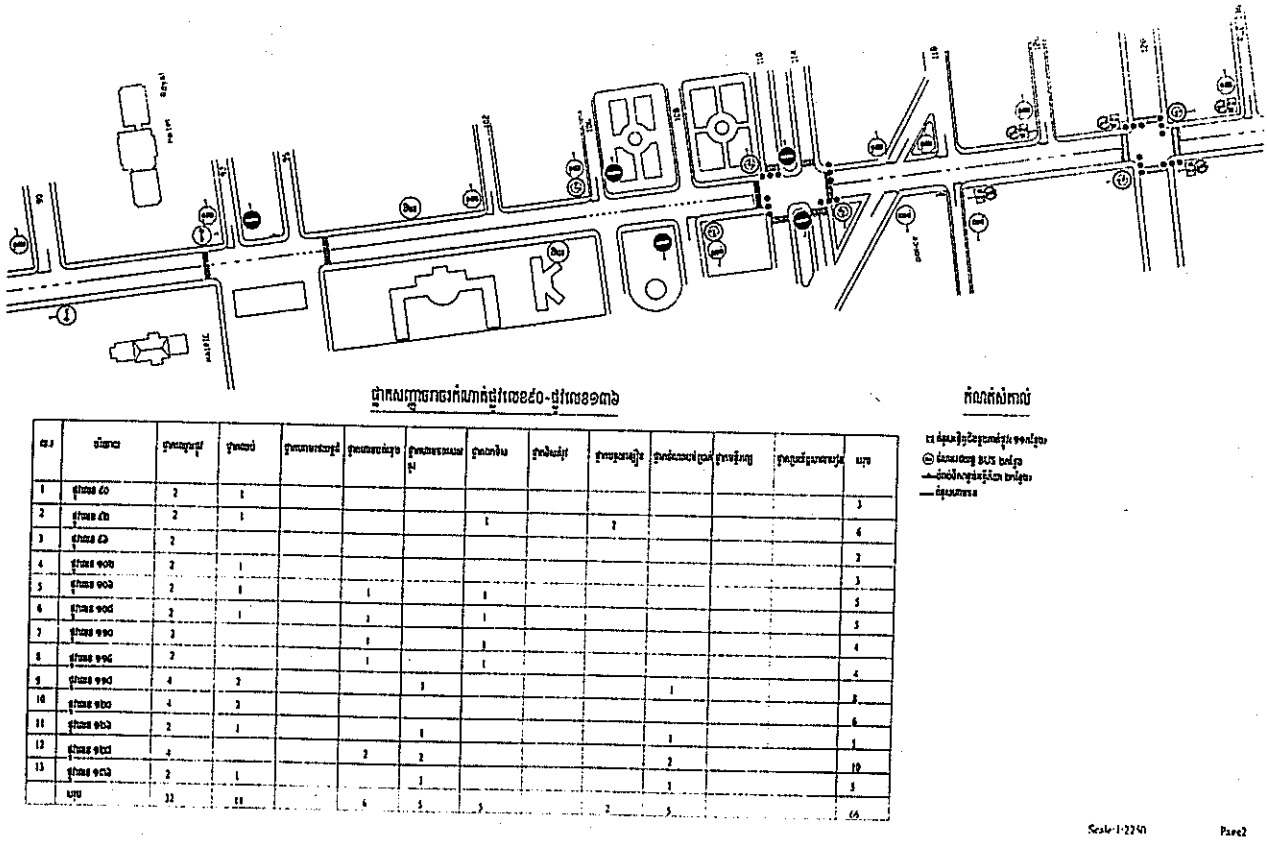


Fig 1.8.1: Example of Sign Database of a Rod Section

1.8.2 Road Markings

(1) Definition

Markings are generally defined as all lines, patterns, symbols, letters, words, colors or other such devices set into the surface of the pavement or curbing and placed for the purpose of regulating, warning or guiding traffic. (form "Fundamentals of Traffic Engineering -13th Edition" by Institute of Transportation Studies, University of California at Berkeley)

Markings are often used to supplement other traffic safety devices such as traffic signs and signals; or to stand alone in providing regulatory or warning messages to road users.

Markings are generally used to:
- display traffic regulations (e.g. curb markings, no passing zones, etc)
- supplement other devices (e.g. stop lines, 'No Left Turn' messages, etc.)
- guide traffic (e.g. lane lines, crosswalks, etc.)
- warn traffic (e.g. signals ahead message and other markings)

(2) Standards of pavement markings in Cambodia

The Ministry of Public Works and Transport is preparing standards on the design and installation of pavement markings and a draft of which has already been completed. Standards contained in this draft document are being applied to roads currently undergoing improvement or upgrading works.

Similar to traffic signs, the standards on markings are based on extensive references to practices in other advanced countries. For example, yellow and white are the colors used for line markings. Yellow is used for segregating two opposing traffic streams while white is used for traffic lanes, stop lines, and pedestrian crosswalks. Lines are either bold or broken lines. Bold lines indicate 'no crossing over' while broken lines indicate 'crossing over allowed'. These are similar to international standards as shown in Figure 1.8.2.

However, zebra markings are used for pedestrian crosswalks at intersections in Cambodia. In general, zebra markings are not used. Two white lines perpendicular to the road are commonly used to define the crosswalk at intersection. In Japan, the zebra markings are also used.

In Cambodia, mud or dirt on the road often obscures pavement markings, which make them difficult to see from a distance. The use of zebra markings, for instance, is suitable for Cambodia as they can emphasize or improve the visibility of the facility.

(3) Operation and problems

Thermal plastic material is used for pavement markings on the following major roads in Phnom Penh. Yellow is used for the central or median line. White is used for stop lines, lane lines and crosswalk lines and zebra markings. Zebra markings are also used for pedestrian crossings at intermediate points along several road sections.
- Blvd. Monivong
- Blvd. Norodom
- Blvd. URSS
- Blvd. Sihanouk
- Blvd. Mao Tus Toung
- National Route No.2
- Rue Kampuchea (currently undergoing road improvement works)

Markings on Blvd. Monivong are relatively clear compared to the others. On other roads, although the yellow lines are clear, many of the white lines have been worn out and are difficult to see. For the other roads, especially the secondary roads, as the road pavement conditions of many of these roads are very poor, installation of pavement markings is almost impossible.

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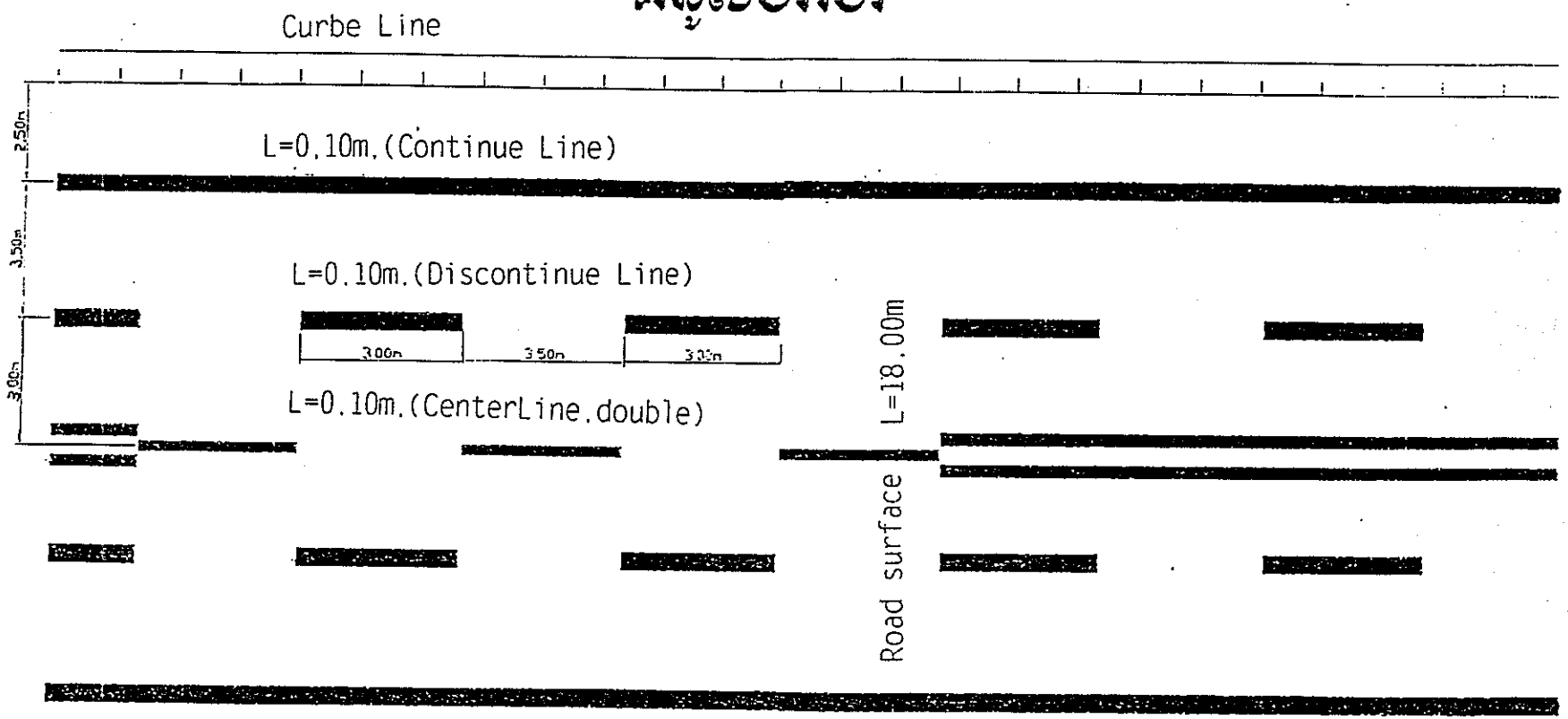


Figure 8-8-2: Example of Draft of Marking Standard

Figure 1.8.2: Example of Draft of Marking Standard

1.9 Parking Facilities and Conditions

Parking facilities in Phnom Penh can be broadly divided into two categories, namely, on-street parking and off-street parking. The present conditions of these facilities and parking situation in the city are presented below.

1.9.1 On-street Parking Facility

(1) Basic Parking Regulation

In Phnom Penh, on street parking (curbside parking) and loading/unloading of goods by trucks are generally permitted on roads in the city, except at prohibited places or roads and the blanket parking prohibition areas (described below).

1) Blanket Prohibition of Curbside Parking
For obvious reasons; stopping, waiting and parking of vehicles are prohibited at the following places, even if no parking prohibition signs are posted. Drivers should be taught to observe these universal blanket parking prohibition requirements.
- On pedestrian walkways,
- On roadways next to a parking vehicle (double parking)
- Within an intersection or along approaches to an intersection,
- On the curb in front of driveways,
- On the curb on a pedestrian crossing,
- On the curb near to a fire hydrant.
- On a highway bridge or in a tunnel.

2) Curbside Parking Regulation
In Phnom Penh, curbside parking is prohibited along some major streets in the city center. Such prohibition however, is enforced with a 'Even day' or 'Odd day' regulation at different sections of these roads.

There are designated curbside parking areas in the city. Such areas are indicated with a yellow pavement marking and are found mostly around market places. At such areas, parking fees are often collected by some parking attendants but not by the MPP office. (show in more detail "1.3.2 Existing control measures and locations")

(2) On-street Parking Situations

1) Parking Situation at Prohibited Areas
- In spite of parking prohibition at these designated areas, drivers often ignore such regulation.
- There is obviously insufficient police enforcement on these illegal parking at such prohibited areas,
- However, at some parking prohibition areas, it is found that the required signage of this regulation is not very clear.

2) Obstruction to Vehicular Traffic
- Curbside illegal parking is very rampant in the city, to the extent that it becomes a serious obstruction to traffic flow and a major cause in the reduction of traffic handling capacity of the affected road sections. Parking or waiting vehicles are common at both the approaches and downstream exits of intersections. Double row parking is also common along some road sections near the shopping or business districts.
- Parking generally occurs on the motorcycle lane, i.e. on the curbside lane; thus posing danger to motorcycle traffic.

3) Parking or Garages on Pedestrian Sidewalks
- Surprisingly, there are certain areas where parking is allowed on the pedestrian pavement. Parking of vehicles on pedestrian sidewalks has become too rampant that these vehicles become serious obstructions to safe pedestrian movements. Parking on pedestrian sidewalks should not be allowed

at any time or anywhere within the city.

- Pedestrian sidewalks or curbsides have become private vehicle garages. At present, except for the city center, this has yet to become a serious problem for the city. However, considering the rapid increase in traffic demand and the chronic shortage of off-street parking facilities, such matter will surely and quickly become a major problem in the near future.

(3) Parking Enforcement

Parking of vehicles in or near to an intersection is universally prohibited anywhere in the world. However, most Phnom Penh drivers ignore or do not understand this basic driving regulation. Uncontrolled parking actions can easily disrupt smooth traffic flow and endanger other road users.

Parking along prohibited streets is not effectively enforced by the police, except on Blvd. Monivong, which has the even or odd-day limited parking prohibition and control. Enforcement is also rarely conducted on such irresponsible actions as parking on sidewalks, parking in or near intersection, and double parking.

1.9.2 Off-street Parking Facility

Off-street parking facilities are inadequate in the city center of Phnom Penh. These facilities can be generally classified into the following types:

a. Public or government buildings,
b. Multi-storey buildings
c. Office buildings or single homes
d. Rows of Shophouses
e. Market, supermarket complexes.

(1) Public or Government Buildings

There are many public or government buildings for both the national and city government functions distributed throughout the city. These also include foreign embassies or high commissioners. These buildings are generally sited on large plots of land with large open spaces around the buildings. Many of these open spaces within the compound are used as parking facilities.

(2) Multi-Storey Buildings

Multi-storey buildings in the city are mostly the luxury hotels. The top hotels in Phnom Penh are equipped with large parking floors and ample parking lots.

However, hotels sited along Blvd.Monivong obviously do not have sufficient parking provided for their clients. Vehicles belonging to the hotels as well as hotel guests are often found parked on the pedestrian sidewalks or on the streets.

(3) Office Building or Single Homes

Single homes and office buildings generally have their own parking spaces provided within their compounds.

(4) Rows of Shophouses

The old shophouse rows found in the city center along shopping streets or business district, generally do not have off-street parking provisions. Shoppers and shopowners are forced to park their vehicles on the streets or on pedestrian sidewalks. In front of restaurants, in particular, streets are often crowded with parked vehicles. In some cases, the pedestrian sidewalks have become permanent garages for the shopowners.

(5) Market, Supermarket Complexes

1) Major Markets

The city of Phnom Penh manages the following 7 public markets:

- Central Market
- Olympic Market
- Deum Kor Market
- Chab Ampar Market
- Depot Market
- Russian Market
- Orussey Market

All the above markets, except for Orussey Market, have no off-street parking facility. Parking is therefore done on streets around these markets.

At the Central and Russian Markets, there are designated on-street paid parking areas provided with recognizable markings. Orussey Market is presently under construction. Off-street parking facilities are provided around this market. Furthermore, a multi-storey car park is also being constructed next to the market.

2) Supermarkets

The recently opened multi-storey supermarkets along Blvd.Monivong have no proper off-street parking facilities. Loading and unloading of goods are all done on the pedestrian sidewalks or streets. Shoppers are forced to park their vehicles on the streets.

Supermarkets sited along Blvd.Sihanouk and Blvd.Mao Tse Toung are however provided with multi-storey car parks.

In summary, off-street parking facilities are sufficiently provided among the public or government buildings, single homes and office buildings. On the other hand, off-street parking facilities within the shopping and commercial districts in the city center are seriously lacking. Shoppers are forced to park on the streets. As these business and shopping districts are concentrated around the major roads, such on-street parking has become a serious obstruction to smooth traffic flow. Rampant parking on pedestrian sidewalks also obstructs the safe movement of pedestrians. These situations are particularly obvious along Blvd.Monivong, Blvd. C.de Gaulle and Blvd.Kampuchea Krom.

With rapid increases in vehicle parking demand in the near future, there is obviously a serious shortage of off-street parking facilities. As traffic demand increases, improvement to the traffic flow on major roads becomes a priority measure. Improvement to pedestrian walkways will also become necessary with the introduction of mass transit modes in the near future. With such measures, on-street parking prohibition and enforcement will be inevitable. Therefore, a satisfying resolution of the existing parking demand on the streets and pedestrian sidewalks will become one of the major issues for the city.

1.10 Traffic Safety Education and Enforcement

1.10.1 Traffic Safety Education

Any traffic safety education for Phnom Penh must be plan with the entire city's population in mind. All vehicle drivers are also pedestrians themselves at other times. In the present situation, where many pedestrians are found to cross any streets randomly without any regards to their own safety as well as other road users. Except for those unfortunate few who had experienced personally the trauma of accidents, many residents here can be said to be quite unaware of the horror of traffic accidents. Most residents here have a very low awareness of traffic safety. Information on accidents is not widely propagated to drivers nor the general public. Statistics showed that traffic accidents, fatality and injuries from accidents are on a rising trend. This phenomenon can become a major social problem in the future if it is not addressed soon and properly.

With such a background, the city of Phnom Penh has recognized the importance of traffic safety education to its residents. Consequently, a traffic safety campaign was implemented in the city throughout February and March 2000.

(1) Program of Traffic Safety Education Campaign

The Municipality of Phnom Penh, the Department of Public Works and Transport and the Traffic Police have jointly conducted a traffic safety education campaign in February and March of 2000. The campaign was aimed at educating and enhancing the traffic safety awareness among children and students, as well as the general public, particularly the drivers of cars and motorcycles. It was the first of its kind in Cambodia.

1) Agencies involved
   The main government agencies involved in the organization of this campaign include:
   - Transport section, Department of Public Works and Transport in MPP,
   - Municipal Traffic Police Force.

   The other agencies and institutions involved are;
   - All the primary, secondary and high schools in the city of Phnom Penh,
   - The seven district offices within the Municipality.

2) Contents of Campaign
   The campaign program included three main activities as:
   - Traffic safety education for children/students,
   - Traffic safety education for the general public
   - Traffic safety education and driving for all drivers on the field.

   a) Traffic safety education for children and students
      The major task for this activity was for the Transport Section of the DPWT to prepare and print educational pamphlets on traffic rules, regulations especially on traffic signs, traffic markings and traffic controls. The Municipal Traffic Police was then given the task to distribute these pamphlets to 159 schools in Phnom Penh in March of 2000. At the same time, Traffic Police Officers were dispatched to schools to instruct the respective teachers in each school on the basic traffic rules and regulations using the printed pamphlets.

      The school teachers were then able to teach the school children on the traffic rules and regulations using the printed pamphlets at the beginning of the school term (2 hours were spent for each class). The pamphlets were also displayed on notice boards in the school premises.

   b) Traffic safety education for the general public
      i) TV broadcasting of traffic safety program
         A special traffic safety education TV program was produced and this was broadcast to the public everyday each time lasting for about 10 minutes. (This video tape was also made available to the public from the police station). However, radio broadcasting was not used for

this purpose. Local newspapers were also used to carry news and features of the campaign to arouse the awareness of the public.

ii) Delivery of pamphlets to the public
The printed traffic safety education pamphlets were first distributed to the 7 district offices of the Municipality government. Each of these district offices was then given the responsibility to distribute the pamphlets to residents within its district. The pamphlets were also displayed on public notice boards in all districts.

c) Traffic safety education for drivers
Driver education during the traffic safety campaign was conducted on the filed along a selected road section. The road section along Blvd.Monivong between its intersection with Blvd.Sihanouk and the National Route No.1 and 2.

Traffic policemen were divided into two groups (168 persons in any one time and total 558 persons). One group was to scatter along the selected road section. The other group then got on their white traffic police motorcycles (20 of them) and patrolled the road section.

Microphones were installed at seven main intersections along the selected road sections to provide vocal advice on traffic rules and driving manners to the public particularly the drivers.

The policemen stationed along the road section were instructed to spot any traffic violation and ill disciplined drivers. When such a driver was spotted on the road, the vehicle (either a car or motorcycle) was immediately stopped. The driver was then instructed by the police on his bad driving and how to achieve safe driving. No penalty was given out to drivers during the campaign period.

3) Published traffic safety pamphlets
Three types of pamphlets were prepared and published by the MPP.
- Types of traffic signs and their meanings,
- Types of traffic control by signs and markings,
- Traffic signs details.

More than 40,000 copies of these pamphlets were printed and distributed to schools and the 7 district offices of the Municipal government. (Tables 1.10.1 and 1.10.2) Samples of these materials were attached in this report.

4) The effects
An evaluation has yet to be made on this traffic safety campaign but a questionnaire prepared by the Transport Section of the DPWT was sent to the various departments in the MPP that are related to traffic management/safety education as well as to the 7 Municipal district offices. Answers to these questionnaire have not been received yet but were expected in the coming weeks. Quoting an officer from the department, 'the number of traffic accidents seemed to have reduced after the safety campaign.'

(2) Traffic safety education for schools

Traffic safety education for primary, secondary and high schools was introduced as part of the traffic safety campaign in year 2000. No such education was given previously.

Traffic safety education conducted this time can be considered to be very effective. Traffic police officers were first dispatched to various schools to instruct the teachers on traffic safety. The teachers then pass on such knowledge to the students. However, it is not realistic to expect all the students to be completely conversant with all the traffic rules and regulations with only one classroom session. It is essential that such classroom education on traffic safety be continued. Furthermore, efforts must also be made to further improve and strengthen the teaching materials as time goes on.

Table 1.10.1: Number of Pamphlets Printed

	Type 1	Type 2	Type 3
Number of Pamphlets Printed	14,200	12,000	20,000

Table 1.10.2: Number of Pamphlets Distributed

School / District Office	Type 1	Type 2	Type 3
Kindergarten (18)	193	146	0
Primary Schools (109)	7,391	5,896	10,601
Secondary Schools (14)	770	595	1,085
High Schools (14)	1,813	1,499	2,781
Teacher training college (3)	180	165	210
Orphanage (1)	120	100	220
SUB-TOTAL	10,467	7,861	14,897
District 1 (pram pi makara)	364	312	476
District 2 (toul kork)	392	336	528
District 3 (cham kar morn)	420	360	550
District 4 (dorn penh)	392	336	528
District 5 (resey kev)	420	360	580
District 6 (mean chey)	308	264	472
District 7 (dang kor)	504	432	636
SUB-TOTAL	2,800	2,400	3,770
Departments of MPP	910	810	1,310
GRAND TOTAL	14,177	11,071	19,977

The young generation is to become the pillars of society and knowledge acquired when young is less likely to be forgotten. It is therefore very important for this education program to be given appropriate priority.

(3) Traffic safety education for the public

In the traffic safety campaign, TV and radio were used to broadcast news on traffic accidents in an attempt to impart awareness on the importance of safe driving, observing traffic rules as well as the horrors or losses of traffic accidents. Through this effort, many residents are made aware to a certain extent on the traffic accident issue that is affecting them.

Traffic safety and accident are also widely reported in the local news media, namely Rasmey Kampuchea and Kaoh Sante Peap. Wherever there is a major accident, pictures of the accident scene are also printed to give certain level of 'shock' treatment to residents, forcing them to rethink when the next time they drive recklessly.

Radio broadcast is through FM 105.0 MHz radio station. News on major traffic accidents are frequently broadcast to the public.

(4) Traffic safety education for drivers of 4wheel vehicles

A legal driving license issued by the Ministry of Public Works and Transport is required for driving a 4wheel vehicle on the public roads. To obtain such a license, the following conditions must be met:

- Above 18 years of age,
- Learned the technique of driving by attending a private driving school and completed at least 16 days (0.5 to 1.0 hour/day) of practical driving under guidance on the public roads,
- At the same time, attend classes to learn the basic traffic rules, safe driving and basic mechanism of a vehicle.
- To pass the paper test and driving technique conducted by the Ministry of PWT.

In meeting these requirements, most 4wheel drivers can be said to have acquired the basic traffic rules and safe driving techniques. The learning material used in Cambodia is the 'What the drivers have to know?' published by the Ministry of Public Works and Transport. This teaching material is divided into three parts:

- Discipline and safety in driving,
- How to drive (Traffic rules and regulations)
- Automobile mechanism

This material however has lots of written passages and it is not easy to comprehend if the learner has not achieved a certain level of formal education. It is therefore doubtful that using just one such material, all the public can sufficiently be taught on traffic rules and regulations.

(5) Traffic safety education for motorcycle drivers

One of the main traffic safety problems in Phnom Penh is the lack of traffic safety awareness and knowledge among the motorcycle drivers. Either they have not formerly received any instruction on traffic safety or there is little opportunity for them to undertake such learning.

Anyone above the age of 16 can drive a motorcycle without any legal license. However, a license to drive is required by law if the motorcycle is of 100 cc and above. (at present such license has not be issued)

The current situation in the city is that many motorcycle drivers are driving on the public roads without receiving proper education on traffic safety and rules or regulations. Considering this, education in schools is thus even more important.

(6) Teaching material

For all the public to be taught on traffic rules and regulations, it is essential that a simpler teaching material be produced and made easily available to the general public in the near future

1.10.2 Traffic Enforcement

All drivers are required to observe the traffic rules and regulations. Violations of these rules are direct causes of traffic accidents as well as chronic traffic congestion. Any violation of these traffic rules should be punished to prevent recurrence. However, enforcement of traffic rules is very difficult when there are severe constraints of shortage in manpower and equipment.

(1) Enforcement setup and equipment

Traffic rules enforcement is carried out by the municipal traffic police force. There are about 500 persons under this force.
Equipment available to this setup for traffic rules enforcement are:

- 20 white police motorcycles equipped with microphones,
- microphones installed at 5 major intersections along Blvd.Monivong.

(2) Enforcement methods

Two common methods in enforcement are practiced in Phnom Penh.

- Policemen are stationed at the major intersections along major roads. Vehicles found to have violated the traffic rules are stopped. The drivers are then reprimanded for their illegal behavior or violations. They are told on the correct behavior and safe driving methods.
- Police white motorcycles are used to patrol the roads. When any violation by vehicle is spotted, the driver is reprimanded for their actions and instructed on proper behavior.

Fines are not collected from drivers by the municipal government or police. Policemen stationed at the intersections are also required to monitor the traffic. When a congestion or an accident occurs, he will take over the control of the traffic until the traffic is returned to normal.

(3) Penalties

Up to May of 2000, no penalties have been enforced. Drivers were instructed on the proper driving manners by traffic policemen.

Plan is underway to impose fines on errand drivers from 2000. Two types of traffic violation tickets are being prepared which will be given out to errand drivers depending on their severity of violations. Figure 1.10.1 shows the samples of these violation tickets.

Fines will be 5,000 reils and 1,000 reils. Traffic violations as contained in the Land Traffic Law Decree N68 (see Table 1.10.3) are to be used as legal provision to strengthen the enforcement.

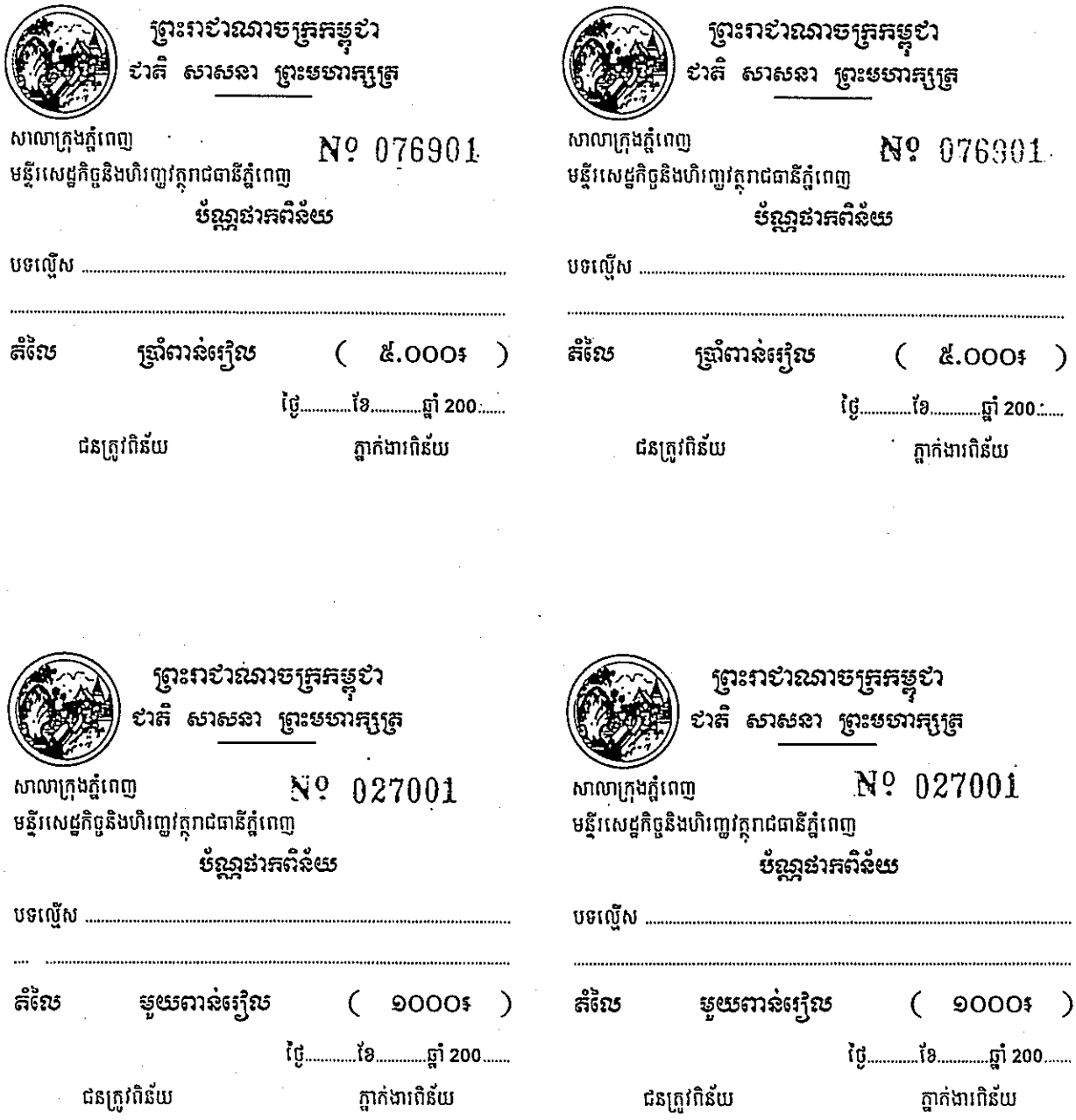


Figure 1.10.1: Sample of Violation Tickets

Table 1.10.3: Items of Penalization to enforce violation

Articles	Contents
Article 17	To obey the ordinance or rule of the MPP or each province when driving in the district
Article 18	To keep to the right at all times
Article 19	To use the left lane only when overtaking
Article 20	To slow down in speed controlled zones
Article 21	To drive under the speed limits
Article 22	To obey rule of priority of vehicles when crossing roads
Article 24	To use horn in daytime and blinkers at night at designated areas
Article 25	To obey rule of priority of vehicles on bridges
Article 28	Do not park at prohibited areas
Article 33	To install a registration number plate and to keep lighting of vehicle in good conditions
Article 35	To prohibit overloading of vehicles and use of over dimensions (width, length and height) of any vehicles.

Among the above articles are enforcement on speeding and overloading of vehicles. To effectively enforce these violations, appropriate equipment is required. Full enforcement is often difficult to achieve. Many violations such as listed above however can be quite effectively enforced by mere visual observations. By studying the accident data, three other areas of violations beside those listed above can also be targeted.

- Drunk driving or driving under the influence of alcohol,
- Under-aged drivers (below 15 years old),
- Driving without legal licenses.

It is more effective to select certain regulations and enforce them emphatically at a selected time period rather than trying to enforce all the rules. This method of selective enforcement provides more impressions to drivers and is easier for the enforcement officers to conduct their duties.

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

In this manner, more effective results can be achieved by the enforcement efforts. Moreover, with such selective enforcement, there is a better chance to reduce traffic accidents at a faster rate. Furthermore, drivers will be able to receive a more effective traffic safety education.

1.11 Data Base

For any efficient and effective traffic management plan, a good database is indispensable. The following types of data items are essential in building up this database.

1) Road inventory data
2) Traffic data (volume, composition, etc)
3) Traffic control and other facility installation data
4) Traffic accident data
5) Vehicle registration and inspection data
6) Driver licensing data

1.11.1 Road Inventory Data

There is no road inventory data covering all the roads in Phnom Penh at present. The major source of data on roads is the 1:2000 scale road maps. However, this data source has great limitations where the fundamental dimensions such as road width, number of lanes, road length are not available. For this reason, when information on a particular road or road section is required, one has to go on site to conduct survey or measurement.

It is therefore essential that the DPWT gathers the various basic road data and computerized into a useful and comprehensive road inventory database in the near future.

1.11.2 Traffic Data

There is also no database on traffic at present. Traffic data such as traffic volumes is very scarce, confining only to those gathered by past studies or projects (by the UN, ADB or JICA). Traffic data gathered in this JICA Study is therefore the latest traffic volume data available for the city.

Although the city has no specific plan or program to gather traffic information at present, such a plan should be set up soon to gather traffic information on a regular basis, such as yearly or twice yearly. Such chronological data are necessary for traffic engineering and transport planning in future. As the road network in the city expands and more intersections are added, advanced traffic control system is going to be indispensable in the near future. These traffic data will form the basic data necessary for such plans.

1.11.3 Traffic Control and Facility Installation Data

Traffic control and facility installation data includes the following two categories of information.

- Traffic operation and control data
- Inventory and maintenance data on traffic control devices installed.

Various kinds of traffic control measures and devices are presently being installed in Phnom Penh. Information on these measures and devices such as methods, type of facility, date of installation, maintenance or inspection, are not standardized and are scattered among various departments. Information if exists is only held by the responsible agency or department. Information is not frequently shared with other departments. The public also has no access to such information. To know any traffic control regulation, one has to go to the site and find out there and then what kind of measures and signs or markings are installed. If such information is made available to the public, road users can have prior knowledge of these measures and much confusion and hence congestion on the roads can be avoided.

Efforts are now made to construct a database on traffic control facility especially traffic signs and pavement markings. Such data for the recently improved Blvd.Monivong are now being input into a personal computer as the first step towards building the database. From this data source, any information on traffic control facility along Blvd.Monivong can now be obtained easily. Such information is useful for checking of devices and their maintenance.

From now on, as roads get improved, data of various facilities should be added on to this database.

1.11.4 Traffic Accident Data

Currently, no traffic accident data is available or being prepared for setting up programs to reduce traffic accidents. In addition, information on accidents that are essential and related to programs for roads and traffic improvements are also lacking.

Traffic accident records are kept by the central traffic police office as well as the respective district police offices. To gather any form of traffic accident data therefore, one has to start from gathering entries from these records before any analysis can be made. Under such a situation, there is practically no analysis being done at present on traffic accidents. As data is not standardized, there is also a danger in committing various errors when doing any analysis.

It is therefore essential that proper traffic accident data be gathered and kept in future in response to the needs for accident analyses. One method, for instance, is for the traffic police to prepare such an accident data sheet simultaneously when he is on site to investigate a particular accident.

This method of accident data gathering is much easier and efficient than to gather from the records. As these accident data sheets accumulate, they themselves become a good database for various types of accident analyses.

As such accident data are automatically sent to the central police office from the various district police offices, a good and standardized accident data base covering the entire city can easily be built up. It is most desirable that such a plan be quickly put into practice so that such an essential database can be made available in the near future.

1.11.5 Vehicle Registration and Inspection Data

(1) Vehicle registration data

Although the system of vehicle registration has been well established in Cambodia, occasionally vehicles especially motorcycles without any registration number plates can still be seen on the roads.

The Ministry of Public Works and Transport was responsible for registering all vehicles in the country. Recently, the task of registering motorcycles only was transferred to the Department of Public Works and Transport of Phnom Penh City. A national decree has been passed recently requiring all motorcycle owners to have their vehicles registered by the end of May 2000. By June, such registration is still going on and enforcement by the police has been stepped up.

Compared to motorcycles, most 4-wheel vehicles are registered with the Ministry of Public Works and Transport and there is little problem with them. Once the Ministry has issued a registration card for a new vehicle, such data are input into the computer and processed. Data is accumulated and kept in the computer center set up by the Ministry in 1996. The issuance of driving license is also conducted in a similar manner.

(2) Vehicle inspection data

Vehicle inspection system is to be managed by the Ministry of Public Works and Transport. The actual inspection began only in June this year when equipment for vehicle inspection is imported from China. In the initial stage, only commercial vehicles such as buses, trucks are required to be inspected. This requirement will slowly be extended to private vehicles in the near future. Plan is in place to put such data on vehicle inspection into a database.

1.11.6 Driver Licensing Data

Drivers licensing system is presently being managed by the Department of Transport, Ministry of Public Works and Transport. Once the Ministry issues a driving license, data such as description of the licensee, date of issue, etc are input into the computer and processed.

The Ministry issues 5 different categories of driving licenses. These are:

Category 1: Motorcycles with engine capacity exceeding 100 cc. (however, no such license has been issued yet).
Category 2: Motor vehicles (maximum 9 persons excluding the driver), with a maximum load not exceeding 3,500 kg.
Category 3: Heavy vehicles for goods transport with maximum load exceeding 3,500 kg.
Category 4: Buses for the transport of passengers with a maximum load exceeding 3,500 kg.
Category 5: Farm tractors or public work vehicles with or without trailer.

The minimum age requirements to apply for a driver license are:

- 16 years old and above for motorcycle license
- 18 years old and above for 4wheel driving license.
- 22 years old and above for bus and truck license

Renewal of valid licenses is done according to the following:

- Every 2 years for license in category 3.
- No renewal is required for others. This implies that once a driver obtains a valid license, it can be used for a long time since there is no expiration of such licenses.

1.12 Present Traffic Situation at Major Intersections

When deciding on the method of traffic control at an intersection, It is essential to consider carefully such factors as its design, operation, cost, the traffic capacity, delays, safety level and aesthetics. For an urban area in particular, it is more important to examine the required traffic capacity for that intersection compared to a similar situation in the rural area.

An intersection is not meant to stop vehicles but rather to facilitate the safe passages of vehicles. Intersections in the urban area tend to suffer from frequent delays and stopping and appropriate traffic control is therefore an important issue.

Traffic control for at-grade intersections may be broadly classified into the following categories:

1) Uncontrolled intersections,
2) Priority Intersections,
3) Signalized intersections,
4) Roundabout intersections.

In formulating measures to alleviate the current traffic problems, it is necessary to examine and analyze the current traffic situations at the existing traffic intersections in Phnom Penh in a quantitatively manner. Such an analysis is also needed in order to predict the future traffic situations at intersections or to prevent any further deterioration of the existing traffic conditions.

To understand the traffic situations in Phnom Penh, a traffic volume survey was conducted at selected signalized intersections and roundabouts that are representative of such intersections in the city. The survey was carried out for a duration of 16 hours and traffic volumes were recorded by vehicle types and directions at 15 minutes intervals. In addition, travel time survey was conducted along road sections whose intersections had been selected for the above traffic volume survey.

This section presents the quantitative investigations into the present traffic situations by comparing the traffic volumes at the intersection with its design capacity using the survey data. This analysis, however, does not take into account such effects as blockage of traffic flow in the intersection caused by left turning vehicles or illegal entries during the red phase or parking in the intersection. (With traffic control improvement and better enforcement in future, such adverse effects can be minimized).

1.12.1 Method of Traffic Condition Analysis at Intersections

Methods in analyzing intersection traffic capacity and its level of service often differ between countries. Method for a particular country is often selected to accommodate the peculiar nature of intersection conditions or traffic behavior in that country. In Cambodia, considering that the traffic is predominantly two wheelers rather than four wheelers and most drivers have a relatively low awareness on the need to observe traffic lanes or even direction of flow, it is in fact necessary to devise an independent method of analysis for this country.

At this moment however, analyses of intersection traffic capacity and level of service are carried out using proven analytical methods that are considered suitable for application to the current traffic situations in Cambodia. Both the British and American methods were first considered. However, the British method of analysis is finally selected on account of the following reasons;

a. the British analytical method also covers that for roundabout intersection,
b. the British method uses the intersection approach width for determining the basic traffic capacity while the American method uses the number of traffic lanes. In Cambodia, where observation of traffic lanes among drivers is not a norm, the British method is easier to apply,
c. the British method uses PCU (passenger car unit) for its quantitative analysis. For Cambodia where the number of motorcycles is huge, this method is easier to apply.

In Cambodia, the adopted Road Design Standard has specified the conversion factors of vehicles into PCU as shown in Table 1.12.1 below. As a comparison or reference, Table 1.12.2 shows the equivalents used in the British Analytical Method.

Table 1.12.1: Present Conversion Factors to Passenger Car Units in Cambodia

Type of Vehicle	Equivalent Value in Passenger Car Units (PCUs)			
	Rural Standard	Urban Standard	Roundabout Design	Traffic Signal Design
Passenger cars	1.00	1.00	1.00	1.00
Motorcycles	1.00	0.75	0.75	0.33
Light Vans	2.00	2.00	2.00	2.00
Medium Lorries	2.50	2.50	2.80	1.75
Heavy Lorries	3.00	3.00	2.80	2.25
Buses	3.00	3.00	2.80	2.25

Table 1.12.2: Passenger Car Unit Equivalents in British

Type of Vehicle	Passenger car units			
	Rural roads (Ministry of transport)	Urban Streets	Roundabouts	Traffic Signals
Cars and Light vans	1.0	1.0	1.0	1.0
Commercial vehicles medium	3.0	1.75	2.8	1.75
Commercial vehicles heavy		2.5		
Buses and coaches	3.0	3.0	2.8	2.25
Motorcycles	1.0	0.75	0.75	0.33
Pedal cycles	0.5	0.33	0.5	0.2

・With moderate amounts of gradient and curvature.

(From "Research on Road Traffic" by Department of Scientific and Industrial Research, Road Research Laboratory, British in 1965)

The PCU conversion factors adopted in Cambodia do differ slightly between different categories of vehicle types, the factors are however quite similar to those used in Britain.

1.12.2 Location of Intersections Selected for Analyses

Analyses of traffic capacity is carried out for intersections selected for the conduct of traffic volume survey in this Study. The locations of these intersections are given in Figure 1.12.1 and Table 1.12.3.

There are 3 signalized intersections and 5 roundabouts. Although traffic volumes were observed for 16 hours at these locations, for the purpose of intersection analyses, traffic volumes for the morning and evening peak hours (one hour each) were extracted from the survey data. These are specified in the table below.

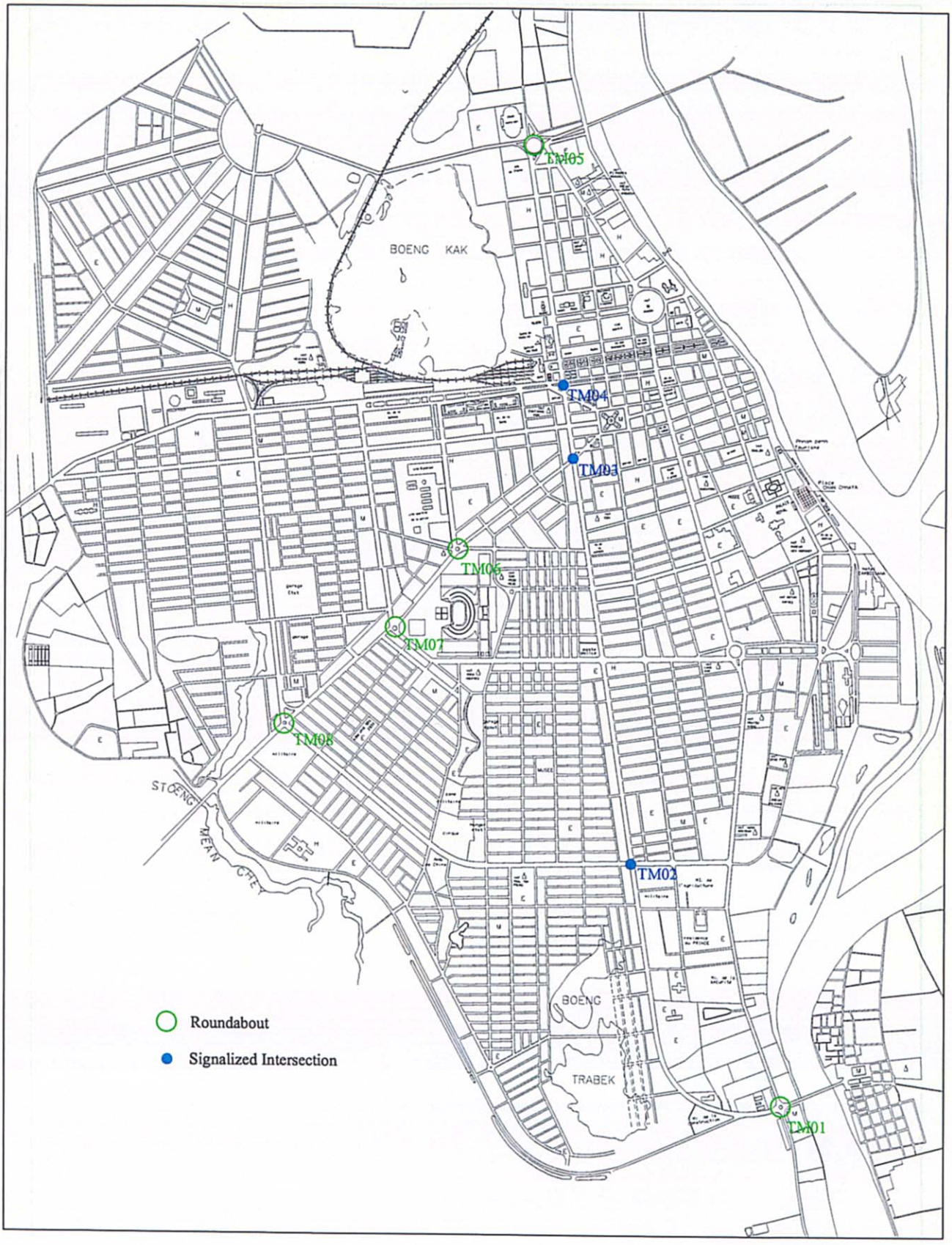


Figure 1.12.1: Location of Intersections Selected For Analyses

Table 1.12.3: Location of Intersections and Time Periods Used for Analysis

Signalized intersections		
TM02	intersection of Monivong /Mao Tse Toung	(07:00~08:00) & (18:00~19:00)
TM03	intersection of Monivong /Charles de Gaulle	(07:00~08:00) & (17:00~18:00)
TM04	intersection of Monivong /Conf. de la Russie	(07:00~08:00) & (17:00~18:00)
Roundabout intersections		
TM01	intersection of Nordom /Monivong /National Road No.1 /National Road No.2	(07:00~08:00) & (17:00~18:00)
TM05	intersection of Street No.93 /National Road No.6A /Monivong /Street No.70	(07:00~08:00) & (17:00~18:00)
TM06	intersection of Charles De Gaulle /Street No.182 /Tchecoslovaquie	(07:00~08:00) & (17:00~18:00)
TM07	intersection of Charles De Gaulle /Sihanouk /Monireth /Jawaharlal Nerhu	(08:00~09:00) & (17:00~18:00)
TM08	intersection of Monireth /Mao Tse Toung	(07:00~08:00) & (16:00~17:00)

1.12.3 Traffic Condition at Signalized Intersections

(1) The British Analytical Method

The British analytical method for estimating traffic streams at signalized intersection was developed for the main objective of assigning the most appropriate signal phasing and timings for an intersection.

For this Study, this method is used to estimate the maximum handling capacity at each approach of the signalized intersection. The practical capacity is computed and this is then compared to the actual traffic volume observed on site thus expressing the current traffic situations by a quantitative indicator. (From "Research on Road Traffic" by Department of Scientific and Industrial Research, Road Research Laboratory, British in 1965)

The computation method is given as follows:

- Saturation flow on an approach road:
  The saturation flow is taken as = 160w (during peak hour), where
  w = approach width (in ft) for cases of 60 ft or more.

- Effect of traffic composition:
  (see Table 1-12-2)

- Effect of right-turning vehicle:
  This is also expressed in terms of number of straight-ahead vehicles;
  1 right turning vehicle = 1.75 straight-ahead vehicle (if crossing an opposing stream)

- Dependence of capacity on cycle time
  $Cm = L / (1-Y)$
  where, Cm : cycle time (in seconds),
  Y : sum of the selected y-value over the phases,
  y : the ratio of the flow to the saturation flow for each arm of an intersection and the highest ratio for each phase,
  L : total lost time in the cylce.

  If Cm is given, then the maximum value of Y which can be accommodated is therefore given by:
  $Y = 1 – L / Cm$

For practical purposes, Ypract is 90 percent of its maximum possible value, then
$Yp = 0.9 – L /Cm$

(2) Assumptions and Initial Analysis

As an initial analysis for the signalized intersections, the existing traffic situations (actual surveyed traffic volumes) and signal control parameters were input into the computation to examine the appropriateness of this analytical method.

In this analysis, left turning is not allowed as it is currently practiced in Phnom Penh while right turning is allowed at all times. The signal phasing and timings were input into the computation (2 phase control with 60 seconds cycle time, 25 sec green, 5 sec yellow and 30 sec red for both directions).

An initial computation was carried out. The resultant V/C values were very large, and were not able to accurately express the current traffic situations at these intersections. In other words, the present situation is such that vehicles rarely have to wait for more than 1 cycle. If they have to wait for more than 1 cycle, then besides the effect of the traffic signal, there would usually be other factors such as blockage by left turning vehicles, double parking or vehicles in the process of parking or the occurrence of traffic accident.

The initial computation values were too large and this is probably due to the PCU conversion factor for motorcycles at 0.33 being too large for Cambodia. Moreover, there is a lost time of 4 seconds set for each cycle. Since no data on lost time is available, it is assumed to be 4 seconds judging from the present traffic situations.

It is therefore necessary to estimate a smaller PCU conversion factor for motorcycles. Table 1.12.4 shows some of the PCU conversion factors used in other countries.

Table 1.12.4: PCU Conversion Factors for Motorcycles in Other Countries

Country	PCU Conversion Factor
Austria	0.5
France	0.3
West Germany	0.5 (motorized)
	0.33 (bicycle)
Japan	0.33
Netherlands	0.5
Norway	0.3 – 0.7
Switzerland	0.5 – 1.0
UK	0.33 – 1.0

(Form "The Planning and Design for At-Grade Intersections"
by Japan Society Traffic Engineers in June 1988)

From the above table, a factor of 0.3 is used in France and Norway. This smaller value is applied for further computation in this Study.
Factors for the other vehicle types are further set at;

Heavy vehicle …….. 2.0
Cycle and Bicycle …… 0.3

Further considerations on these factors were not carried out as the proportions of these types of vehicles were much smaller compared to passenger cars and motorcycles in Phnom Penh.

(3) Expressing Traffic Situations

The results of the traffic capacity analyses for each signalized intersection for morning and evening peak hours are given in Table 1.12.5. Furthermore, signal timings which have responded to traffic demand (optimum timings) are also shown in the table.

In this table, the traffic situation is represented by means of an indicator (C/V : ratio of flow to saturation flow). In other words, a smaller value indicates a smoother traffic flow while a larger value means a congested traffic. If the value is higher than 1.0, it means that the flow has exceeded the saturation flow and traffic congestion has occurred.

Table 1.12.5: Predicted Traffic Situation at Signalized Intersections

TM02 Monivong/Mao Tse Toung

(Morning Peak Hour) (07:00~ 08:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing)			(under Existing timing)		
		Practical Capacity (pcu) /h	V/C	Critical Phases	Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,111	3,941	0.28		1,970	0.56	
West	1,882	3,941	0.48	0.48	1,970	0.96	
South	1,913	3,941	0.49	0.49	1,970	0.97	0.97
East	975	2,627	0.37		1,314	0.74	
	5,881			0.96			0.97

(Evening Peak Hour) (18:00~ 19:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing)			(under Existing timing)		
		Practical Capacity (pcu) /h	V/C	Critical Phases	Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,825	3,941	0.46	0.46	1,970	0.93	
West	2,047	3,941	0.52	0.52	1,970	1.04	1.04
South	1,326	3,941	0.34		1,970	0.67	
East	1,154	2,627	0.44		1,314	0.88	
	6,352			0.98			1.04

TM03 Monivong/Charles de Gaulle

(Morning Peak Hour) (07:00~ 08:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing)			(under Existing timing)		
		Practical Capacity (pcu) /h	V/C	Critical Phases	Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,406	3,941	0.36	0.36	1,970	0.71	
South-West	2,010	4,160	0.48	0.48	2,080	0.97	0.97
South	1,398	3,941	0.35		1,970	0.71	
North-East	1,610	4,379	0.37		2,189	0.74	
	6,424			0.84			0.97

(Evening Peak Hour) (17:00~ 18:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing)			(under Existing timing)		
		Practical Capacity (pcu) /h	V/C	Critical Phases	Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,325	3,941	0.34		1,970	0.67	
South-West	2,283	4,160	0.55	0.55	2,080	1.10	1.10
South	1,899	3,941	0.48	0.48	1,970	0.96	
North-East	1,242	4,379	0.28		2,189	0.57	
	6,748			1.03			1.10

TM04 Monivong/Conf. de la Russie

(Morning Peak Hour) (07:00~ 08:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing)			(under Existing timing)		
		Practical Capacity (pcu) /h	V/C	Critical Phases	Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,234	3,284	0.38		1,642	0.75	
West	1,341	3,941	0.34	0.34	1,970	0.68	
South	2,231	3,941	0.57	0.57	1,970	1.13	1.13
East	1,169	4,028	0.29		2,014	0.58	
	5,975			0.91			1.13

(Evening Peak Hour) (17:00~ 18:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing)			(under Existing timing)		
		Practical Capacity (pcu) /h	V/C	Critical Phases	Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,404	3,284	0.43		1,642	0.86	
West	1,319	3,941	0.33	0.33	1,970	0.67	
South	2,033	3,941	0.52	0.52	1,970	1.03	1.03
East	1,132	4,028	0.28		2,014	0.56	
	5,888			0.85			1.03

Lost time = 4 sec

PCU for composition of traffic
Light Vehicles = 1.0 Motorcycles = 0.3
Heavy Vehicles = 2.0 Cyclo & Bicycle = 0.3

Existing Signal Timings		Green	Red
Cycle = 60 sec	Ph1	25 sec	30 sec
	Ph2	25 sec	30 sec

(4) Traffic Conditions at Each Signalized Intersection

The following subsections discussed the traffic situations at each of the selected signalized intersections, using analytical results computed by assuming a PCU conversion factor of 0.3 for motorcycles.

a. Intersection of Monivong/Mao Tse Toung
If the existing signal timings are applied, although the maximum V/C ratio is smaller than 1.0 during the morning peak hour, it is approaching the practical capacity. On the other hand, the V/C ratio is 1.04 during the evening peak hour. This shows that the demand has exceeded the capacity.

During the morning peak, the southern approach on Monivong (towards the city center) is congested while in the evening peak, both the lateral approaches on Mao Tse Toung have exceeded the capacity and resulting in traffic congestion.

If signal timings are adjusted in accordance to traffic demand, the V/C ratio for the morning peak shows little difference, indicating that the present timing is appropriate. But for the evening peak hour, the new V/C ratio is reduced to less than 1.0, indicating that congestion can be reduced by adjusting the signal timings.

b. Intersection of Monivong/De Gaulle
Under the existing signal timing setting, the most congested approach is the south-western approach on de Gaulle. The morning peak V/C ratio is 0.97 while it is 1.10 for the evening peak. The demand has exceeded the capacity by 10% in the evening.

Even with signal timing adjustment in the evening, the demand still exceeds the capacity.

c. Intersection of Monivong/de la Russie
Under the existing signal timing setting, the V/C ratios of the southern approach on Monivong have exceeded 1.0 for both the morning and evening peak hours. The ratio is 1.13 for the morning peak. However, with timing adjustment, the ratio can effectively be reduced to 0.92 for the morning peak and 0.35 for the evening peak.

(5) Conclusion of Analyses

- The selected signalized traffic intersections for this study are representative of other signalized intersections in Phnom Penh. The present traffic demand situations at these intersections are already near their design capacities if not slightly exceeded the capacities. In view of traffic demand increases in the near future, improvement to the present traffic control method is necessary.

- This analysis has not taken into account various existing offensive driver behaviors. Existing traffic congestion at these intersections are obviously caused by factors other than delays due to the signal control. Removal of such inherent factors are very necessary.

- The selected intersections for this Study are the intersecting points of major roads where demands on both cross roads are almost the same. The present signal timings (with equal green times for both directions) are relatively effective in handling such traffic demand situations.

- During the traffic survey period, road improvement works were carried out on Rue Kampuchea. Due to this reason, traffic demand on this road was extremely low. Traffic was seen to concentrate at the selected intersections of Monivong/de Gaulle and Monivong/de la Russie. Traffic demands at these two intersections were considered as larger than normal.

- Works on Rue Kampuchea has been completed (as of July 2000) and traffic on the two selected intersections is now relatively smooth flowing.

- The British traffic analysis method for signalized intersection is considered as appropriate for application to Cambodia. Although there are also the American and Japanese methods of computation but they are not based on the conversion factor of PCU as in the British method. Instead, for each of the causes that influences the intersection capacity, coefficient peculiar to traffic behavior in their respective country have to be set up. For this reason such methods are difficult to apply in Cambodia as setting such coefficients is a very difficult task. Moreover, traffic in Phnom Penh has an exceptional high proportion of motorcycle and the coefficient of such factor is probably beyond the limit and setting an appropriate value is extremely difficult.

- In this analysis, a conversion factor of 0.3 is used for the motorcycle. Even with this adjusted value of 0.3, the V/C ratios computed are still considered as slightly on the high side. In other words, the factor of 0.3 may still be too high for Phnom Penh. If we observe carefully the traffic behavior at the intersections, vehicles (motorcycles in particular) when waiting for the green signal, tend to overflow into the neighboring exit lanes of the opposing traffic stream. This means that the approach width may have been extended slightly resulting in a bigger volume of traffic passing through the intersection. (However, such behavior often block the exit points of an intersection causing a lowering of the overall traffic capacity of the intersection, not to mention that it poses great danger to other users).

- In future, more traffic studies on the existing traffic behavior should be carried out to derive an independent method of analyzing the traffic demand at intersections. This would then allow for more accurate predictions of traffic behavior at intersections in Cambodia. It is clear that more signalized intersections are required to be installed in Phnom Penh in the near future. An accurate computation method is therefore also necessary for the effective operation of these new signalized intersections.

<For Reference>

(Results of analysis if the PCU factor of M/C is set at 0.25)
Table 1.12.6 shows the analytical results if the M/C conversion factor is adjusted to 0.25 PCU (i.e.4 motorcycles are equivalent to 1 car). From this table, only the morning peak hour at Monivong/de la Russie shows a V/C ratio of more than 1.0. Judging with a subjective observation of traffic flows on Monivong/Mao Tse Toung, the V/C ratios computed in this table at 0.86 and 0.95 are somehow considered as smaller than expected. From this comparative analysis, one can arrived at the conclusion that the conversion factor for motorcycle in Phnom Penh may well be somewhere between 0.25 to 0.3.

Table 1.12.6: Predicted Traffic Situation at Signalized Intersections (in case of Motorcycle's PCU of 0.25)

TM02 Monivong/Mao Tse Toung

(Morning Peak Hour) (07:00~ 08:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing) Practical Capacity (pcu) /h	V/C	Critical Phases	(under Existing timing) Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,014	3,941	0.26		1,970	0.51	
West	1,704	3,941	0.43	0.43	1,970	0.86	
South	1,697	3,941	0.43	0.43	1,970	0.86	0.86
East	872	2,627	0.33		1,314	0.66	
	5,287			0.86			0.86

(Evening Peak Hour) (18:00~ 19:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing) Practical Capacity (pcu) /h	V/C	Critical Phases	(under Existing timing) Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,637	3,941	0.42	0.42	1,970	0.83	
West	1,877	3,941	0.48	0.48	1,970	0.95	0.95
South	1,219	3,941	0.31		1,970	0.62	
East	1,044	2,627	0.40		1,314	0.79	
	5,775			0.89			0.95

TM03 Monivong/Charles de Gaulle

(Morning Peak Hour) (07:00~ 08:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing) Practical Capacity (pcu) /h	V/C	Critical Phases	(under Existing timing) Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,247	3,941	0.32	0.32	1,970	0.63	
South-West	1,787	4,160	0.43	0.43	2,080	0.86	0.86
South	1,294	3,941	0.33		1,970	0.66	
North-East	1,432	4,379	0.33		2,189	0.65	
	5,760			0.75			0.86

(Evening Peak Hour) (17:00~ 18:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing) Practical Capacity (pcu) /h	V/C	Critical Phases	(under Existing timing) Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,191	3,941	0.30		1,970	0.60	
South-West	2,053	4,160	0.49	0.49	2,080	0.99	0.99
South	1,783	3,941	0.45	0.45	1,970	0.90	
North-East	1,107	4,379	0.25		2,189	0.51	
	6,134			0.95			0.99

TM04 Monivong/Conf. de la Russie

(Morning Peak Hour) (07:00~ 08:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing) Practical Capacity (pcu) /h	V/C	Critical Phases	(under Existing timing) Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,097	3,284	0.33		1,642	0.67	
West	1,240	3,941	0.31	0.31	1,970	0.63	
South	1,990	3,941	0.50	0.50	1,970	1.01	1.01
East	1,058	4,028	0.26		2,014	0.53	
	5,384			0.82			1.01

(Evening Peak Hour) (17:00~ 18:00)							
Approach	Adjusted Volume (pcu)	(under Optimum timing) Practical Capacity (pcu) /h	V/C	Critical Phases	(under Existing timing) Practical Capacity (pcu) /green(h)	V/C	Max. Phase
North	1,279	3,284	0.39		1,642	0.78	
West	1,225	3,941	0.31	0.31	1,970	0.62	
South	1,818	3,941	0.46	0.46	1,970	0.92	0.92
East	1,050	4,028	0.26		2,014	0.52	
	5,372			0.77			0.92

Lost time = 4 sec

PCU for composition of traffic
Light Vehicles = 1.0 Motorcycles = 0.25
Heavy Vehicles = 2.0 Cyclo & Bicycle = 0.25

Existing Signal Timings		Green	Red
Cycle = 60 sec	Ph1	25 sec	30 sec
	Ph2	25 sec	30 sec

1.12.4 Traffic Condition at Roundabouts

(1) British Analytical Method

In expressing the traffic situation in a roundabout, the traffic demand is compared to the practical capacity of a number of weaving sections within the roundabout. The practical capacity (taken as 80% of the maximum capacity) has to take into account the weaving traffic and its effect on traffic flow.

The maximum traffic capacity of a roundabout (Qm) is derived from the following formula:

$$Qm = \frac{108w\left(1+\frac{e}{w}\right)\left(1-\frac{p}{3}\right)}{\left(1+\frac{w}{l}\right)} PCU/h$$

while the practical capacity (Qp) is derived from the following equation:

$$Qp = \frac{86w\left(1+\frac{e}{w}\right)\left(1-\frac{p}{3}\right)}{\left(1+\frac{w}{l}\right)} PCU/h$$

where,

w = width of weaving section (ft)
e = average of entry widths (ft)
l = length of weaving section (ft)
p = proportion of weaving traffic to total in weaving section

(From "Research on Road Traffic" by Department of Scientific and Industrial Research)

(2) Assumptions and Expressing the Traffic Situation

The geometric dimensions of the selected roundabouts as well as the actual surveyed traffic volumes by approach were input into the formulae and the V/C ratios were computed.

The PCU conversion factors used in this analysis are set at:

- Light vehicle …….. 1.0
- Heavy vehicle …… 2.0
- Motorcycle …… 0.3
- Cycle and bicycle …… 0.3

(Although the conversion factor for motorcycle in the Cambodian design standards is set at 0.75, results of initial computation have indicated that such value cannot be applied to actual traffic operation. For this reason, a similar value of 0.3 as used in the signalized intersection analysis was applied.)

The results of this analysis are given in Table 1.12.7 and Figure 1.12.1.
In this table, the V/C ratios are expressed for each weaving section. Similar to those in the signalized intersection analysis, values of V/C ratios approaching 1.0 means higher degrees of congestion. Values exceeding 1.0 indicate traffic congestion in the weaving section.

However, unlike a signalized intersection, when one weaving section in a roundabout is congested, it directly affects the flow of the downstream weaving section. Eventually the overall traffic handling capacity of the roundabout can be adversely affected. (In the case of a signalized intersection, congestion on an approach has no effect on the handling capability of the intersection.)

Table 1.12.6: Predicted Traffic Situation at Roundabout Intersections

TM01 Nordom /Monivong /National Road No.1 /National Road No.2

(Morning Peak Hour)		(07:00~ 08:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
E-N	4,008	3,654	0.91
S-E	3,807	3,554	0.93
W-S	4,434	3,389	0.76
N-W	3,800	2,728	0.72

(Evening Peak Hour)		(17:00~ 18:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
E-N	3,940	2,932	0.74
S-E	3,875	3,948	1.02
W-S	4,399	4,022	0.91
N-W	3,924	2,733	0.70

TM05 Street No.93 /National Road No.6A /Monivong /Street No.70

(Morning Peak Hour)		(07:00~ 08:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
E-N	4,367	2,205	0.50
SE-E	4,073	2,041	0.50
S-SE	3,131	1,926	0.62
W-S	5,361	2,307	0.43
N-W	5,893	2,232	0.38

(Evening Peak Hour)		(17:00~ 18:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
NE-N	4,376	2,346	0.54
E-NE	4,165	2,208	0.53
S-SE	3,185	2,472	0.78
W-S	5,379	2,256	0.42
N-W	5,849	2,265	0.39

TM06 Charles De Gaulle /Street No.182 /Tchecoslovaquie

(Morning Peak Hour)		(07:00~ 08:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
NE-N	3,485	3,401	0.98
E-NE	4,338	3,008	0.69
SW-E	4,899	3,526	0.72
W-SW	3,440	3,028	0.88
N-W	4,323	3,128	0.72

(Evening Peak Hour)		(17:00~ 18:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
NE-N	3,784	3,613	0.95
E-NE	4,184	3,631	0.87
SW-E	4,881	3,748	0.77
W-SW	3,372	3,457	1.03
N-W	4,327	3,994	0.92

TM07 Charles De Gaulle /Sihanouk /Monireth /Jawaharlal Nerhu

(Morning Peak Hour)		(08:00~ 09:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
NE-N	3,894	3,959	1.02
SE-NE	3,891	3,594	0.92
SW-SE	3,821	3,137	0.82
N-SW	4,487	3,358	0.75

(Evening Peak Hour)		(17:00~ 18:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
NE-N	4,039	3,585	0.89
SE-NE	3,902	4,044	1.04
SW-SE	4,028	3,154	0.78
N-SW	4,353	2,938	0.68

TM08 Monireth /Mao Tse Toung

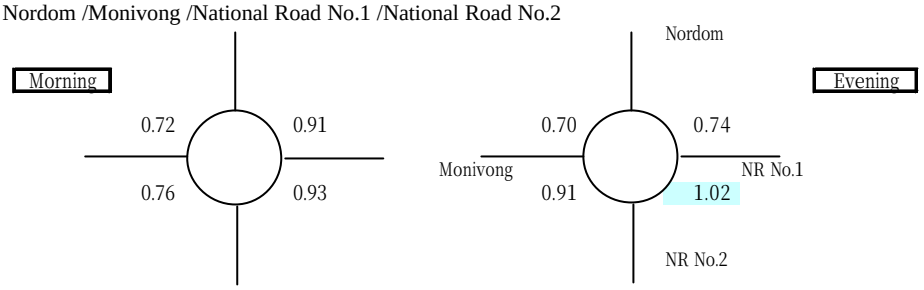
(Morning Peak Hour)		(07:00~ 08:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
NE-N	3,832	3,940	1.03
SE-NE	3,726	3,625	0.97
SW-SE	3,271	2,346	0.72
N-SW	3,727	3,546	0.95

(Evening Peak Hour)		(16:00~ 17:00)	
Weaving Section	Practical Capacity	Weaving Volume	V/C
NE-N	3,778	3,083	0.82
SE-NE	3,708	2,837	0.77
SW-SE	3,334	2,869	0.86
N-SW	3,880	3,352	0.86

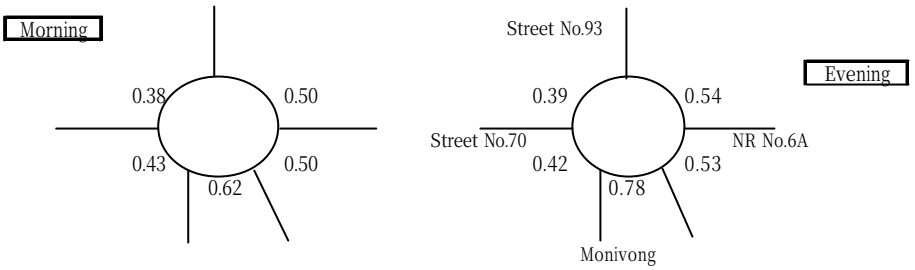
PCU for composition of traffic	
Light Vehicles = 1.0	Motorcycles = 0.3
Heavy Vehicles = 2.0	Cyclo & Bicycle = 0.3

number : V/C (Volume(pcu)/Capacity)

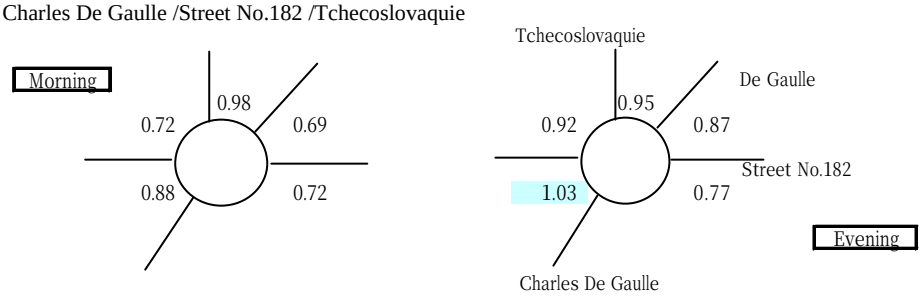
TM01 Nordom /Monivong /National Road No.1 /National Road No.2



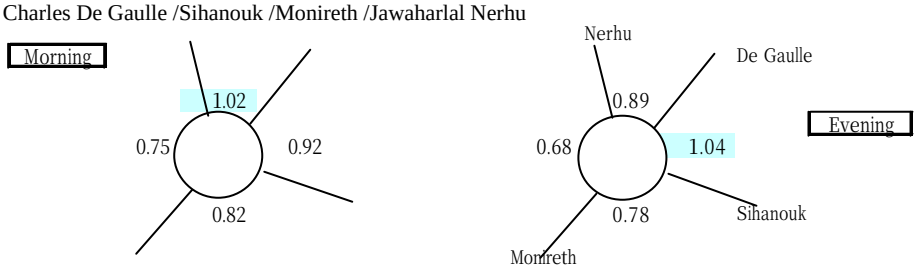
TM05 Street No.93 /National Road No.6A /Monivong /Street No.70



TM06 Charles De Gaulle /Street No.182 /Tchecoslovaquie



TM07 Charles De Gaulle /Sihanouk /Monireth /Jawaharlal Nerhu



TM08 Monireth /Mao Tse Toung

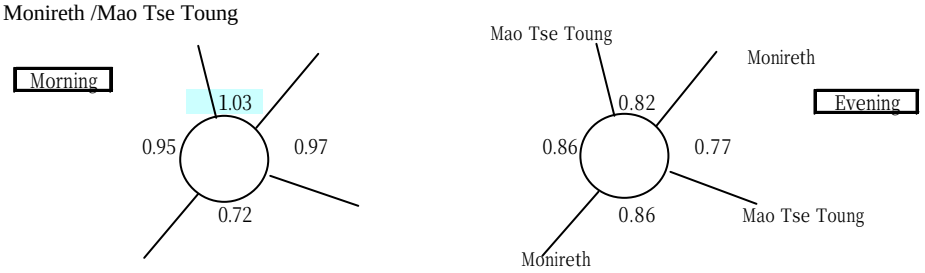


Figure 1.12.2: Predicted Traffic Situation at Roundabout Intersections

(3) Traffic Conditions at Each of the Roundabouts

1) General
Among the five roundabouts selected for analysis in this Study, except for the Roundabout at St.No.93/NR No.6A/Monivong and St.No.70, the V/C ratios for the morning or evening peak or both for the other four roundabouts have exceeded 1.0. For the Roundabout at de Gaulle/Sihanouk/Monireth, in particular, the V/C ratio for the morning peak has exceeded 1.0 while the value for the evening peak is 1.04.

2) Roundabout at Norodom/Monivong /NR No.1 /NR No.2
For this particular roundabout, the weaving section from NR No.2 towards NR No.1 shows high degrees of congestion during both the morning and evening peak hours. In the evening, the V/C ratio has exceeded 1.0 indicating that congestion has actually occurred.

3) Roundabout at St. No.93 /NR No.6A/Monivong /St.No.70
This roundabout has a large central island with a radius of about 50m. For this reason, each of the weaving sections has ample length and width. Traffic on all weaving sections displays smooth flows.

4) Roundabout at de Gaulle /St. No.182 /Tchecoslovaguie
At this roundabout, the V/C ratio in the evening hour for weaving section from the western approach on St.No.182 towards the southern approach of de Gaulle is at 1.03. Furthermore, the upstream sections from the northeast approach on de Gaulle to the western approach on St.No.182 have large V/C ratios of 0.95 and 0.92. Therefore, high degrees of traffic congestion can be seen at this roundabout.
In the morning peak hour, the V/C ratio for section from de Gaulle to Tchecoslovagie has a high value of 0.98 which is close to the capacity.

5) Roundabout at de Gaulle/Sihanouk /Monireth/Nerlu
The V/C ratios of weaving sections in this roundabout are higher than 1.0 for both the morning and evening peak hours. The values for the evening peak are higher than those in the morning. However, weaving sections having ratios of more than 1.0 are different between the morning and evening peak hours. In the morning the congested weaving section is from de Gaulle to Nerlu while in the evening, it is from Sihanouk to de Gaulle.

6) Roundabout at Monireth /Mao Tse Toung
For this roundabout, 3 out of the 4 weaving sections display high V/C ratios in the morning peak hour. The section from the north eastern approach on Monireth to Mao Tse Toung in the northern approach has a value of 1.03.
However, in the evening, the traffic situation at this roundabout is better with smoother flow than in the morning.

(4) Conclusion of Analyses

- In this Study, traffic analysis for the 5 frequently congested roundabouts were carried out. Out of these, 4 locations have concentrated traffic demands that are already about equal to their capacities. These roundabouts will not be able to handle any traffic demand increases expected in the near future. Some forms of countermeasures are therefore necessary.
- The special feature of traffic control at a roundabout is such that when demand is small compared to the capacity, traffic can flow very smoothly without any form of signal control or others. For the users, this form of control is very desirable. Moreover, monuments can be erected within the central island, thus contributing to increase aesthetics in the city.
- The British method in analyzing traffic conditions in a roundabout is suitable for application to Phnom Penh, notwithstanding that the PCU conversion factor for motorcycle needs to be adjusted. A PCU factor of 0.5 to 0.75 is used for motorcycle in the UK, Germany and other European countries. (For signalized intersection, the factor is set at 0.3 to 0.5). Nevertheless, judging from the results of the analysis for Phnom Penh, a value of 0.3 which is similar to that used for the signalized intersection analysis is more appropriate.

1.13 Problem Identification and Evaluation

The traffic situation in Phnom Penh during the morning and evening peak hours is beginning to show signs of congestion at most locations and in particular, at major intersections. Statistics on accidents and injuries also showed a rapid rise of traffic incidents and considering the steady increase in traffic demand in the coming years, this situation is expected to deteriorate further. As traffic situation worsen, problems such as wastage of energy, air pollution and other adverse effects as faced by many large cities will creep in as well.

Based on the findings of the preceding sections, this section summarizes the various problems on traffic congestion, causes of road traffic capacity reduction and traffic accidents, as viewed from the perspectives of traffic engineering, traffic safety education and enforcement.

1.13.1 Problem Identification

(1) From Traffic Engineering Perspective

1) Traffic Congestion Situation
The result of analyses based on data of traffic survey conducted in this Study has revealed that the major roundabouts and signalized intersections in Phnom Penh are now operating close to their design capacities. If countermeasures are not taken soon, it is only a matter of time that chronic daily traffic congestion will occur.

2) Traffic Accidents
The number of traffic accidents (475 cases in 1999) and fatalities (133 cases) are showing signs of rapid increases. The present fatality rate stands at 11.0 person/100,000 population. Fatality rates in Japanese cities with a similar population size of about one million, such as Kawasaki City and Hiroshima City are only 3.9 and 6.3 respectively. Comparing these rates, the City of Phnom Penh has a fatality rate of 2 to 3 times that of the Japanese cities. Anticipating that traffic accidents and fatalities in Phnom Penh will continue to increase in the near future, traffic safety planning and countermeasures must be carried out soon and implemented as quickly as possible.

3) Traffic Disorderliness caused by Mixed Traffic
Traffic in Phnom Penh is a highly mixed traffic comprising of passenger cars, trucks, buses, motorcycles, cyclos, motor-remoks, bicycles and pedestrians. These different modes of transport differ significantly in their operational behavior on the same roads due to their differences in travel speed, vehicle size and energy mode (motorized versus non-motorized). Such a highly mixed traffic is one of the causes in the rapid deterioration of traffic capacity of the road network. It also poses many critical dangers to the road users. Although sidewalks are provided at most places, pedestrians are often found to walk on the road pavement and cross the streets at random.

Along road sections, lane markings have recently being introduced in an attempt to physically segregate the 4 wheelers from the other vehicles. At intersections, however, regulations on turning movement by types of vehicles become ambiguous and many drivers are unsure of any proper traffic behavior. This gives rise to confusion and disorderliness resulting in very chaotic traffic operation at the intersections.

At the moment, heavy trucks and large buses are prohibited from entering the city center during the daytime hours. This measure has helped in maintaining a manageable level of traffic operation during the daytime hours at the present moment. Without such a measure, traffic in the city center would undoubtedly have to face a higher level of congestion than it is.

4) Traffic Accident and Congestion Along Road Sections
In most advanced countries, traffic congestion and accidents occurred predominantly at the intersections than along road sections. This is obviously due to the fact that at an intersection, the same road space has to handle two opposing traffic streams and thus its capacity is lowered. Similarly, due to the conflicting travel directions of traffic at an intersection, the probability of

collision is much higher.

However, in the city of Phnom Penh, traffic congestion is equally common on both the road sections as well as at intersections. Although it is not visibly obvious, traffic accidents have occurred more frequently along the road sections. There are many reasons that have caused a reduction in traffic capacity along the road sections and a higher frequency in traffic accidents.

The main causes are the poor and waterlogged road surface conditions, illegally parked vehicles (especially double row parking), parking maneuvers affecting flow of other vehicles, travelling against the designated traffic flow, random crossing by pedestrians, vendors, accidents, road maintenance works, building construction works, illegal storage of building materials, machinery on road pavements and many more. On top of all these, characteristics of the mixed traffic have contributed further to the confusion and disorderliness of the traffic behavior, leading to more congestion and a higher degree of danger on the roads.

To improve the situation, large scale and costly measures such as road widening and expansion are in fact not necessary. Small scale and economical counter- measures are sufficient to significantly improve the present situation. Such measures however, need to be planned out carefully and implemented immediately and diligently. It should be noted here that such measures often require time and patience to yield the desired results.

5) Traffic Accident and Congestion at Intersections

Given the present state of traffic signal control at intersections, traffic congestion can be anticipated in view of the increasing traffic demand in the near future which may further lead to increases in traffic accidents.

a. At an intersection, there is no specific rule on traffic movement by types of vehicles. All vehicle types behave and move in the same manner, whether they are traveling forward, making a turn to the left or right. The highly mixed traffic composition makes the movement at intersection highly confusing and chaotic, thus giving rise to higher chances in collision.
b. Channelization by movements at an intersection is not well implemented.
   - Traffic lanes by directions are often not clear, contributing to confusion among drivers,
   - Lane markings and directional arrows markings by directions are not adequate,
   - Channelization facilities including islands within large intersections are inadequate.
c. Lack of traffic safety facilities to induce observation of traffic rules (pavement markings, traffic signs).
   - Stop lines or signs at an intersection approach are often unclear or non- existence (in particular, stop lines are often not provided at non-signalized intersections).
   - At an intersection, markings do not clearly indicate the priority from the low priority roadways.
   - Although left-turn prohibition signs are installed, their corresponding pavement markings are not provided.
   - Due to the high number of violators, physical barriers are needed to enforce the rules, such as installing central dividers, railings to prevent vehicles entering the traffic lane from the opposite stream as well as pedestrians from walking on the road pavement.
d. Exclusive left-turning lanes are not provided.
   - Left turn vehicles waiting at an intersection often obstruct the flow of through traffic stream.
   - Many left turning vehicles have the habit of waiting for the signal at traffic lanes meant for the opposing traffic stream,
   - At intersections with high left-turning vehicle volumes, exclusive left-turning lanes are not provided.
e. Pedestrian crossing facilities are inadequate. Pedestrians would randomly cross the road at intersections.
   - Pedestrian crossing facilities at an intersection are either not provided for or not clearly marked,
   - At intersections where crossing facilities are in fact provided, some of them are poorly deployed if evaluated from the perspective of the users (the use of shortest distance and refuge islands for enhancing their safety).

6) Complexity in Traffic Control at Irregular Intersections and Roundabout

In Phnom Penh, traffic congestion is becoming rather common at irregular intersections and roundabouts.

Irregular intersections (multiple legged intersection or crank intersection) or roundabouts normally have no problem in processing traffic demand if the volume is small. In fact, for low volume traffic flow, roundabout is a very convenient facility for the road users. However, as traffic demand increases, it also brings about an increase in the complexity of traffic flows, difficulty in processing the large traffic volume as the capacity is small, difficulty in crossing the road by pedestrians and a concentration or traffic at such intersections. Under these circumstances, such types of intersections become prone to congestion and traffic accidents.

7) Inadequacy and Insufficiency of Traffic Control Signals

a. Inadequacy in Traffic Control Signals

Presently there are only 20 intersections that have been signalized. There are several more that needed to be signalized. As traffic demand increases in the near future, many more intersections in the city would have to be signalized in order to meet the increased demand.

b. Method in Signal Control

- Signal parameters do not correspond to the traffic demand situation at many of the existing signalized intersections,
- Signal control for adjacent signalized intersections is either not effective or appropriate,
- Since the signal cycle lacks an 'all red' phase, there is a tendency that through traffic would conflict with left-turning traffic as the signal light changes. This can cause severe traffic congestion.
- Pedestrian signal timings are found to be too short at some locations for all pedestrians crossing the road to clear the distance within the timing allocated. This poses great danger to the pedestrians using such signals. At such locations, when the pedestrian signal changes from green to red, within 5 sec., the vehicular signal for the intersecting road changes to green. Within such a short time of 5 sec., even a fast walker cannot cover a distance of 6 to 7 meters.
- During late night hours, some of the signals are shut down. Blinking function is not used to indicate priority of cross roads from the non-priority ones.
- At some signalized intersections where left-turning traffic volume is high, an exclusive left-turn signal phase is not provided.
- At intersections where congestion is common, the present traffic signal control method is deemed inadequate to meet the traffic demand.

c. Shut down of Signal Functions

- Power failure is presently the main cause of traffic signal shut downs. Power failure in the city is quite common and if the duration of such failure becomes significantly long, traffic confusion at intersections would occur.

The Minimum Requirements for New Signal Control Function;

- Splits need to be incorporated into the signal control function in order to response to changing traffic demand.(eg. time of day control)
- Signal controls of adjacent intersections must be linked to enable system coordinated control,
- Uninterrupted power supply to ensure no signal shut down.

8) Traffic Control Measures

Traffic control measures currently implemented in the city either throughout the day or for specific time period such as one way traffic circulation, left turn prohibition, no entry for bicycles and others; are suitable measures. However, considering the traffic situations, coverage areas of these measures need to be extended to a wider area.

- In the absence of basic traffic data, effective traffic control measures are difficult to be formulated and planned,
- If sufficient signs or pavement markings on the traffic control measures are not provided to the road users, they may not aware or clearly understand such measures.
- Traffic control measure that cannot be enforced by the present set up should not be left as it is. Such measure should preferably be removed.

- There is inadequate information given to the public regarding the various traffic control measures enforced by the city. There is no city maps or information boards indicating such measures in public places.

9) Roadside Parking

a. Parking Prohibition Area

- In spite of parking prohibition for certain designated areas, drivers often ignore such regulation,
- There is insufficient enforcement on illegally parked vehicles.
- At some parking prohibition areas, signage on such measure is not clear.
- Designated parking areas are indicated by pavement markings and parking fees are collected. However, such parking charges are not actually collected by the MPP Office.

b. Obstruction to Vehicular Traffic

- Curbside parking is very rampant in the city. Double row parking is also common along some road sections.
- Parking generally occurs on the motorcycle lane as well as vehicular lane.

c. Parking or Garages on Pedestrian Sidewalks

- Parking of vehicles on pedestrian sidewalks has become too rampant that these vehicles become serious obstructions to safe pedestrian movements. .
- Pedestrian sidewalks or curbsides have become private vehicle garages.

10) Vehicular Traffic

The majority of drivers in the city do not seem aware of the danger and seriousness of traffic accident and the need to observe traffic safety rules. Most of these drivers can be seen to drive with the notion that if they act more aggressively, other road users would surely give way to them.

Including the motorcycle drivers, most drivers in the city can be observed to behave with the following manners:

- There is almost no concept of 'give way' to pedestrians on sidewalks, pedestrian crossings or at/near to bus stops or other public vehicle terminals.
- There is a lack of respect for the right-of-way of vehicles already traveling within the designated traffic lanes.
- There is also no awareness of priority traffic stream at non-signalized intersections.
- Some even travel against the designated traffic direction just so they can get ahead and cut into the opposite side of the road. This is a total disregard of traffic safety of other road users and should be strictly prosecuted.
- Drivers are also found to ignore the left turning prohibition measure. This is another serous traffic offence.
- Ignoring traffic signals (another serious traffic offence).
- Parking within or near to intersections (another traffic offence)
- Entering the intersections even though the downstream exit is already congested, thus creating gridlock situation when the signal light changes.
- Rampant changing of lanes when traveling and keeping unsafe headway to the vehicle in front.

Motorcyclists also have the following undesirable behaviors:

- Too many passengers are riding on motorcycle.
- Ignore the requirement to use safety helmets when driving. Many of them are seen to wear high heel sandals without realizing the danger they pose.
- Many young motorcyclists are driving without licenses. Stricter enforcement on underage motorcyclists should be carried out. (3% of the total reported traffic accidents involved drivers who are below 15 years of age).

11) Low-speed Vehicular Traffic

- Cyclos, motor-remoks and bicycles are traveling at speeds far too slow compared to those of 4 wheelers and motorcycles. There is a need to segregate these two groups of vehicles on the roads.
- These low speed vehicles would travel on the motorcycle lane nearest to the curbside along road sections with clear pavement markings. However, when it comes to an intersection and making a

left turn, these vehicles shift to other lanes and the turning from any lane.
- Drivers of these low speed vehicles are quick to seek any shortcuts even to the extent of infringing on the opposing traffic lanes when making a left turn.

12) Pedestrians

a. Unpaved pedestrian sidewalks

There are many areas where pedestrian sidewalks are not paved but covered with grass or exposed earth, forcing pedestrians to walk on the roadway.

b. Discontinuous pedestrian walkways

Where pedestrian walkway suddenly comes to an abrupt end, pedestrians are forced to divert to the bicycle lane or traffic lanes. Not only they invite danger to themselves but they also obstruct the flows of other traffic. The discontinuity of pedestrian walkways may be due to any of the following causes:

- Presence of parked vehicles,
- Storage of goods and materials,
- Extensions from buildings or illegal structures,
- Commercial activities (especially near markets)
- Presence of building materials/machinery used by construction at adjoining lots.

c. Pedestrian mall

- There is no designated pedestrian mall in the city where a street with low traffic volume is closed for the exclusive use of pedestrians, ensuring their safety and comfort during weekends or public holidays.

d. Pedestrian crossing facilities

- At the city outskirts where distance between two adjacent intersections is large, there are very few pedestrian crossing facilities where pedestrians can cross the road safely.
- There is little provision of various comprehensive pedestrian crossing facilities, namely zebra marking, warning sign, pavement markings, pedestrian signals, safety islands and special lighting for pedestrians.
- Inadequate pedestrian crossing facilities both within the city center and the outskirts. Pedestrian crossing markings at intersections are particularly lacking.
- Pedestrian signal timings at the existing signalized intersections for pedestrians to clear the distance are too short, inappropriate and dangerous to the users,
- The crossing distances for pedestrians at large scale intersections are too long. No thoughts are given to shorten such distances or providing refuge islands.

e. Pedestrian behaviors

- Pedestrians tend to cross the streets or intersections wherever they like,
- There is no physical barriers erected to prevent such rampant jaywalking,
- Such behavior is extremely dangerous along road sections where traffic is traveling at high speeds or in future, where more roads are improved thus allowing higher travel speeds.
- Presence of pedestrians on roadways and the uncontrolled and sudden crossings by pedestrians are some of the main causes resulting in low travel speeds of vehicles in the city.

(2) From Traffic Safety Education Perspective

Traffic safety education must be taught to all residents in the city. All drivers are also pedestrians at certain time of the day. Such education would benefit all persons throughout their entire lives.

At present, many residents would not pause to think twice when crossing the street at random. Except for those unfortunate few who had personally experienced the horrors and loss due to traffic accidents, most residents in Phnom Penh have yet to realize the dangers of such actions. From general observations of the residents' behavior on the roads, the level of awareness on traffic safety can be said to be rather low. Information and statistics on traffic accidents are not widely publicized to the general public. They should be made aware of the rapid increase in traffic accidents and fatalities and how such incidents can become a major social problem in the future.

1) School children, Students and General Public
   - Traffic safety education program or campaign targeting at all the city residents by means of mass media such as newspaper, radio, television, public notice boards are rare.
   - News reports on traffic accidents and related issues are occasionally given in these media, but their frequency is not high.
   - Traffic safety education has just been taught in schools this year to all primary and secondary school children and students. On now on, such education should be regularly given to all school children, not just once a year, but regularly and following a properly structured curriculum.
   - Currently there is no suitable teaching materials containing statistics and data on accidents and actual cases for the general public.
   - Similarly, suitable teaching materials for the school children and students are still lacking.
   - MPP is the only public institution actively involved in traffic safety education. Traffic safety is something that cannot be handled by just one public institution. For better results, it requires the cooperation and participation of other public agencies and schools as well as other resident organizations and informal groups.

2) Motorcyclists
   - Presently, there is very little opportunity or avenue for imparting traffic safety education to motorcyclists,
   - To some motorcyclists, the only avenue available now is through schools. And this is insufficient.

3) Drivers
   When obtaining driving licenses, all the 4-wheel vehicle drivers have to attend driving skill and traffic regulation lessons as well as undertake both the written and practical tests. However, judging from the actual driving behavior on the roads, many drivers have displayed poor driving manners and skills. The following are some of the obvious poor driving behaviors:
   - No concept of 'Give-way' to pedestrians along sidewalks, pedestrian crossings, bus stops or other public transport terminals.
   - Lack of respect for the right-of-way of other vehicles already traveling within the traffic lanes.
   - No notion of the difference in priority of right-of-way between major road and side street at non-signalized intersections.
   - When congestion occurs, they have no hesitation to use lanes in the opposing roadway.
   - Ignoring left-turn prohibition measures at intersections,
   - Parking at or near to intersections,
   - Entering the intersection even though the downstream exit is already congested. Such selfish behavior often creates the difficult traffic grid-lock situations.
   - Erratic driving behavior with frequent lane changing and keeping dangerously short headway to the vehicle in front.

4) Cyclo and Motor-remok Drivers
   Drivers of these modes of transport have no formal compulsory education on traffic safety.

5) Education Materials
   No simpler education material is produced and made easily available to the public.

(3) From Traffic Enforcement and Driving Guidance Perspective

One of countermeasures against the rapid increase in traffic accidents and congestion is the enforcement of traffic rules and regulations. Without enforcement, traffic control measures that have been implemented will have no or very limited positive effects.

1) Enforcement Practice
   - Presently, the number of traffic offenders is just too many for the poorly equipped and under-staff traffic police force to effectively enforced the rules.
   - For more effective enforcement, concentrated method of enforcement on dangerous driving behavior and other irresponsible driving manners that cause traffic congestion must be carried out regularly.

2) Driving Guidance on Site
Traffic policemen are to be stationed on site especially at notorious intersections and with the help of microphone systems, provide guidance to the drivers, targeting at those who do not observe traffic rules and display ruthlessness. Such guidance should be continuously provided.

3) Penalty System
A penalty system must be enforced to penalize errant drivers. It is very important that such fines be diligently collected from all offenders without prejudice or favors using clear, transparent accounting system.

(4) Other Problems and Issues

1) Cooperative Efforts from other Traffic Management Related Agencies
Traffic management cannot be entirely undertaken by just one agency, that is the MPP. Cooperation from the national level ministries as well as private organizations is necessary. At the national level, department such as the MPWT and Police Agency are obvious, but others like Ministry of Education, Ministry of Social Welfare Services must also be involved. In the private sector, active involvement must also come from driving schools, insurance companies and emergency/first-aid hospitals.

In addition, within MPP, cooperation from all sections is needed. For instance, traffic signal and traffic control device sections are separate units within MPP. Full cooperation from all such sections or divisions are absolutely necessary for operating a uniform traffic management practice in the city.

Presently, traffic management in MPP is not undertaken by a specific unified division, but rather by the cooperative efforts from various related sections. Considering that traffic management is very important for the city, an independent division must be set up in MPP to undertake all the tasks.

2) Preparation of a Uniform Traffic Control Device Deployment Guidelines
The MPWT is still in the process of preparing a uniform traffic control device deployment guidelines. However, there are some portions in this guideline that will not be able to reflect the current traffic situations in Cambodia based on the actual traffic survey results. For this reason, this guideline when completed, should be regularly and repeatedly reviewed, updated and improved. For all the vehicle drivers, a uniform standards in the deployment of various traffic control devices is most desirable.

3) Regular Collection of Basic Traffic Data
The formulation of traffic management plans require up to date and sufficient basic traffic data that can be analyzed to understand the trend and behavior of traffic. The city of Phnom Penh has very little traffic data. The collection and accumulation of traffic data must be taken seriously and implemented. The basic traffic data to be collected regularly should include traffic volume, traffic behavior and accidents.

4) Emergency Rescue System
Presently there are only two hospitals with their emergency units dealing with injury treatment for traffic accident victims. Each of these hospitals has two emergency vehicles responding to '119' calls from the general public and police. Considering the number of accidents occurring in the city, 4 emergency vehicles are not sufficient to respond effectively to the needs of accident victims. With more vehicles and thus shorter response times, it is possible that more lives can be saved.

Insufficient emergency vehicles and lack of in-vehicle first aid equipment are two problems that need to be addressed.

1.13.2 Evaluations Relating to Traffic Management

To cope with the traffic management problems identified in the preceding section, a traffic management plan shall be formulated taking account of countermeasures for the following main issues.

(1) Reduce traffic congestion

a. Increase traffic capacity
- Develop road and its associated facilities,
- Improve and optimize traffic operation method to make smooth traffic flow and increase capacity at road sections as well as intersections,
- Strengthen the traffic enforcement operation,
- Reduce traffic accidents thus reducing the occurrence of congestion.

b. Restraint traffic demand
- Disperse traffic demand from certain locations and areas with high concentrated demand.

(2) Reduce traffic accident

a. Develop various road auxiliary facilities and strengthening traffic operation
- Develop facilities to segregate pedestrians, non-motorized vehicles and the motorized vehicles.
- At traffic accident prone sections or areas, develop and improve the various road auxiliary facilities and at the same time strengthen the traffic operation practice.

b. Strengthen traffic safety education
- Emphasize on traffic safety education to school children, pedestrians, drivers of non-motorized vehicles and also vehicular drivers,
- Implement traffic safety campaigns as well as regular campaigns.

c. Strengthen traffic enforcement practice
- Implement effective enforcement of traffic violators and offenders so as to reduce traffic accidents and congestion. (Efforts to be applied to improve traffic enforcement contents, method, period and timing, etc)
- Implement more stringent vehicle inspection practice and act on defective or non-road worthy vehicles.

(3) Prevent further deterioration of traffic environment

- Reduce traffic congestion,
- Reduce noxious gases, noise and vibration
- Save fuel consumption
- Others.