CHAPTER 8 Origin and Destination based on HVS

8.1 OD Flow

8.1.1 OD Flow of All Trips

Movement of the Western Province residents on an average weekday is depicted in Figure 8.1.1 below.

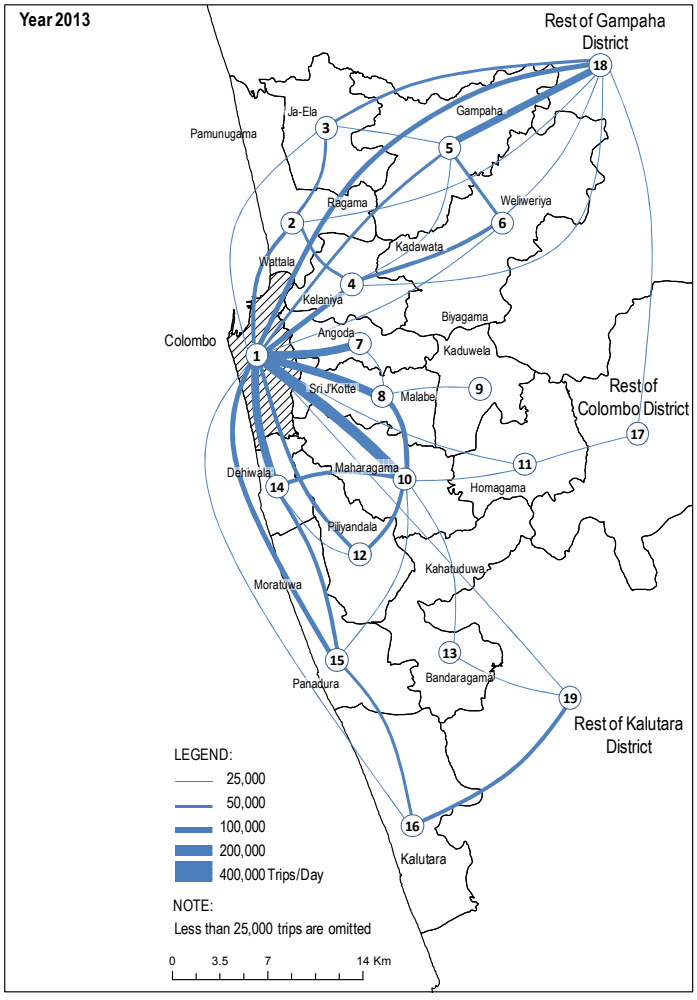


Figure 8.1.1 Desire Line of All Trips in Western Province

8.1.2 OD Flow by Purpose

To understand from and to where most trips are made, figures illustrating the desire line by purpose were prepared in which each integrated zone represents a DS division (Figure 8.1.2,

Figure 8.1.3, Figure 8.1.4 and Figure 8.1.5).

For home-based work trips, it is observed that heavy flows are between CMC and the surrounding DS divisions such as Kaduwela, Kelaniya, Sri Jayawardanapura Kotte, Dehiwala, and Moratuwa. For home-based school trips, heavy flows are also found between CMC and adjacent DS divisions such as Kaduwela, Kelaniya, Dehiwala, and Moratuwa. Additionally, noticeable flow between Negombo and Katana DS divisions is also found. A similar pattern is seen for home-based other in which most trips are made within CMC, between CMC and Dehiwala and Moratuwa, and between Maharagama and Kesbewa. Heavy flow for non-home-based seems to mainly concentrate within CMC, between CMC and Sri Jayawardanapura Kotte. Between Kaduwela and CMC and Kelaniya is also observed to have a significant flow. In conclusion, the desire line indicates that most trips are made within CMC as well as between CMC and surrounding DS divisions. For all purposes, it is seen that a noticeable number of trips are made from all DS divisions of Gampaha district and Colombo district to CMC. However, from Kalutara district, mainly trips from DS divisions along coastal area are seen, but not trips of other DS divisions.

8.1.3 OD Flow of Motorised Trips Attracted to CMC

For further understanding, Figure 8.1.6 and Figure 8.1.7 show the desire lines of the motorised trips (i.e. all trips excluding those made by non-motorised transport such as walking and bicycle) to CMC, which is divided into Colombo DSD and Thimbirigasyaya DS division.

It is observed that the majority of trips coming to Colombo DS division are from Thimbirigasyaya DS division, a DS division within CMC. Trips from other origins are not so frequent, and they are from almost all DS divisions of Gampaha and Colombo district and the coastal area of Kalutara. Similarly, the trips ending in Thimbirigasyaya DS division are dominated by those of Colombo DS division. Additionally, there are also heavy flows from Kolonnawa, Kaduwela, Sri Jayawardanapura Kotte, and Dehiwala.

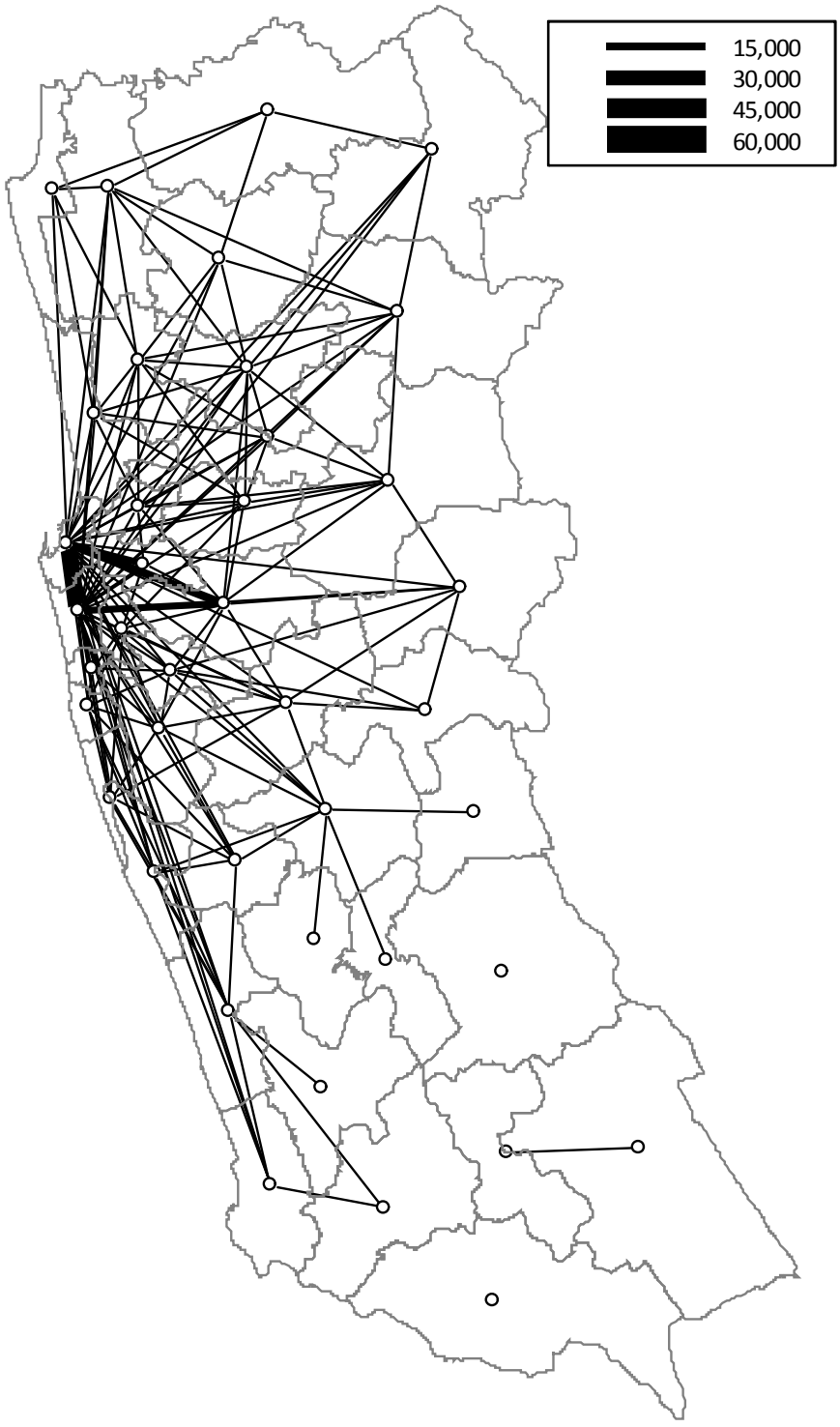


Figure 8.1.2 Desire Line of Home-based Work Trips (excluding < 2,000 trips)

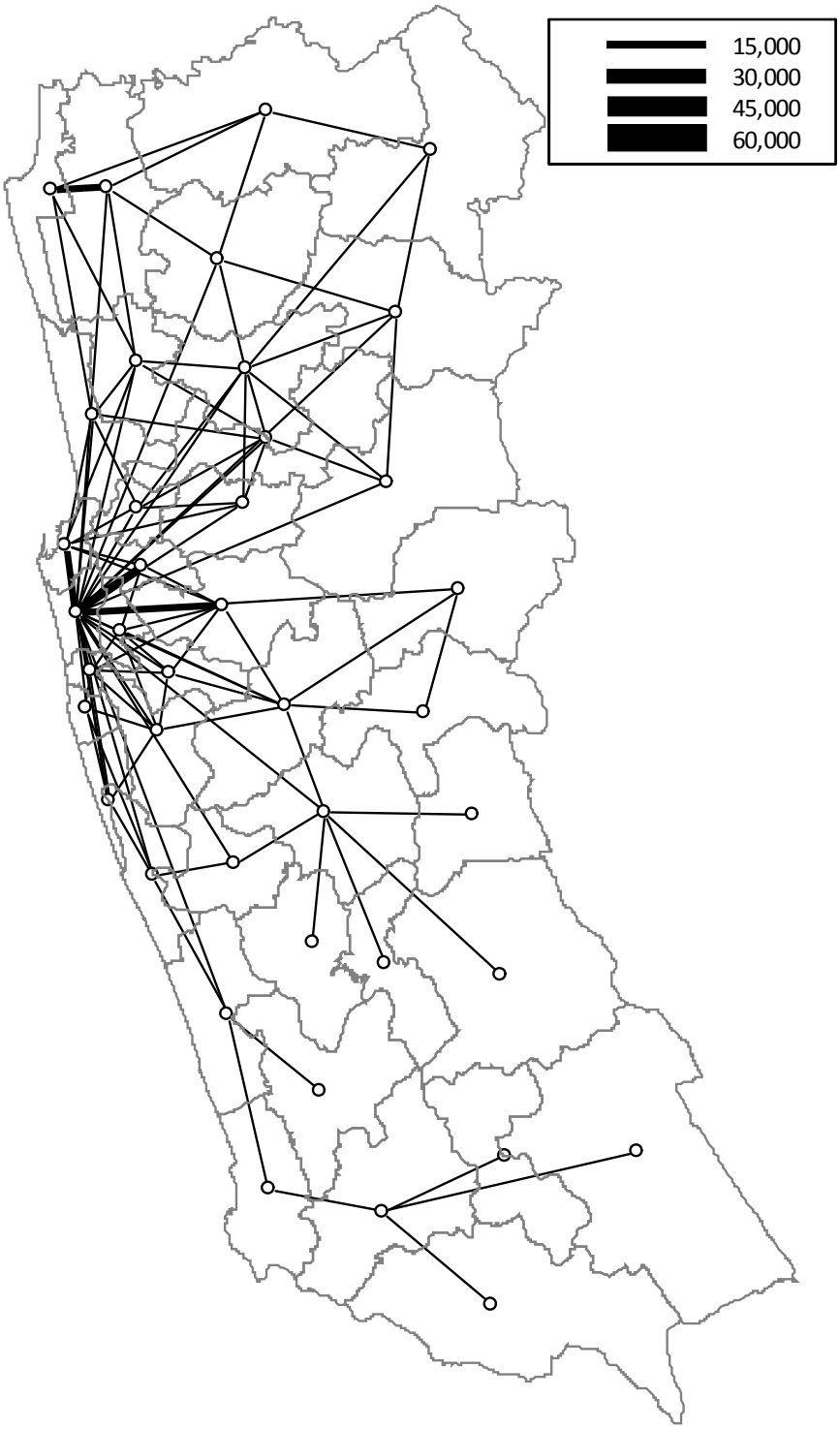


Figure 8.1.3 Desire Line of Home-based Education Trips (excluding < 2,000 trips)

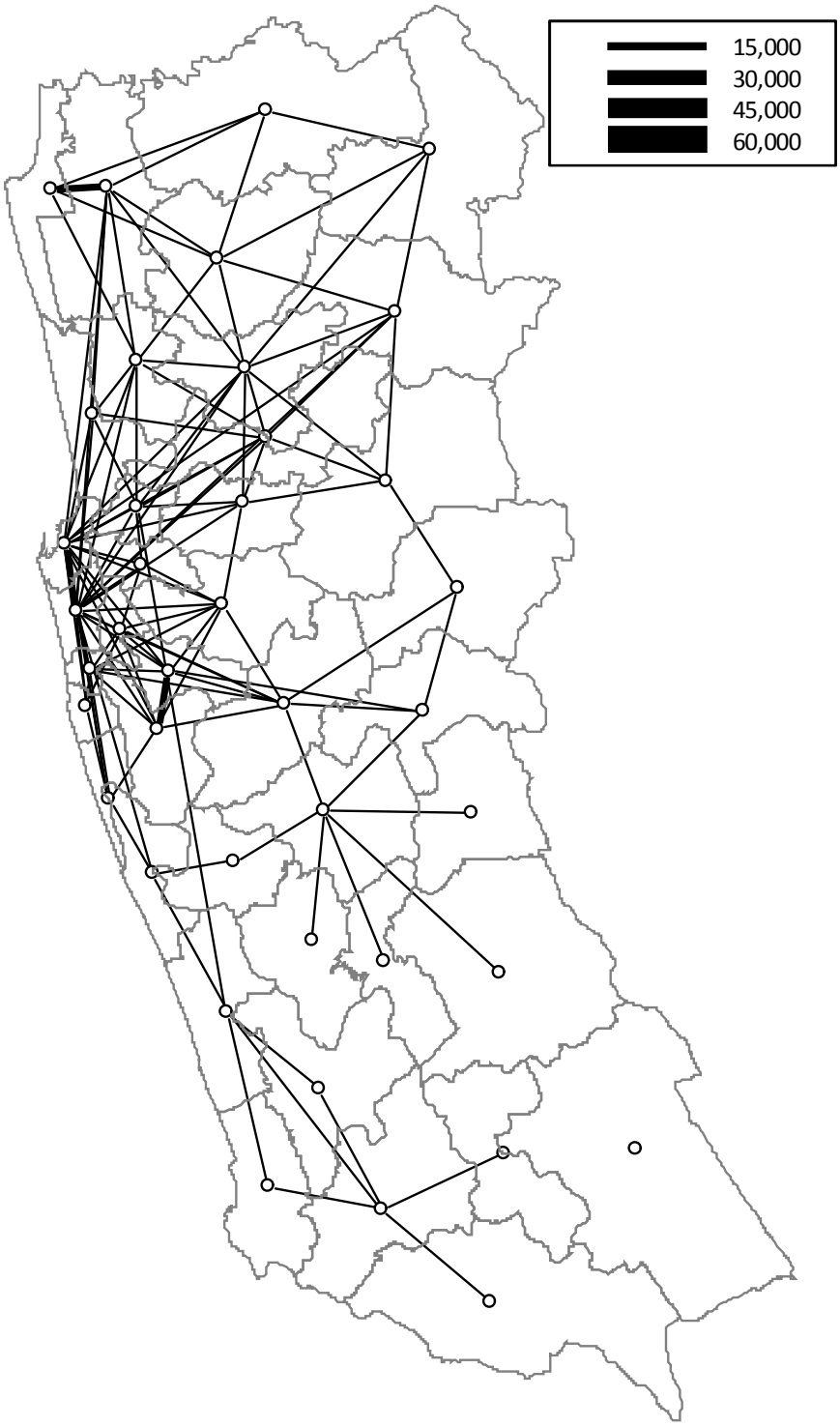


Figure 8.1.4 Desire Line of Home-Based Other Trips (excluding < 2,000 trips)

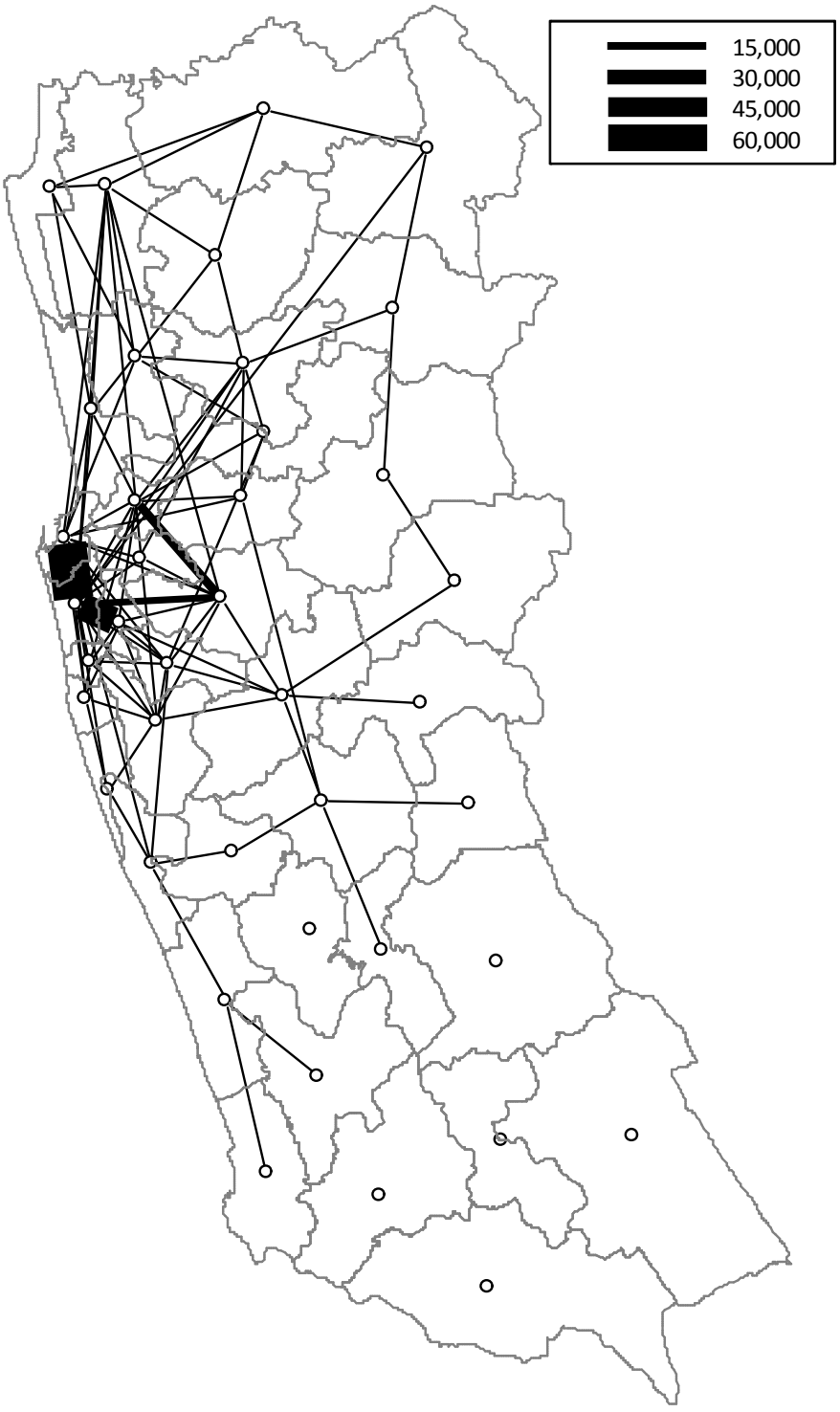


Figure 8.1.5 Desire Line of Non-Home-Based Trips (excluding < 2,000 trips)

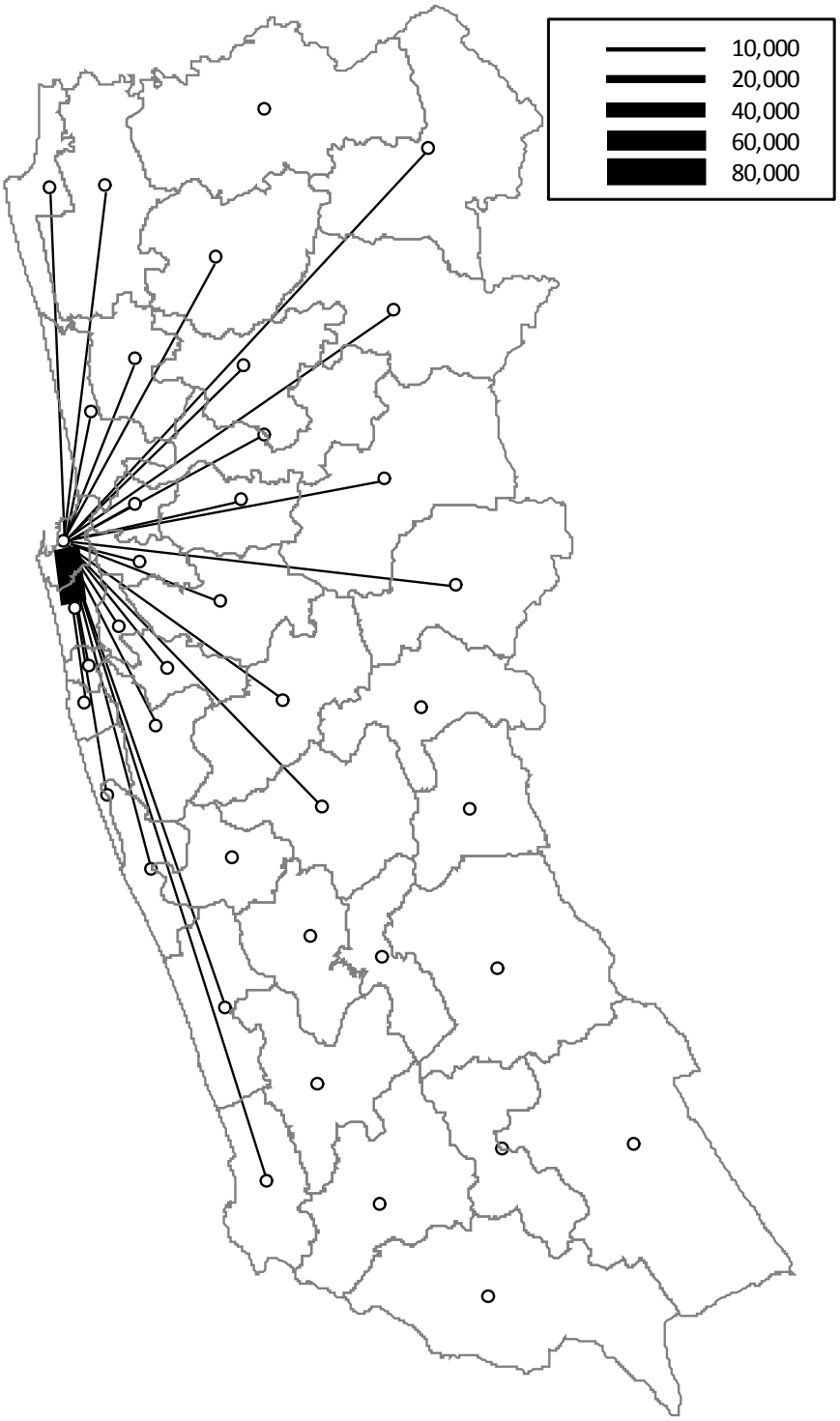


Figure 8.1.6 Desire Line of Motorised Trips Attracted to Colombo DSD

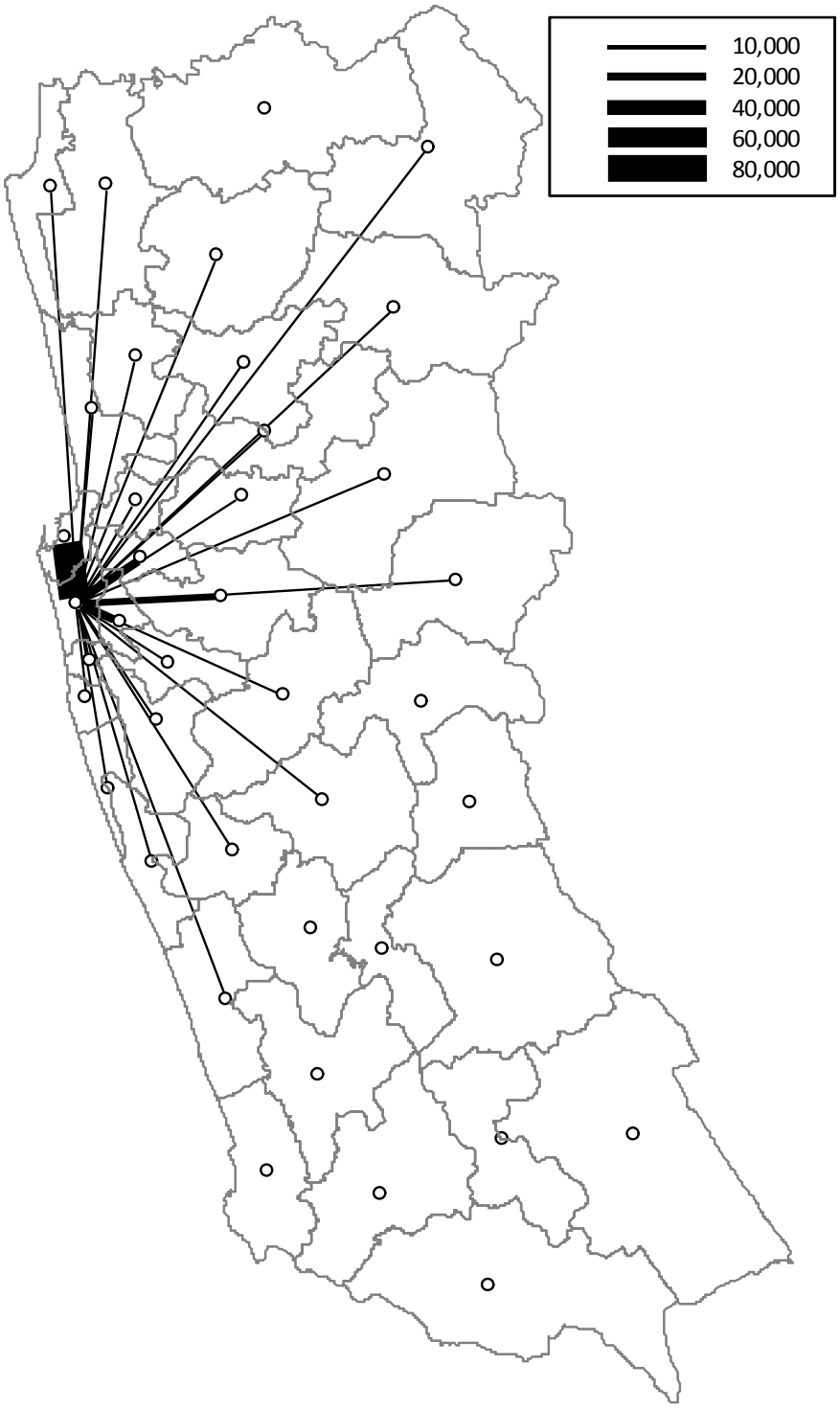


Figure 8.1.7 Desire Line of Motorised Trips Attracted to Thimbirigasyaya DSD

8.2 Trip Distance

8.2.1 By Trip Purpose

Travel distance by trip purpose is illustrated below. Home-based work has the largest average of distance travelled, which is 10 km. The distribution of the travel distance by purpose reveals that for the travel distance beyond 8 km, home-based work trip is the highest category.

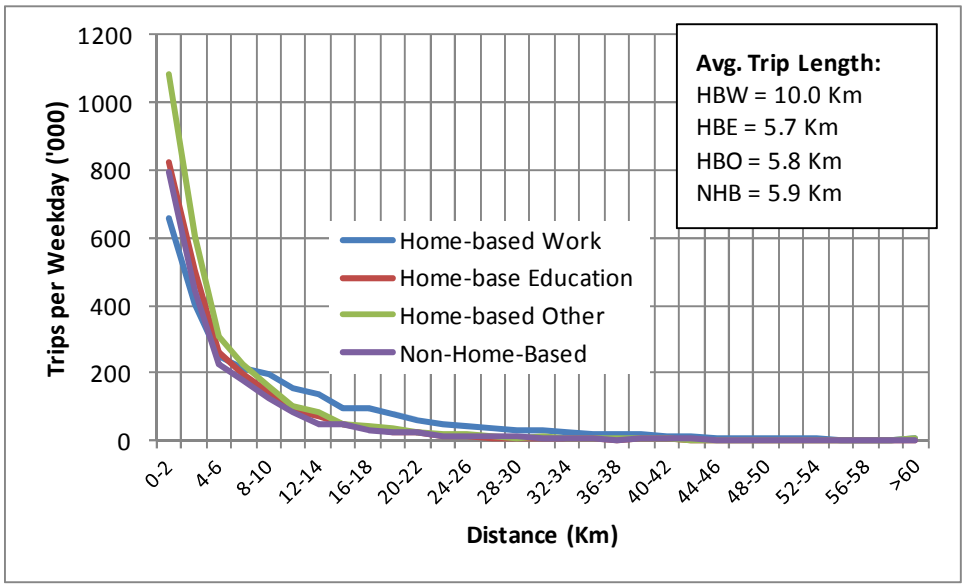


Figure 8.2.1 Trip Distribution by Purpose by Travel Distance in Western Province

8.2.2 By Transport Mode

The analysis result also indicates that those who travel by public transport (including buses and the railways) travel further than those who use a private mode. The distribution of travel distance by transport mode depicts that when the distance is 4 km or longer, the number of trips by public transport becomes the highest.

Further details of trip distance by mode indicate that railway users have the longest trips in which the average distance is about 25 km. Bus users and car users have average travel distances of 9 km and 8 km respectively.

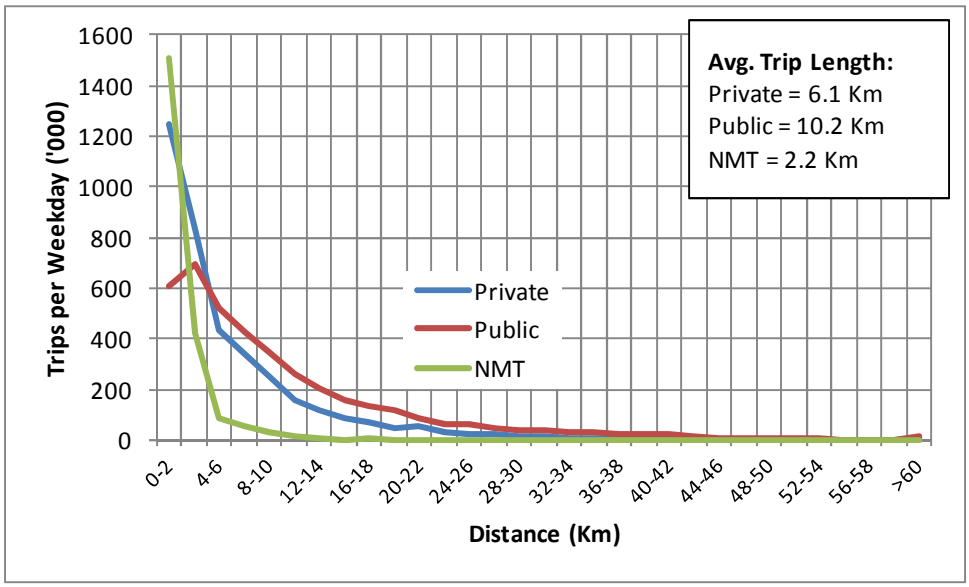


Figure 8.2.2 Trip Distribution by Transport Mode by Travel Distance in Western Province

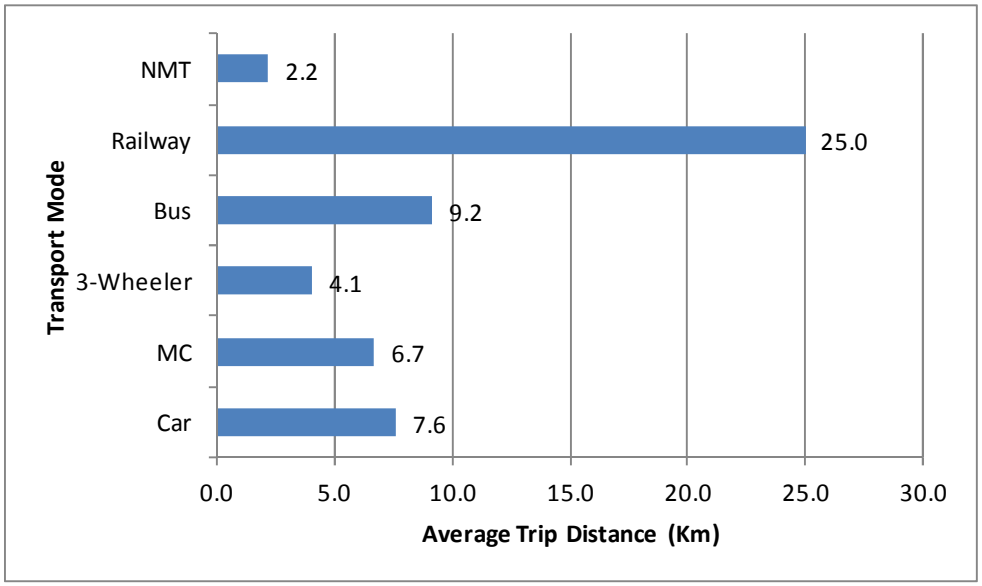


Figure 8.2.3 Average Trip Distance by Transport Mode

8.2.3 By Income

As income increases, the average travel distance also increases. The larger average distance of Group A is attributed to their higher ownership of vehicles. In contrast, it also signifies that Group C people are constrained in travelling long distances.

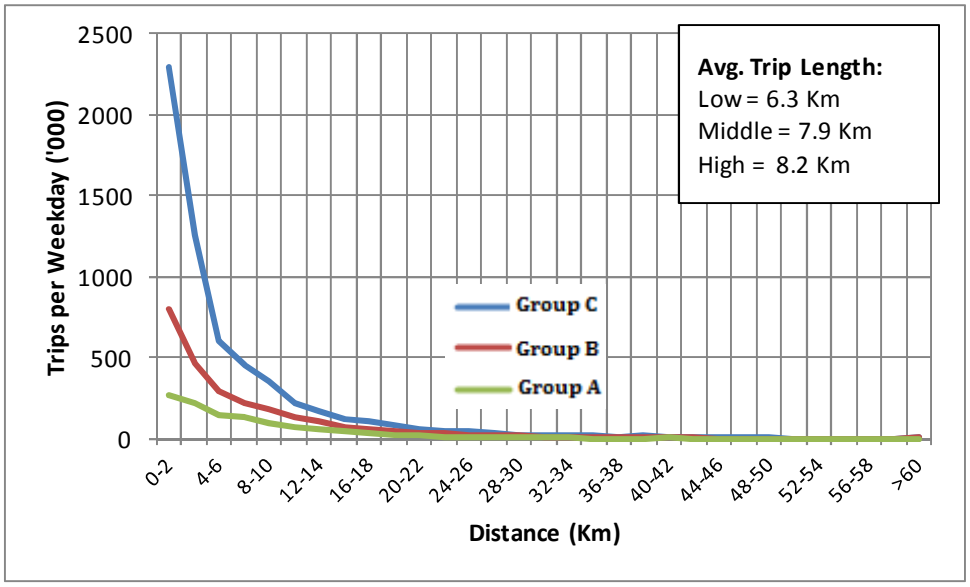


Figure 8.2.4 Trip Distribution by Income Level by Travel Distance in Western Province

CHAPTER 9 Cordon Line Survey

9.1 Introduction

The Home Visit Survey collects trip information of the residents in the Western Province. The Cordon Line Survey was conducted for 4 modes of transport, which are Private vehicles, Buses, Railways and Airplanes at several cordon lines to passengers or drivers to collect non-residents' trip information of coming into and going out from the Western Province. The data obtained was utilised as a basic database for developing transport demand forecast models.

The following sections describe the details for each mode of transport in the survey:

9.2 Roadside OD Interview Survey
9.3 Bus Passenger OD Interview Survey
9.4 Railway Passenger OD Interview Survey
9.5 Air Passenger OD Interview Survey

9.2 Roadside OD Interview Survey

9.2.1 Objective

The main objective of the survey was to collect trip information of passengers and drivers of the private vehicles on the major arterial roads and expressway crossing the Western provincial boundary. The data obtained was utilised to estimate the present travel demand.

9.2.2 Types of the Surveys

Under the Roadside OD Interview Survey, the following 2 surveys were conducted:

- Classified Vehicle Count Survey
- Roadside OD Interview Survey (Passenger Vehicles and Goods Vehicles)

9.2.3 Survey Days, Durations and Locations

The Classified Vehicle Count Survey was conducted at 21 locations as shown in the Figure and Table below. Among those locations, the survey was conducted at 9 locations on major arterial roads for 24 hours and 12 locations on arterial roads in the suburbs and Southern Expressway for 16 hours. Also, the Roadside OD Interview Survey was conducted at the same locations as the Classified Vehicle Count Survey, except for the provincial boundary on Southern Expressway.

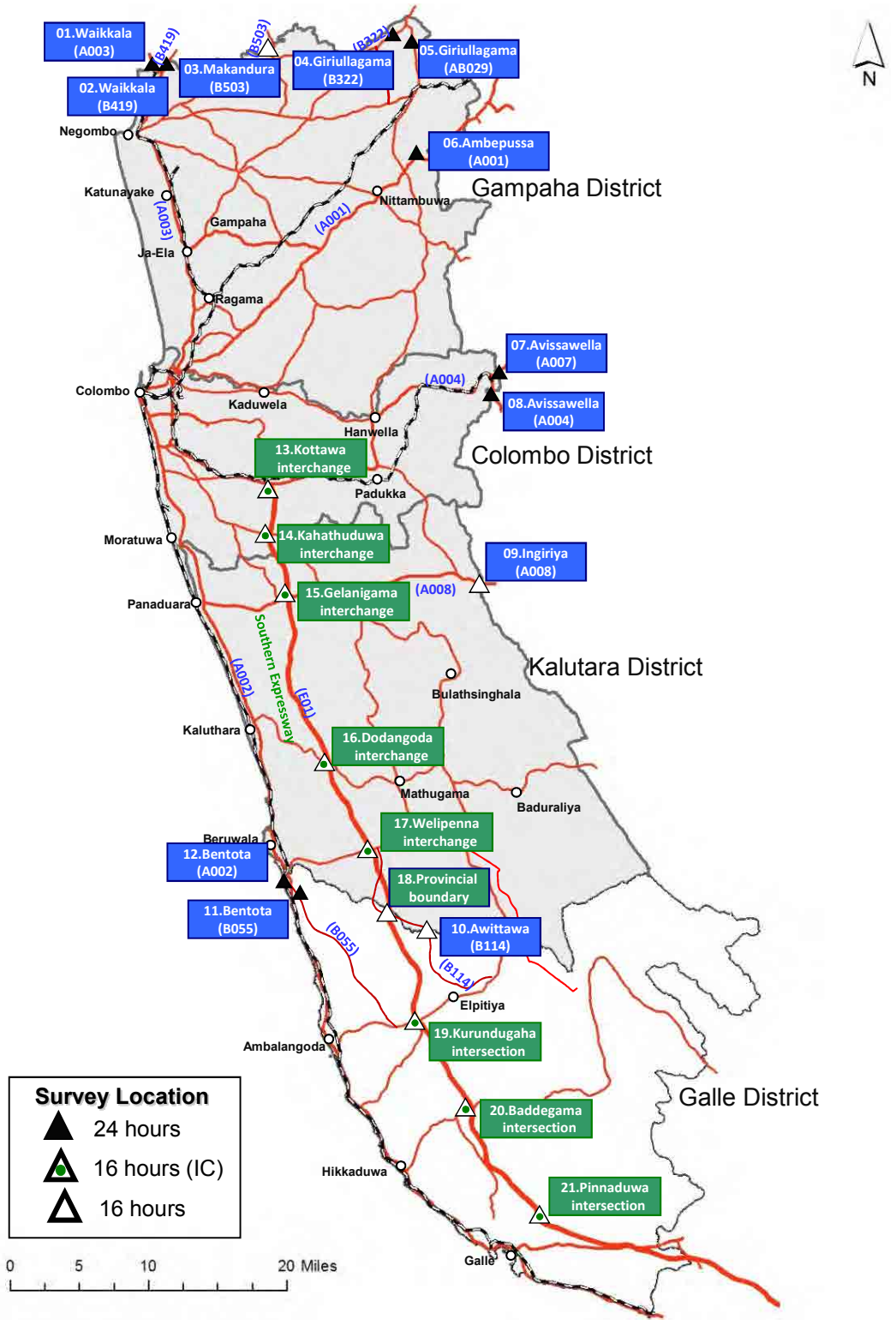


Figure 9.2.1 Survey Days, Durations and Locations

Table 9.2.1 Survey Days, Durations and Locations

No	Road Class	Survey Location	Survey Duration	Survey Day
1	A001	Ambepussa	24 hour	27-Feb-13
2	A002	Bentota		05-Feb-13
3	A003	Waikkala		31-Jan-13
4	A004	Avissawella		07-Feb-13
5	AB29	Ambepussa		20-Feb-13
6	A007	Avissawella		07-Feb-13
7	A008	Ingiriya	16 hour	30-Jan-13
8	B322	Giriullagama	24 hour	06-Feb-13
9	B419	Waikkala		31-Jan-13
10	B503	Makandura	16 hour	31-Jan-13
11	B114	Awittawa		05-Feb-13
12	B055	Bentota	24 hour	05-Feb-13
13	Southern Expressway	Kottawa Interchange	16 hour	14-Feb-13
14		Kahathduwa Interchange		12-Feb-13
15		Gelenigama Interchange		12-Feb-13
16		Dodangoda Interchange		12-Feb-13
17		Welipenna Interchange		13-Feb-13
18		Kurundugaha Interchange		13-Feb-13
19		Baddegama Interchange		13-Feb-13
20		Pinnaduwa Interchange		14-Feb-13
21		Provincial boundary	16 hour *	13-Feb-13

* Only Classified Vehicle Count Survey

9.2.4 Preparation of Survey

(1) Selection of Survey Site

Prior to the survey implementation, each site was visited in order to ensure the safety of the survey personnel and road users and visibility. Night time conditions were also considered to prepare a light or an illuminator to avoid traffic accidents.

(2) Recruitment of Survey Personnel

Under the survey, Transport Engineers in the field of transport engineering, supervisors who have experience in transport surveys and surveyors from personnel who have GCE qualifications

(ordinary level), were recruited to obtain reliable survey results.

(3) Preparation of Survey Forms

The following survey forms were used in the survey:

- Form 1: Classified Vehicle Count Survey
- Form 2-1: Interview Form for Passenger vehicles at Major Alternative Roads
- Form 2-2: Interview Form for Passenger vehicles at the Southern Expressway
- Form 3-1: Interview Form for Goods vehicles at Major Alternative Roads
- Form 3-2: Interview Form for Goods vehicles at the Southern Expressway

(4) Permission and ID card

It was necessary to obtain the official permission for conducting the field survey prior to starting the field survey. Specifically, the Road Development Authority (RDA), Expressway Operations and Maintenance Division of Southern Expressway and each police station were visited prior to survey implementation. Assistance was also requested from each police station of every survey site for stopping the vehicles. In addition, ID cards were prepared for the surveyors and shown every time the survey was conducted.

(5) Training of Survey Personnel

Prior to survey implementation, training of survey personnel was carried out. The detailed description of the survey process, explanation of survey forms, identification of the type of vehicles and safety considerations were instructed through the training.

9.2.5 Field Survey

(1) Classified Vehicle Count Survey

<u>Types of Vehicles</u>

The types of vehicles for the Classified Vehicle Count Survey are grouped into the following 11 categories.

Type 1	Motorcycle
Type 2	Three Wheeler
Type 3	Car, Jeep
Type 4	Passenger Van
Type 5	Pick-up (Single/ Double Cab)
Type 6	Medium Truck (2 axels)
Type 7	Large Truck (3 axels and more)
Type 8	Container Trailer
Type 9	Minibus (29 seats and below)
Type 10	Bus
Type 11	Others

Survey Period

The survey was conducted on one weekday (Tuesday, Wednesday or Thursday) either for 16 hours (6:00 AM to 10:00 PM) or 24 hours (6:00AM to 6:00AM of the following day) depending on the survey location (see Table 9.2.1).

Methodology

The surveyors continuously counted the number of vehicles by hour-band by type of vehicle by direction using manual traffic counters or tally marks. The surveyors recorded the number of vehicles on the survey sheet every hour.

(2) Roadside OD Interview Survey

Types of Vehicles

The types of vehicles for the Roadside OD Interview Survey were grouped into the following 8 categories.

Type 1	Motorcycle
Type 2	Three Wheeler
Type 3	Car, Jeep
Type 4	Passenger Van
Type 5	Pick-up (Single/ Double Cab)
Type 6	Medium Truck (2 axels)
Type 7	Large Truck (3 axels and more)
Type 8	Container Trailer

Survey Period

The survey was conducted in the same periods as the Classified Vehicle Count Survey.

Methodology

The surveyors interviewed the drivers and passengers with the assistance of the Police officers at the roadside of the arterial roads near the provincial boundary and all the off ramps in the Southern Expressway. The sampled vehicles by vehicle type were selected by a random sampling method.

Classification of Survey Items

The following information was obtained from the drivers and passengers:

Table 9.2.2 Classification of Survey Items

SQN		Survey Items	Classifications
1	Common Question	Number of Passengers including Driver	-
2		Addresses of Origin and Destination	-
3		Type of Origin and Destination	- Home - Work Place - School - Others
4		Trip Purpose	- To Home - To Work - To School - Shopping - Business - Private Matters - Others
5		Location of Residence	- Western Province - Other province
6	Only for Trucks	Type of Commodity	-
7		Loading Ratio	-
8	Only for Southern Expressway	Entry Interchange	-

9.2.6 Data Processing

(1) Editing and Zone Coding

After the completion of the field survey, zone coding for Origin and Destination was carried out on the original survey forms based on the zone system of the Home Visit Survey.

(2) Data Input and Error Checking

After the data input, range error and logical error were checked. If a critical error was observed, the data was excluded from the valid samples.

9.2.7 Survey Results

(1) Daily Traffic Volumes on the Western Provincial Boundary

As shown in the Table below, approximately 80,000 vehicles, excluding buses, crossed the Western provincial boundary. The high class roads, such as A003, A001 and A002 had been observed to have high daily traffic volume compared with low class roads.

Table 9.2.3 Daily Traffic Volumes on the Western Provincial Boundary

No	Road Class	Motorcycle	Three-wheeler	Car/Jeep/Passenger Van	Pickup	Truck	Total
1	A003	2,442	1,181	3,175	707	3,059	10,564
2	B419	2,387	537	1,246	141	879	5,190
3	B503	1,617	298	600	91	836	3,442
4	B322	1,169	557	1,271	202	1,061	4,260
5	AB29	1,295	491	700	169	989	3,644
6	A001	645	948	2,429	393	2,107	6,522
7	A007	2,646	2,935	2,569	410	2,275	10,835
8	A004	1,615	2,329	2,549	449	2,222	9,164
9	A008	1,739	1,064	1,219	215	1,180	5,417
10	B114	437	164	54	15	124	794
11	B055	895	458	235	47	339	1,974
12	A002	3,365	2,456	2,219	244	2,241	10,525
Southern Expressway		-	-	5,860	445	559	6,864
Total		20,252	13,418	24,126	3,528	17,871	79,195

* The traffic volume of buses was summarised in the Bus Passenger OD Interview Survey.

(2) Vehicle Composition

The vehicle composition is shown in the Figure below. Approximately 40 % of the vehicles observed on the Western provincial boundary were motorcycles or three wheelers. The car, jeep and passenger van category was 30% and truck was 23%.

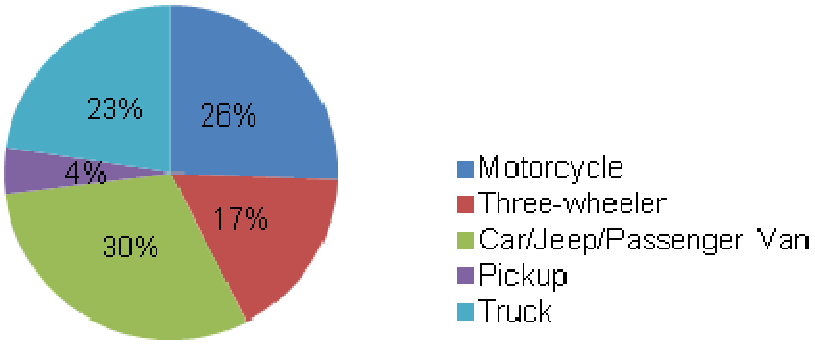
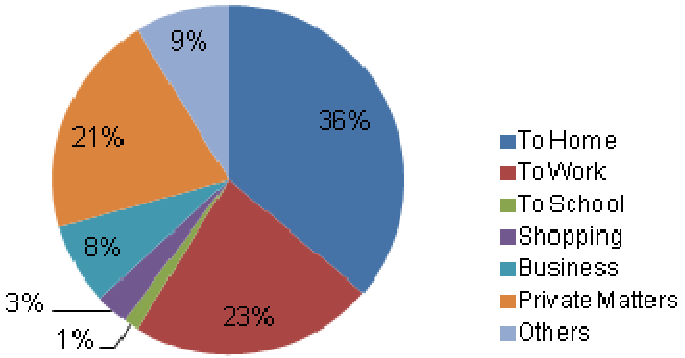


Figure 9.2.2 Vehicle Composition

(3) Trip Purpose

The composition of trip purposes on the western provincial boundary is shown in the Figure below. Trip purposes mainly consisted of three purposes, To home, To work and Private matters. Shares of to school and business were low.



*The freight vehicles were excluded

Figure 9.2.3 Trip Purpose

9.3 Bus Passenger OD Interview Survey

9.3.1 Objective

The main objective of the survey is to collect trip information of bus passengers on the major arterial roads and Southern Expressway crossing the Western province boundary. The data obtained was utilised to estimate the present travel demand.

9.3.2 Types of Surveys

Under the Bus Passenger OD Interview Survey, the following 3 surveys were conducted:

- Bus Fleet Count Survey
- Bus Passenger Count Survey
- Bus Passenger OD Interview Survey

9.3.3 Survey Days, Durations and Locations

The survey was conducted at 14 locations as shown in Figure 9.3.1. Among those locations, the survey was conducted at 12 locations on major arterial roads for 16 hours and 2 locations at bus stands for highway buses for 16 hours.

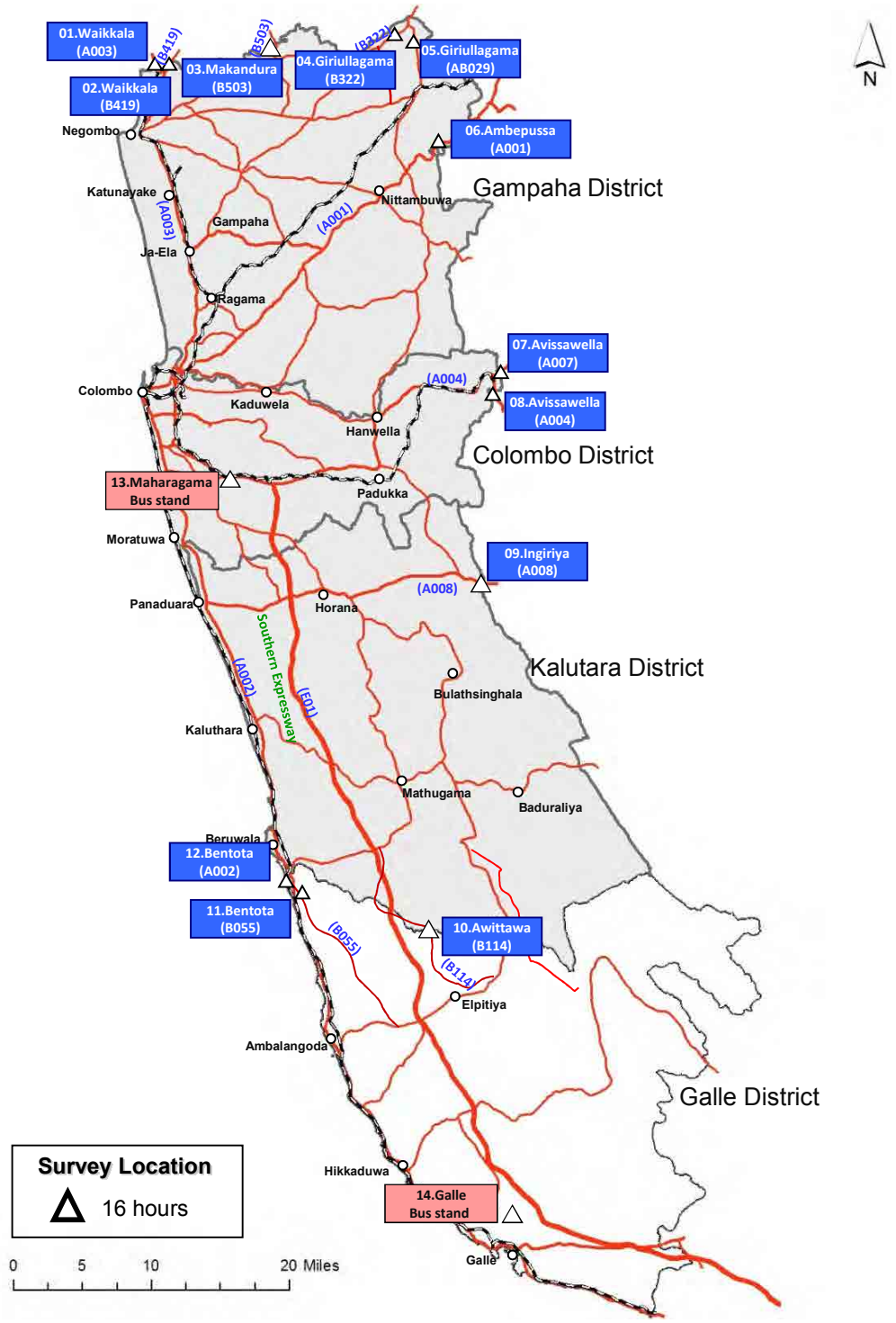


Figure 9.3.1 Survey Locations

Table 9.3.1 Survey Days, Durations and Locations

No	Road Class	Survey Location	Survey Duration	Survey Day
1	A003	Waikkala	16 hour	19-Feb-13
2	B419	Waikkala		19-Feb-13
3	B503	Makandura		20-Feb-13
4	B322	Giriullagama		20-Feb-13
5	AB29	Ambepussa		20-Feb-13
6	A001	Ambepussa		27-Feb-13
7	A007	Avissawella		06-Mar-13
8	A004	Avissawella		12-Mar-13
9	A008	Ingiriya		14-Feb-13
10	B114	Awittawa		21-Feb-13
11	B055	Bentota		21-Feb-13
12	A002	Bentota		21-Feb-13
13	Maharagama bus stand			14-Feb-13
14	Galle bus stand			14-Feb-13

9.3.4 Preparation of Survey

(1) Selection of Survey Sections

Prior to the survey implementation, each survey section was visited in order to ensure the safety of the survey personnel and road users and road space to stop buses.

(2) Recruitment of Survey Personnel

Under the survey, Transport Engineers in the field of transport engineering, supervisors who have experience in transport surveys and surveyors from personnel who have GCE qualifications (ordinary level), were recruited to obtain reliable survey results.

(3) Preparation of Survey Forms

The following survey forms were used in the survey:

- Form 1: Bus Fleet Count Survey and Bus Passenger Count Survey
- Form 2: Interview Form for Bus Passenger OD Interview

(4) Permission and ID card

It was necessary to obtain official permission for conducting the field survey prior to starting the field survey. Specifically, the National Transport Commission (NTC) and Sri Lanka Transport

Board (SLTB) were visited prior to survey implementation. Assistance was also requested from NTC of each survey site for stopping the Buses. In addition, ID cards were prepared for the surveyors and shown every time the survey was conducted.

(5) Training of Survey Personnel

Prior to survey implementation, training of survey personnel was carried out. The detailed description of the survey process, explanation of survey forms and safety considerations were instructed through the training.

9.3.5 Field Survey

(1) Bus Fleet Count Survey

The following items of all route buses were surveyed during the survey duration. Also, the number of buses by direction was continuously recorded on the survey sheet every hour.

Table 9.3.2 Classification of Survey Items

SQN	Survey Items	Classifications
1	Route Number	
2	Origin and Destination	
3	Bus Condition	- Without A/C Ordinary - Semi Luxury - With A/C
4	Bus Type	- Private Bus - SLTB (CTB)
5	Bus Size	- 20-29 - 30-39 - 40-49 - 50 and more

(2) Bus Passenger Count Survey

All the route buses were stopped by the security staff (NTC Squad) of the National Transport Commission (NTC) at the survey stations for bus passenger counting. When buses were stopped, the surveyors got into the buses and counted the number of passengers on the way to other survey stations. If it was difficult to count the number of bus passengers due to over loading, the bus passenger loading ratio was recorded from outside of the buses.

(3) Bus Passenger OD Interview Survey

The survey was conducted at the selected sections at an average of 4-6 kilometres between points inside and outside of the Western Province. The surveyors got into the selected buses and interviewed the passengers and got off at another survey station on the side of the arterial road. The sampled buses by routes were selected by a random sampling method.

The following items were surveyed by the surveyors:

Table 9.3.3 Classification of Survey Items

SQN	Survey Items	Classifications
1	Address of Origin and Destination	-
2	Type of Origin and Destination	- Home - Work Place - School - Others
3	Bus Station (Boarding station and Alighting station)	-
4	Trip Purpose	- To Home - To Work - To School - Shopping - Business - Private Matters - Others
5	Access and Egress Mode	- Walking - Bicycle - Motor Bike - Three Wheeler (Private use) - Three Wheeler (Hired) - Car, Jeep, Passenger Van - Pickup - Non A/C Bus (Private) - Non A/C Bus (SLTB) - A/C Bus (Private) - Taxi - Others
6	Location of Residence	- Western Province - Other province

9.3.6 Data Processing

(1) Editing and Zone Coding

After the completion of the field survey, zone coding for the Origin and Destination was carried out on the original survey forms based on the zone system of the Home Visit Survey.

(2) Data Input and Error Checking

After the data input, range error and logical error were checked. If a critical error was observed, the data was excluded from the valid samples.

(3) Estimation of Expansion Factor

The expansion factors were calculated by bus route by direction by time band, however, when the number of samples was not sufficient, similar bus routes were grouped.

9.3.7 Survey Results

(1) Number of Buses and Passengers

The number of buses and passengers on the Western provincial boundary are shown in the Table below. Approximately 5,800 buses and 220,000 passengers per day crossed the Western provincial boundary. The largest

Table 9.3.4 Number of Buses and Passengers on the Western Provincial Boundary

No	Survey Location		Number of Buses			Number of Passengers		
			Outbound	Inbound	Total	Outbound	Inbound	Total
1	A003	Waikkala	397	254	651	15,097	10,529	25,626
2	B419	Waikkala	243	225	468	4,884	10,868	15,752
3	B503	Makandura	10	10	20	133	144	277
4	B322	Giriullagama	79	87	166	3,800	3,472	7,271
5	AB29	Ambepussa	98	112	210	1,683	3,456	5,139
6	A001	Ambepussa	731	690	1,421	28,516	31,964	60,481
7	A007	Avissawella	407	331	738	12,595	12,159	24,754
8	A004	Avissawella	429	380	809	14,154	17,878	32,032
9	A008	Ingiriya	84	87	171	3,736	3,755	7,491
10	B114	Awittawa	21	14	35	401	278	679
12	B055	Bentota	127	120	247	3,703	5,290	8,993
13	A002	Bentota	422	349	771	14,640	14,355	28,995
22	Bus	Maharagama	45	-	45	1,541	-	1,541
23	Stands	Galle	-	43	43	-	1,256	1,256
Total			3,093	2,702	5,795	104,882	115,406	220,288

(2) Trip Purpose

The composition of trip purpose by location is shown in the Figure below. Trip purposes of bus passengers mainly consisted of three purposes, To home, To work and Private matters. Shares of To school and business were low.

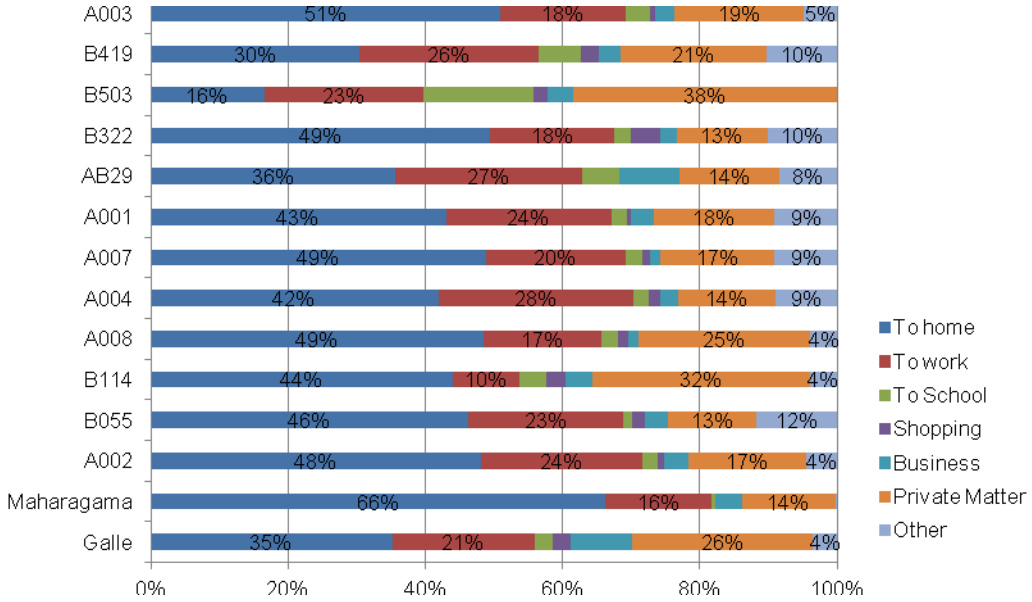


Figure 9.3.2 Trip Purpose

9.4 Railway Passenger OD Interview Survey

9.4.1 Objective

The main objective of the Survey is to collect trip information of the railway passengers crossing the Western Province boundary. The data obtained was utilised to estimate the present travel demand.

9.4.2 Types of the Survey

Under the Railway Passenger OD Interview Survey, the following 2 surveys were conducted:

- Railway Passenger Count Survey
- Railway Passenger OD Interview Survey

9.4.3 Survey Days, Durations and Sections

The survey was conducted on board between the Western provincial boundaries at the selected stations on the 3 railway lines. Selected sections are summarised in the Table below.

Table 9.4.1 Survey Days, Durations and Sections

No	Railway Line	Survey Sections		Survey Day
		Inside WP	Outside WP	
1	PuttalamLine	Lunuwila	Kochchikade	28–Feb-13
2	Main Line	Meerigama	Polgahawela	07-Mar-13
3	Coastal Line	Aluthgama	Ambalangoda	05-Mar-13

9.4.4 Preparation of Survey

(1) Selection of Survey Site

Prior to the survey implementation, train operation schedules and stop stations were reviewed and discussed with railway officers to decide the survey sections.

(2) Recruitment of Survey Personnel

Under the survey, Transport Engineers in the field of transport engineering, supervisors who have experience in transport surveys and surveyors from personnel who have GCE qualifications (ordinary level) or railway training school of Sri Lanka Railways, were recruited to obtain reliable survey results.

(3) Preparation of Survey Forms

The following survey forms were used in the survey:

- Form 1:Interview Form for Railway Passenger OD Interview

(4) Permission and ID card

It was necessary to obtain official permission for conducting the field survey prior to starting the field survey. Specifically, from Sri Lanka Railways, and each station was visited prior to survey implementation. In addition, ID cards were prepared and shown every time the survey was conducted.

(5) Training of Survey Personnel

Prior to survey implementation, training of survey personnel was carried out. The detailed description of the survey process, explanation of survey forms and safety considerations were instructed through the training.

9.4.5 Field Survey

(1) Railway Passenger Count Survey

The surveyors got onto all trains and they counted the number of passengers quickly between stops inside and outside of the Western Province. Also, the following items were surveyed.

Table 9.4.2 Classification of Survey Items

SQN	Survey Items	Classifications
1	Train Number	-
2	Origin and Destination	-
3	Number of Cars by Seat Class	- Fist Class - Second Class - Third Class
4	Number of Passengers	-

(2) Railway Passenger OD Interview Survey

This survey was conducted for passengers over 5 years old at the selected sections between inside and outside of the Western Province. The surveyors got onto the all trains and interviewed the railway passengers and got off at another survey station.

The following items were surveyed by the surveyors:

Table 9.4.3 Classification of Survey Items

SQN	Survey Items	Classifications
1	Address of Origin and Destination	-
2	Type of Origin and Destination	- Home - Work Place - School - Others
3	Railway Station (Boarding station and Alighting station)	-
4	Trip Purpose	- To Home - To Work - To School - Shopping - Business - Private Matters - Others
5	Access and Egress Mode	- Walking - Bicycle - Motor Bike - Three Wheeler (Private use) - Three Wheeler (Hired) - Car, Jeep, Passenger Van - Pickup - Non A/C Bus (Private)

SQN	Survey Items	Classifications
		- Non A/C Bus (SLTB) - A/C Bus (Private) - Taxi - Others

9.4.6 Data Processing

(1) Editing and Zone Coding

After the completion of the field survey, zone coding for Origin and Destination was carried out on the original survey forms based on the zone system of the Home Visit Survey.

(2) Data Input and Error Checking

After the data input, range error and logical error were checked. If a critical error was observed, the data was excluded from the valid samples.

(3) Estimation of Expansion Factor

The expansion factors were calculated by train, however, when the number of samples was not sufficient, similar trains were grouped.

9.4.7 Survey Results

(1) Number of Trains and Passengers on the Western Provincial Boundary

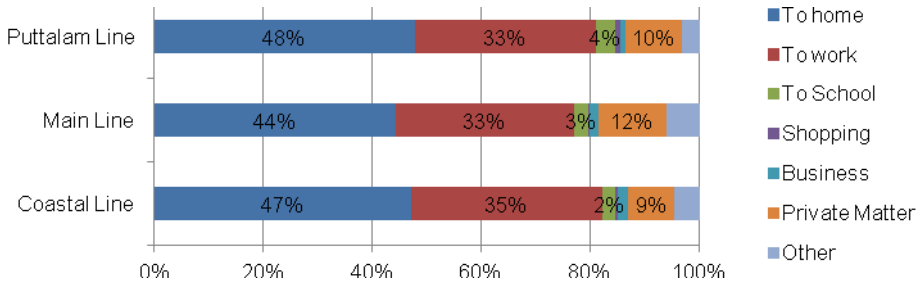
The number of Trains and passengers are shown in the Table below, totally the Main line has the most passengers per day, followed by the Coastal line and Puttalam line.

Table 9.4.4 Number of Trains and Passengers on the Western Provincial Boundary

Railway Line	Number of Trains		Number of Passengers		
	Outbound	Inbound	Outbound	Inbound	Total
Coastal Line	14	14	7,807	8,674	16,481
Main Line	42	41	13,467	16,392	29,859
Puttalam Line	13	13	2,832	2,594	5,426
Total	69	68	24,106	27,606	51,766

(2) Trip Purpose

The trip purpose by railway line is shown in the Figure below, trip purposes of railway passengers mainly consisted of three purposes, To home, To work and Private matters. Share of To school and business was low.



* The unknown trips were excluded

Figure 9.4.1 Trip Purpose

(3) Trip Attraction

The trip attraction of railway passengers on Western Provincial boundary is shown the Figure below, more than 40% of passengers

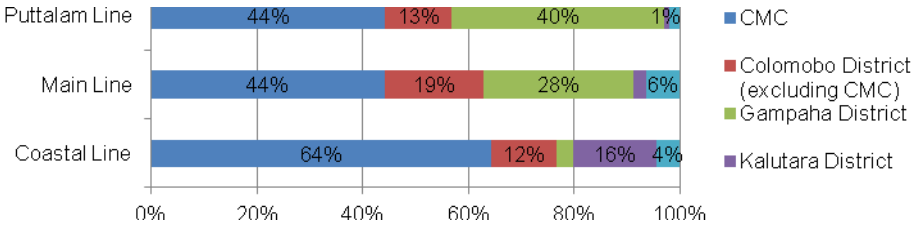


Figure 9.4.2 Trip Attraction

9.5 Air Passenger OD Interview Survey

9.5.1 Objective

The main objective of the Survey is to collect trip information of the air passengers crossing the Western provincial boundary. The data obtained was utilised to estimate the present travel demand.

9.5.2 Types of Survey

Under the Air Passenger OD Interview Survey, the following 2 surveys were conducted:

- Air Passenger Count Survey
- Air Passenger OD Interview Survey

9.5.3 Survey Day, Duration and Locations

The survey was conducted at the departure waiting rooms and 2 departure lounges after

immigration in the Bandaranaike International Airport (BIA). The survey was conducted on March 14th starting from 9:30 AM to 9.30 AM of the following day.

9.5.4 Preparation of Survey

(1) Recruitment of Survey Personnel

Under the survey, Transport Engineers in the field of transport engineering, supervisors who have experience in transport surveys and surveyors who graduated from university were recruited. In addition, fluent language skills in English and Sinhala or Tamil were set as minimum requirements to interview foreigners.

(2) Preparation of Survey Forms

The following survey forms were used in the survey:

- Form 1: Interview Form for the Air Passenger OD Interview
- Form 2: Interview Form for the Stated Preference Survey (SP survey)

(3) Permission and ID card

It was necessary to obtain official permission for conducting the field survey prior to starting the field survey. Specifically, Airport Aviation Services (Sri Lanka) Limited was visited prior to survey implementation. ID cards were prepared and shown every time the survey was conducted.

(4) Training of Survey Personnel

Prior to survey implementation, training of survey personnel was carried out. The detailed description of the survey process, explanation of survey forms and safety considerations were instructed through the training. In addition, a brief introduction to conjoint analysis was given in order to answer questions from passengers.

9.5.5 Field Survey

(1) Air Passenger Count Survey

The number of departure air passengers by seat class and number of transit passengers were interviewed with each airline company during the survey duration.

(2) Air Passenger OD Interview Survey

This Air Passenger OD Interview survey was conducted for passengers over 5 years old in the departure waiting rooms and departure lounges after immigration in the Bandaranaike International Airport (BIA). A total of 4 to 6 surveyors went into each waiting room and interviewed the passengers except for transit passengers. In addition, the Stated Preference Survey (SP survey) was conducted with 200 passengers who came within the area of Colombo Municipal Council (CMC) and its surrounding area after the Air Passenger OD Interview Survey.

The following information was obtained from air passengers:

Table 9.5.1 Classification of Survey Items

SQN	Survey Items	Classifications
1	Flight Information (Flight No and Seat Class)	-
2	Nationality	- Sri Lankan - Other Country
3	Address of Origin and Destination	-
4	Type of Origin and Destination	- Home - Work Place - School - Others
5	Trip Purpose (departure)	- Business - Government Affaires - Private Matters - Sightseeing - To Home - Medical Treatment - Others
6	Access Mode	- Walking - Bicycle - Motor Bike - Three Wheeler (Private use) - Three Wheeler (Hired) - Car, Jeep, Passenger Van - Pickup - Non A/C Bus (Private) - Non A/C Bus (SLTB) - A/C Bus (Private) - Taxi - Others
7	Travel Cost (Access Trip)	-
8	Travel Time (Access Trip)	-
9	Accompanying passengers	-
10	Number of persons that came to the airport for seeing off	-
11	Duration of Visit	-
12	Modal choice for improved railway system	-

(3) Sampling Rate

Total number of departure passengers without transit passengers was approximately 8,185 per day and number of interviewed samples was 1,821. The sampling rate by each flight is summarised in the Table below.

Table 9.5.2 Expansion Factor One Way to Both Ways

NO	Flight No.	Number of Departure Passengers					No of Interviewed Samples	Sampling Rate	Expansion Factor		Note
		Business	Economy	Sub TOTAL	Transit	Total			One way	Both way	
		A	B	C(A+B)	D	E(C+D)	F	G(F/C)	H	I(H*2)	
1	AIC273/4	8	198	206	0	206	80	39%	2.58	5.15	
2	ALK101	4	87	91	146	237	17	19%	5.35	10.71	
3	ALK103	3	31		87						
4	ALK107	4	11		58						
5	ALK109	3	42		69						
6	ALK115	3	20	117	90	538	19	16%	6.16	12.32	*
7	ALK121	3	69	72	162	234	28	39%	2.57	5.14	
8	ALK123	5	106	111	22	133	16	14%	6.94	13.88	
9	ALK125	15	167	182	82	264	36	20%	5.06	10.11	
10	ALK127	11	137	148	8	156	34	23%	4.35	8.71	
11	ALK131	1	1		144						
12	ALK133	17	102	121	86	472	13	11%	9.31	18.62	*
13	ALK141	0	67		138						
14	ALK161	9	136		40						
15	ALK165	16	123		134						
16	ALK167	0	3		75						
17	ALK171	1	85	440	26	1293	54	12%	8.15	16.30	*
18	ALK183	7	85	92	65	157	16	17%	5.75	11.50	
19	ALK195	0	12	12	173	185	11	92%	1.09	2.18	
20	ALK205	1	19	20	43	63	7	35%	2.86	5.71	
21	ALK207	0	219	219	38	257	19	9%	11.53	23.05	
22	ALK217	10	231	241	0	241	55	23%	4.38	8.76	
23	ALK225	12	125	137	88	225	33	24%	4.15	8.30	
24	ALK229	4	251	255	26	281	65	25%	3.92	7.85	
25	ALK263	5	267	272	155	427	64	24%	4.25	8.50	
26	ALK269	12	275	287	16	303	77	27%	3.73	7.45	
27	ALK281	2	16	18	83	101	1	6%	18.00	36.00	
28	ALK302	0	54		124						
29	ALK306	14	144	212	56	604	48	23%	4.42	8.83	*
30	ALK314	2	65	67	156	223	37	55%	1.81	3.62	
31	ALK318	5	48	53	95	148	27	51%	1.96	3.93	
32	ALK503	18	299	317	37	354	63	20%	5.03	10.06	
33	ALK553	18	177		82						
34	ALK563	16	205		98						
35	EY7407	8	111	535	74	1324	56	10%	9.55	19.11	*
36	ALK882	8	112	120	85	205	64	53%	1.88	3.75	
37	ALK888	1	100	101	1	102	41	41%	2.46	4.93	
38	AXB671/2	2	124	126	33	159	36	29%	3.50	7.00	
39	CPA703/0	3	130	133	85	218	43	32%	3.09	6.19	
40	ETD266/7	2	133	135	1	136	51	38%	2.65	5.29	
41	FDB555/6	6	115	121	94	215	59	49%	2.05	4.10	
42	JAI252/5	5	83	88	39	127	49	56%	1.80	3.59	
43	JAI256/3	0	73	73	120	193	10	14%	7.30	14.60	
44	KAL474	0	89	89	87	176	22	25%	4.05	8.09	
45	MAS178	0	128	128	3	131	49	38%	2.61	5.22	
46	ABY0505/6	0	111		86						
47	MLR301	0	159		140						
48	MLR407	3	32		48						
49	MLR501	5	198	508	0	1290	40	8%	12.70	25.40	*
50	MLR215	7	88	95	121	216	4	4%	23.75	47.50	
51	OMA371/2	7	187	194	0	194	59	30%	3.29	6.58	
52	QTR300/1	4	53	57	34	91	6	11%	9.50	19.00	
53	QTR302/3	11	130	141	72	213	15	11%	9.40	18.80	
54	QTR304/5	7	147	154	0	154	30	19%	5.13	10.27	
55	SEJ001/2	9	185	194	10	204	29	15%	6.69	13.38	
56	SIA468/9	11	126	137	163	300	82	60%	1.67	3.34	
57	SVA780/1	22	441	463	104	567	60	13%	7.72	15.43	
58	TK731	4	51	55	122	177	8	15%	6.88	13.75	
59	UAE348	5	80	85	58	143	24	28%	3.54	7.08	
60	UAE349	9	174	183	101	284	85	46%	2.15	4.31	
61	UAE650/1	12	215	227	0	227	45	20%	5.04	10.09	
62	ECI653	4	102		63						
63	UAE652/3	5	41		64						
64	WRFC7147/8	0	201	353	0	833	34	10%	10.38	20.76	*
Total		389	7,796	8,185	4,510	14,981	1,821	22%	-	-	-

* The expansion factors were grouped by similar destination

9.5.6 Survey Results

(1) Number of Air Passengers and Flights

The number of departure air passengers which was excludes transit passengers was 8,185 per day and the number of flights was 64 on the survey date.

(2) Trip Production

The largest component of trip production was observed in Colombo district at about 42% (CMC 24% and other areas 18%), followed by Gampaha district, Kandy District and Kalutara District, with components of about 18%, 12%, 8% and 7% respectively.

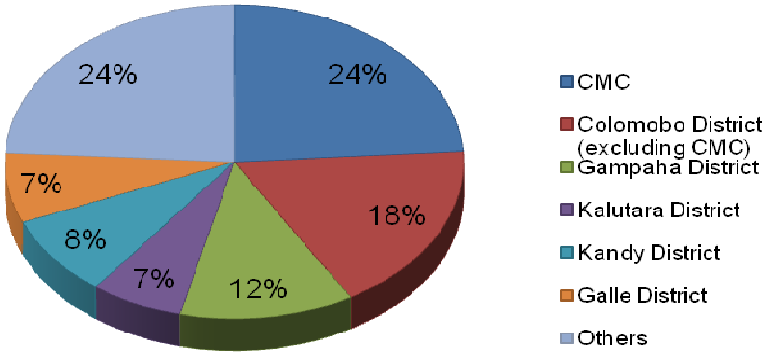


Figure 9.5.1 Trip Production

(3) Nationality

The nationality composition of departure air passengers is shown in the Figure below, around 70% was Sri Lankan and the remaining 30% was other countries.

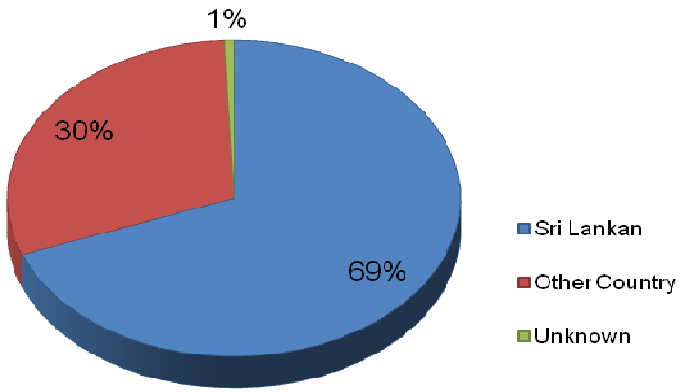


Figure 9.5.2 Nationality

(4) Trip Purpose

The trip purposes composition of departure passengers are shown in the Figure below. The largest component of the trip purposes was 40 % for "Business", followed by 24% for "To Home", 15% for "Private Matters" and 11% for "Sightseeing".

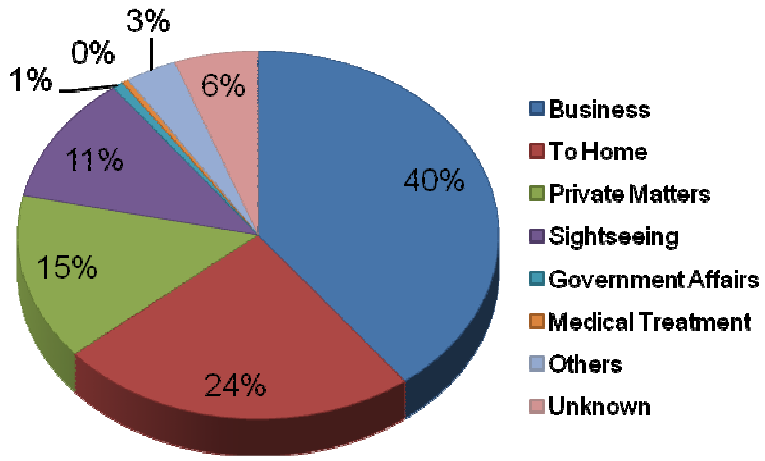


Figure 9.5.3 Trip Purpose

(5) Access Mode

The airport access mode compositions are shown in the Figure below. The largest component of access mode was private vehicles (car, jeep, passenger van and pickup) at about 38%, followed by Taxi for 32%. Public transportation composition such as Bus and railway, were only 16% for Bus and 1% for railway.

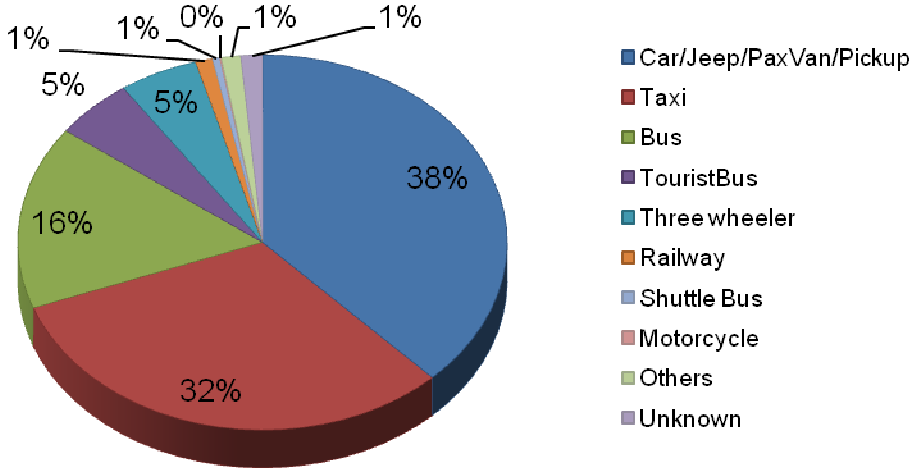


Figure 9.5.4 Access Mode

(6) Number of persons who came to airport for seeing off

The composition of the number of persons who came to the airport for seeing off is shown in the Figure below. Half of the passengers came to the airport with 1 person or more than 1 person.

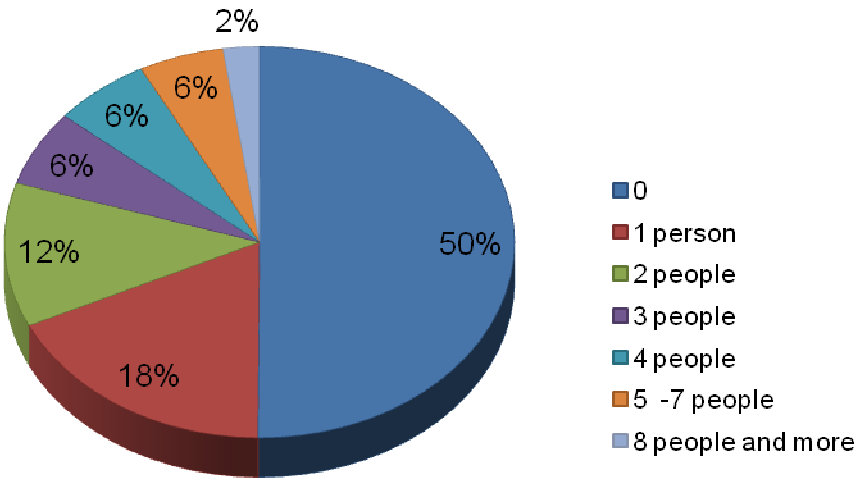


Figure 9.5.5 Number of Persons who came to Airport for seeing off

CHAPTER 10 Screen Line Survey

10.1 Objective

The main objective of the Screen Line Survey was to verify the present OD matrices which were estimated based on the results of the Home Visit Survey and Cordon Line Survey. Also by observing the traffic volume at some of the previous survey locations in Colombo Municipality, the annual growth rate was understood and used to analyse the current traffic problems at each corridor.

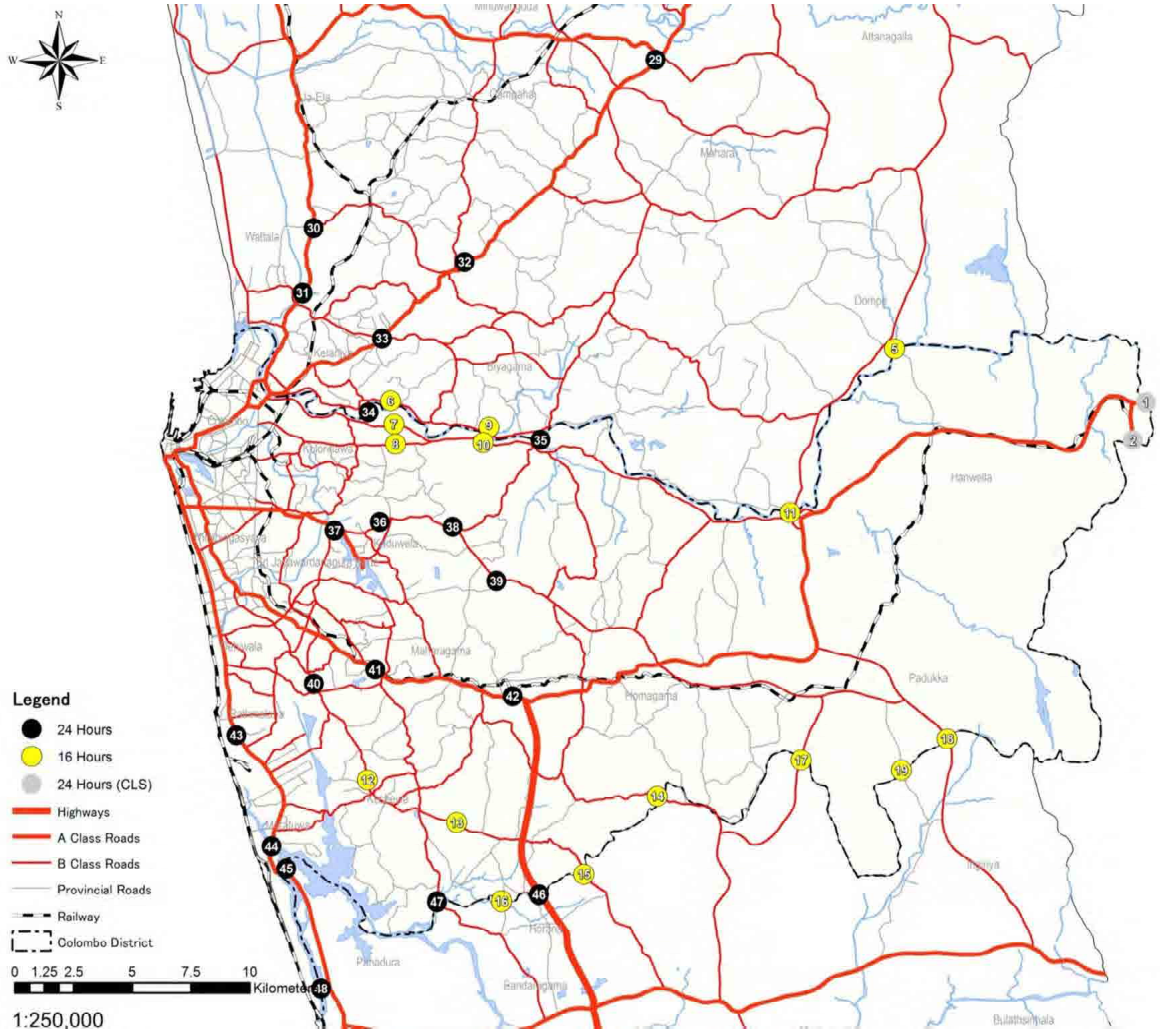
10.2 Types of Survey

Under the Screen Line Survey, the following 2 surveys were conducted:

- Classified Vehicle Count Survey
- Bus Passenger Loading Survey

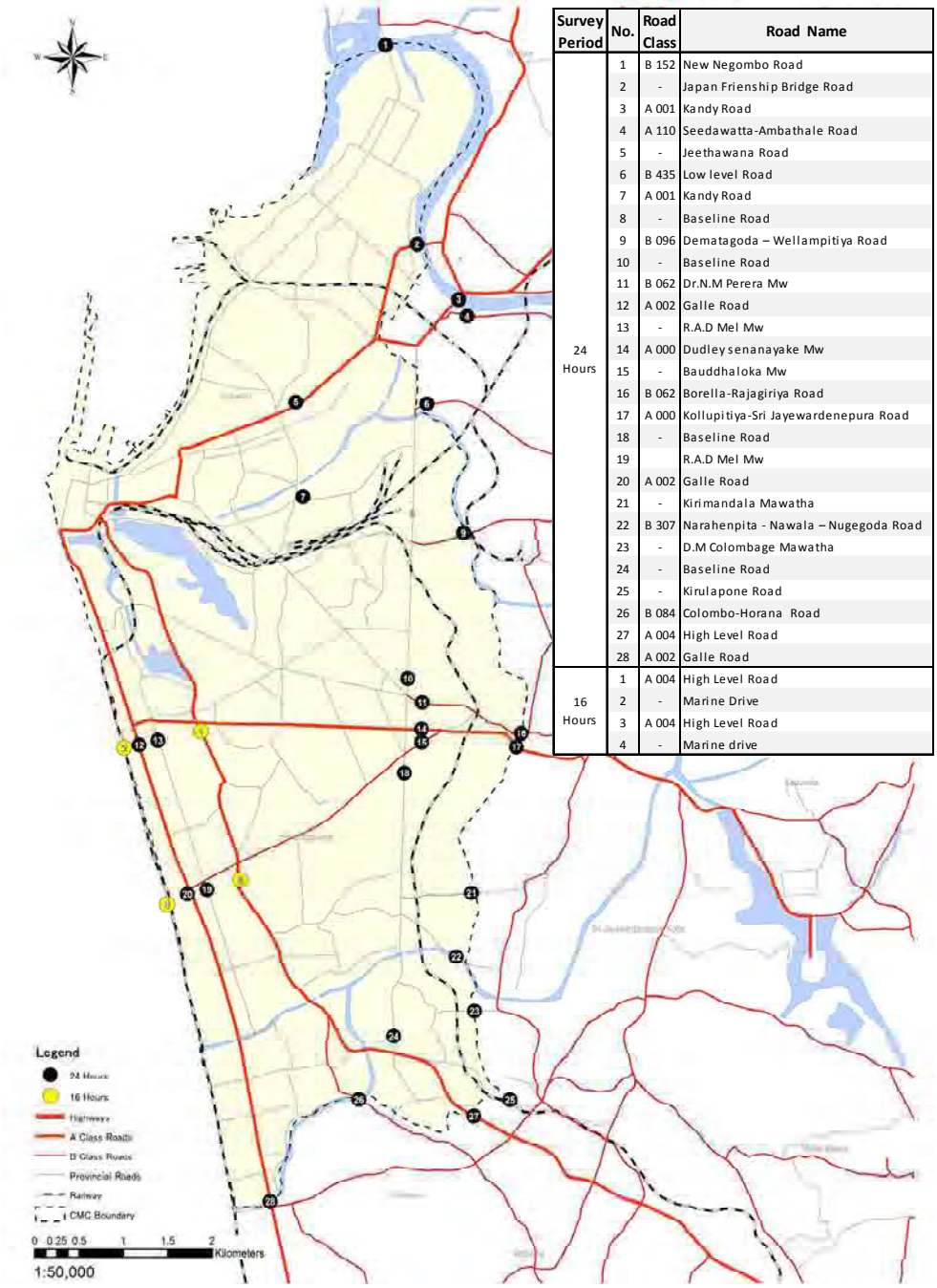
10.3 Survey Locations

The Classified Vehicle Count Survey was conducted at 67 locations as shown in Figure 10.3.1 and Figure 10.3.2. Among those locations, the survey was conducted at 48 locations for 24 hours and 19 locations for 16 hours. Also, the Bus Passenger Loading Survey was conducted at the same locations as the Classified Vehicle Count Survey for 16 hours.



Survey Period	No.	Road Class	Road Name
24 Hours	29	A 001	Kandy Road
	30	A 003	Puttalam Road
	31	A 003	Puttalam Road
	32	A 001	Kandy Road
	33	A 001	Kandy Road
	34	-	Kelanimulla Road
	35	-	New Kandy Road
	36	B 240	Kotte – Bope Road
	37	B 240	Kotte - Bope
	38	B 240	Kotte - Bope
	39	B 240	Kotte - Bope
	40	B 084	Horana Road
	41	A 004	High Level Road
	42	A 004	High Level Road
	43	A 002	Galle Road
	44	A 002	Galle Road
	45	A 002	Galle Road
	46	E 001	Southern Expressway
	47	B 216	Kesbewa - Kindelpitiya - Bandaragama Road
	48	AB 11	New Galle Road
16 Hours	5	-	Pugoda-Kosgama Road
	6	B 214	Kelaniya – Mudungoda Road
	7	-	Sedawatta-Ambatale Road
	8	B 435	Low level Road
	9	B 214	Kelaniya - Mudungoda
	10	AB 10	Low level Road
	11	B 146	Hanwella - Pugoda - Weke – Urapola Road
	12	B 084	Horana Road
	13	B 084	Horana Road
	14	B 239	Kottawa – Talagala Road
	15	B 084	Colombo-Horana Road
	16	-	Palagama Road
	17	B 123	Galagedra-Horana Road
	18	B 285	Meepe-Ingiriya Road
	19	-	Menerigama Road
24 Hours (CLS)	1	A007	Avissawella - Hatton - Nuwara Eliya Road
	2	A004	High Level Road

Figure 10.3.1 Survey Locations (1)



Survey Period	No.	Road Class	Road Name
24 Hours	1	B 152	New Negombo Road
	2	-	Japan Frienship Bridge Road
	3	A 001	Kandy Road
	4	A 110	Seedawatta-Ambathale Road
	5	-	Jeethawana Road
	6	B 435	Low level Road
	7	A 001	Kandy Road
	8	-	Baseline Road
	9	B 096	Dematagoda – Wellampitiya Road
	10	-	Baseline Road
	11	B 062	Dr.N.M Perera Mw
	12	A 002	Galle Road
	13	-	R.A.D Mel Mw
	14	A 000	Dudley senanayake Mw
	15	-	Bauddhaloka Mw
	16	B 062	Borella-Rajagiriya Road
	17	A 000	Kollupitiya-Sri Jayewardenepura Road
	18	-	Baseline Road
	19		R.A.D Mel Mw
	20	A 002	Galle Road
	21	-	Kirimandala Mawatha
	22	B 307	Narahenpita - Nawala – Nugegoda Road
	23	-	D.M Colombage Mawatha
	24	-	Baseline Road
	25	-	Kirulapone Road
	26	B 084	Colombo-Horana Road
	27	A 004	High Level Road
	28	A 002	Galle Road
16 Hours	1	A 004	High Level Road
	2	-	Marine Drive
	3	A 004	High Level Road
	4	-	Marine drive

Figure 10.3.2 Survey Locations (2)

10.4 Preparation of Survey

The following preparations for the survey were conducted prior to the implementation of the field survey

(1) Selection of Survey Sites

Prior to the survey implementation, each site was visited in order to ensure the visibility and safety of the surveyors. Night time visibility for vehicle identification was also considered. The surveys were basically conducted on the same locations, however if it was not possible to record bus information due to the high speed of the bus or visibility, the Bus Passenger Loading Survey was carried out close to or near the bus stops as it was convenient to observe the bus information due to slowing down of the bus speed.

(2) Recruitment of Survey Personnel

Under the survey, Transport Engineers in the field of transport engineering, supervisors who have experience in transport surveys and surveyors from the University of Moratuwa or personnel who have GCE qualifications (ordinary level), were recruited to obtain reliability of the survey results.

(3) Preparation of Survey Forms

The following survey forms were used.

- Form 1: Survey Form for Classified Vehicle Count Survey
- Form 2: Survey Form for Bus Passenger Loading Survey

(4) Permission and ID card

Necessary official permission was confirmed prior to the survey implementation through the consultation with police officers and ID cards were prepared prior to the survey implementation. The ID cards were shown every time the survey was conducted.

(5) Training of Survey personnel

Prior to survey implementation, training of survey personnel was carried out on 11th February 2013. The detailed description of the survey process, explanation of survey forms, identification for type of vehicles and safety considerations were instructed through the training.

10.5 Field Survey

10.5.1 Classified Vehicle Count Survey

(1) Survey Period

The survey was conducted on one weekday (Tuesday, Wednesday or Thursday) from 12th February to 7th March and either for 16 hours (6:00 AM to 10:00 PM) or 24 hours (6:00AM to 6:00AM of the following day) depending on the survey location.

(2) Methodology

The survey was conducted for both directions and the surveyors continuously counted the number of vehicles by hour-band by type of vehicle by direction using manual traffic counters or tally marks. The surveyors recorded the number of vehicles on the survey sheet every hour.

(3) Types of Vehicles

The types of vehicles for the Classified Vehicle Count Survey are grouped into the following 11 categories:

Type 1	Motorcycle
Type 2	Three Wheeler
Type 3	Car, Jeep
Type 4	Passenger Van
Type 5	Pick-up (Single/ Double Cab)
Type 6	Medium Truck (2 axels)
Type 7	Large Truck (3 axels and more)
Type 8	Container Trailer
Type 9	Minibus (29 seats and below)
Type 10	Bus
Type 11	Others( )

10.5.2 Bus Passenger Loading Survey

(1) Survey Period

The survey was conducted on one weekday (Tuesday, Wednesday or Thursday) from 12th February to 7th March and for 16 hours (6:00 AM to 10:00 PM).

(2) Methodology

The survey was conducted for both directions and surveyors continuously recorded the Bus Route information and Bus condition from the side of the road. When there was a high number of buses, one surveyor observed and reported the bus information to the other surveyor and the other surveyor filled in the bus information on the survey sheets.

(3) Classification of Survey Items

The classification of survey items is shown in Table 10.5.1.

Table 10.5.1 Classification of Survey Items

Survey Items	Classifications
Passing Time	-
Route No.	-
Name of Origin and Destination	-
Air-Conditioning	-Without AC Ordinary, - Without AC Semi Luxury, - With AC
Operator	- Private Bus Company, - SLTB
Bus Size	- 20-29 seats - 30-39 seats - 40-49 seats - 50 seats and more
Passenger Loading Level	- Empty - 25% - 50% - 75% - 100% - 125 % - 150% - 175% - 200% and more

10.6 Data Processing

(1) Data Input and Error Checking

The daily traffic volume and hourly fluctuation by direction were checked, and the survey data was compared based on previous traffic count survey data which was obtained from the Ministry of Transport. If missing or irregular traffic movement was observed, the traffic volumes were estimated as the average number of vehicles between 1 hour before and 1 hour after.

(2) Estimation of Expansion Factor 16 hour to 24 hour

The expansion factor was calculated based on the survey results at 24 hour survey locations. Adopted expansion factors to estimate 24 hour traffic volume are shown in Table 10.6.1.

Table 10.6.1 Expansion Factor by Types of Vehicles

Type of Vehicle		Expansion Factor
Type 1	Motorcycle	1.05
Type 2	Three Wheeler	1.08
Type 3	Car, Jeep	1.08
Type 4	Passenger Van	1.15
Type 5	Pick-up (Single/ Double Cab)	1.10
Type 6	Medium Truck (2 axels)	1.14
Type 7	Large Truck (3 axels and more)	1.35
Type 8	Container Trailer	1.45
Type 9	Minibus (29 seats and below)	1.09
Type 10	Bus	1.07
Type 11	Others	1.14

10.7 Survey Results and Major Findings

10.7.1 Traffic Growth on CMC boundary

As shown in the Figure below, present traffic volume by vehicle type was compared with traffic count data in 2004 to understand the traffic growth rate on the CMC boundary. The annual growth rate of motorcycles was 7.3%, three wheelers was 7.8%, and other vehicles was 1.3%.

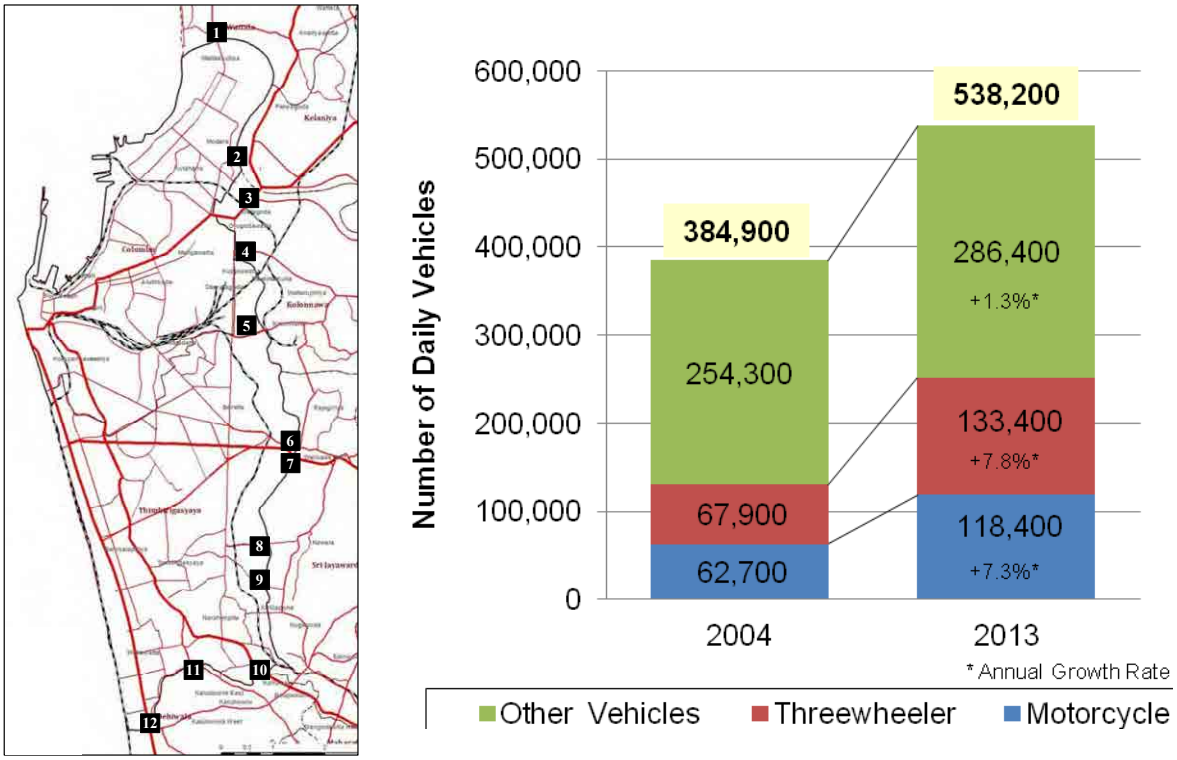


Figure 10.7.1 Traffic Growth on CMC Boundary 2004 -2013

10.7.2 Vehicle Share

A summary of vehicle share for all roads is shown in the Figure below. Vehicle share of motorcycle and three wheeler was around 50% and other types of passenger vehicles (car, jeep and passenger van) was around 40%.

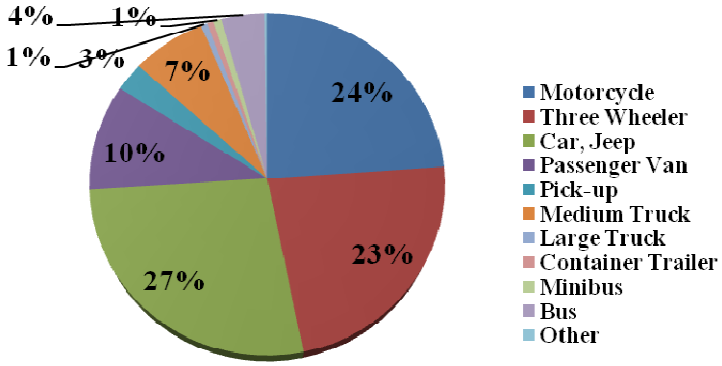


Figure 10.7.2 Summary of Vehicle Share for All Roads

10.7.3 Traffic Volume

The Daily traffic volumes at each survey location are summarised in the tables below. Detailed survey results are attached as an appendix.

Table 10.7.1 Traffic Volume (1)

No.	Survey Period	Road Class	Road Name	1 Motor cycle	2 Three Wheeler	3 Car, Jeep	4 Passenger Van	5 Pick-up	6 Medium Truck	7 Large Truck	8 Container Trailer	9 Minibus	10 Bus	11 Other	1-11 All Vehicles	1-11 PCU
1		B 152	New Negombo Road	7,760	7,260	4,762	2,355	546	1,957	102	100	109	317	24	25,292	22,406
2		-	Japan Frienship Bridge Road	11,104	12,952	9,104	4,649	1,225	3,436	1,145	1,293	547	2,378	193	48,026	51,072
3		A 001	Kandy Road	23,052	18,245	23,900	10,673	2,035	7,214	1,562	1,759	694	5,613	442	95,189	99,077
4		A 110	Seedawatta-Ambathale Road	5,232	8,876	1,478	910	285	2,334	249	364	32	20	82	19,862	18,823
5		-	Jeethawana Road	10,203	18,245	7,803	4,822	1,405	3,342	808	753	570	5,381	191	53,523	56,175
6		B 435	Low level Road	7,391	12,252	2,855	1,480	546	3,030	1,690	1,520	74	1,123	79	32,040	36,833
7		A 001	Kandy Road	8,756	22,263	4,428	2,466	689	1,984	54	30	284	2,113	111	43,178	38,129
8		-	Baseline Road	18,093	23,677	16,975	8,698	1,823	5,959	367	535	275	2,105	220	78,727	74,143
9		B 096	Dematagoda – Wellampitiya Road	11,710	17,384	3,916	2,336	596	1,176	25	24	92	1,061	345	38,665	31,475
10		-	Baseline Road	11,552	13,824	15,970	6,992	1,882	4,981	323	345	183	1,382	181	57,615	56,334
11		B 062	Dr.N.M Perera Mw	10,582	10,485	11,088	3,984	1,029	2,054	51	65	130	2,790	95	42,353	39,514
12	24	A 002	Galle Road	6,186	12,085	16,811	3,762	1,121	810	10	3	464	1,970	18	43,240	40,739
13	hour	-	R.A.D Mel Mw	7,902	15,621	18,545	4,141	1,049	775	6	1	565	1,986	10	50,601	46,534
14		A 000	Dudley senanayake Mw	8,720	8,096	22,656	4,343	1,961	1,345	20	6	357	1,282	44	48,830	46,067
15		-	Bauddhaloka Mw	5,128	5,384	14,118	3,138	1,298	862	6	4	204	65	37	30,244	28,053
16		B 062	Borella-Rajagiriya Road	7,723	9,261	6,663	2,033	718	1,170	49	24	198	3,858	90	31,787	30,617
17		A 000	Kollupitiya-Sri Jayewardenepura Road	16,658	14,996	39,378	8,755	3,449	3,446	111	35	289	241	102	87,460	80,940
18		-	Baseline Road	11,505	14,395	26,252	6,847	2,619	4,610	307	375	210	1,077	174	68,371	66,941
19			R.A.D Mel Mw	7,604	12,563	14,795	3,656	694	476	52	3	656	2,355	11	42,865	39,611
20		A 002	Galle Road	6,285	11,969	16,415	3,802	1,093	564	2	2	498	2,176	5	42,811	40,265
21		-	Kirimandala Mawatha	3,344	3,530	7,394	1,579	748	540	19	4	26	19	36	17,239	15,690
22		B 307	Narahenpita - Nawala – Nugegoda Road	5,401	5,543	12,327	2,339	1,216	1,265	75	34	46	298	72	28,616	26,803
23		-	D.M Colombage Mawatha	2,086	2,800	3,297	658	257	366	1	1	12	2	4	9,484	8,279
24		-	Baseline Road	8,337	6,736	13,801	4,540	1,295	3,128	413	303	147	333	32	39,065	38,393

Table 10.7.2 Traffic Volume (2)

No.	Survey Period	Road Class	Road Name	1 Motor cycle	2 Three Wheeler	3 Car, Jeep	4 Passenger Van	5 Pick-up	6 Medium Truck	7 Large Truck	8 Container Trailer	9 Minibus	10 Bus	11 Other	1-11 All Vehicles	1-11 PCU
25		-	Kirulapone Road	3,326	4,409	6,038	1,403	421	412	1	0	75	2	1	16,088	14,091
26		B 084	Colombo-Horana Road	7,534	9,539	14,863	3,987	1,496	2,019	149	110	324	1,237	48	41,306	39,575
27		A 004	High Level Road	8,203	8,172	16,238	4,379	1,589	2,072	144	174	197	2,863	52	44,083	43,782
28		A 002	Galle Road	8,058	13,097	15,827	5,112	956	1,412	37	8	582	3,020	20	48,129	45,803
29		A 001	Kandy Road	7,297	4,588	5,325	3,547	931	4,853	356	349	361	2,029	143	29,779	32,603
30		A 003	Puttalam Road	17,606	13,275	19,113	11,210	1,295	6,980	704	1,053	841	2,737	320	75,134	76,330
31		A 003	Puttalam Road	15,636	11,924	16,331	10,136	1,722	7,083	1,592	1,841	932	2,670	118	69,985	76,685
32		A 001	Kandy Road	10,475	6,754	7,661	4,386	1,049	3,982	279	219	290	2,671	65	37,831	38,025
33		A 001	Kandy Road	20,569	12,722	14,020	6,594	1,760	6,011	555	630	483	3,893	70	67,307	65,859
34		-	Kelanimulla Road	8,091	4,512	3,993	1,659	655	1,053	4	0	42	138	25	20,172	16,432
35		-	New Kandy Road	11,612	5,441	6,186	3,543	1,114	7,282	350	156	154	687	120	36,645	37,145
36	24	B 240	Kotte – Bope Road	9,983	8,181	9,074	3,048	1,059	1,972	98	62	251	1,783	115	35,626	32,848
37	hour	B 240	Kotte - Bope	18,042	13,125	31,380	7,865	2,913	4,231	173	133	414	2,236	138	80,650	76,170
38		B 240	Kotte - Bope	15,739	9,153	12,096	4,617	1,456	4,514	134	97	375	1,385	73	49,639	45,692
39		B 240	Kotte - Bope	10,417	4,067	5,324	2,216	787	2,411	172	30	108	758	59	26,349	23,479
40		B 084	Colombo -Horana Road	12,257	8,242	9,738	4,475	1,496	2,758	80	180	314	1,209	136	40,885	37,626
41		A 004	High Level Road	11,434	11,508	11,738	4,886	935	2,168	93	44	201	3,141	53	46,201	43,100
42		A 004	High Level Road	8,613	4,572	9,139	5,024	1,432	4,738	92	35	231	2,233	20	36,129	37,136
43		A 002	Galle Road	13,834	11,854	16,338	8,199	1,528	5,100	244	208	853	4,496	92	62,746	62,964
44		A 002	Galle Road	18,404	12,368	11,207	6,506	1,509	4,706	183	143	1,749	4,349	249	61,374	59,033
45		A 002	Galle Road	10,896	8,271	3,022	1,871	321	1,605	33	26	108	951	47	27,151	22,296
46		E 001	Southern Expressway	9	1,968	2,779	1,104	532	194	4	5	51	119	15	6,780	6,932
47		B 216	Kesbewa - Kindelpitiya - Bandaragama Road	6,260	2,254	1,499	1,009	343	1,709	24	23	91	240	32	13,484	11,630
48		AB 11	New Galle Road	7,936	6,918	6,984	4,044	913	3,781	168	130	686	1,767	169	33,496	33,765

Table 10.7.3 Traffic Volume (3)

No.	Survey Period	Road Class	Road Name	1 Motor cycle	2 Three Wheeler	3 Car, Jeep	4 Passenger Van	5 Pick-up	6 Medium Truck	7 Large Truck	8 Container Trailer	9 Minibus	10 Bus	11 Other	1-11 All Vehicles	1-11 PCU
1	16 hour	A 004	High Level Road	1,772	3,093	7,653	1,022	265	132	0	0	29	36	7	14,009	12,776
2		-	Marine Drive	3,344	2,765	6,186	1,777	513	350	3	0	48	138	19	15,143	13,564
3		A 004	High Level Road	8,366	10,757	20,331	4,762	1,327	1,296	23	7	439	3,207	104	50,619	48,747
4		-	Marine drive	7,981	8,353	19,956	4,298	1,137	1,019	5	0	89	149	24	43,011	38,813
5		-	Pugoda-Kosgama Road	1,083	862	298	371	65	372	0	0	9	80	1	3,141	2,789
6		B 214	Kelaniya – Mudungoda Road	7,225	3,798	2,995	1,812	272	1,895	255	257	211	669	23	19,412	18,394
7		-	Sedawatta-Ambatale Road	3,762	2,026	1,264	888	195	1,399	24	20	21	11	39	9,649	8,564
8		B 435	Low level Road	5,665	5,556	2,026	1,300	350	1,677	143	90	113	1,110	282	18,312	17,200
9		B 214	Kelaniya - Mudungoda	4,296	2,376	1,528	1,141	433	3,240	238	110	49	577	32	14,020	15,131
10		AB 10	Low level Road	5,792	3,307	1,698	2,376	429	2,785	263	187	148	1,008	15	18,008	18,544
11		B 146	Hanwella - Pugoda - Weke – Urapola Road	4,001	2,164	1,287	1,431	409	2,843	73	25	170	299	88	12,790	13,099
12		B 084	Horana Road	11,642	7,088	5,132	3,380	772	2,685	155	110	148	1,229	18	32,359	29,067
13		B 084	Horana Road	8,435	4,251	2,675	2,017	499	1,982	54	23	150	762	54	20,902	18,337
14		B 239	Kottawa – Talagala Road	1,374	525	245	200	77	315	9	4	28	308	16	3,101	2,859
15		B 084	Colombo-Horana Road	4,763	1,854	1,152	838	191	1,309	9	23	102	501	29	10,771	9,578
16		-	Palagama Road	555	215	49	66	43	82	0	0	5	5	3	1,023	788
17		B 123	Galagedra-Horana Road	1,544	581	511	629	234	1,101	74	13	37	186	71	4,981	5,324
18		B 285	Meepe-Ingiriya Road	1,358	647	281	352	134	738	30	4	29	162	30	3,765	3,753
19		-	Menerigama Road	639	260	146	173	42	310	0	0	50	28	8	1,656	1,575

10.7.4 Passenger Volume

The number of route buses and passengers by each survey location are summarised in the tables below.

Table 10.7.4 Passenger Volume (1)

No.	Road Class	Road Name	Number of Buses					Number of Passengers					Average Occupancy Rate			
			20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more	Total	20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more	Total	20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more
1	B 152	New Negombo Road	Route Bus was not operated													
2	-	Japan Frienship Bridge Road	162	35	1,332	270	1,799	3,379	1,138	49,250	13,882	67,649	83%	93%	82%	93%
3	A 001	Kandy Road	93	97	2,636	1,390	4,216	2,089	2,944	93,504	63,097	161,634	90%	87%	79%	83%
4	A 110	Seedawatta-Ambathale Road	-	9	5	-	14	-	273	304	-	577	-	87%	135%	-
5	-	Jeethawana Road	166	57	3,863	572	4,658	3,032	1,141	130,267	26,863	161,303	73%	57%	75%	85%
6	B 435	Low level Road	9	8	760	124	901	182	246	35,120	6,366	41,914	81%	88%	103%	93%
7	A 001	Kandy Road	69	74	450	786	1,379	1,219	1,782	15,966	32,746	51,713	71%	69%	79%	76%
8	-	Baseline Road	1	16	1,417	4	1,438	13	658	66,190	235	67,096	52%	118%	104%	107%
9	B 096	Dematagoda – Wellampitiya Road	1	7	812	57	877	31	201	32,954	2,704	35,890	124%	82%	90%	86%
10	-	Baseline Road	-	12	1,087	10	1,109	-	405	48,748	481	49,634	-	96%	100%	87%
11	B 062	Dr.N.M Perera Mw	7	32	2,018	422	2,479	108	654	76,330	22,967	100,059	62%	58%	84%	99%
12	A 002	Galle Road	216	15	1,196	430	1,857	3,068	351	39,321	17,445	60,185	57%	67%	73%	74%
13	-	R.A.D Mel Mw	298	49	1,330	343	2,020	4,536	985	46,458	10,666	62,645	61%	57%	78%	57%
14	A 000	Dudley senanayake Mw	124	28	832	269	1,253	2,602	720	31,279	14,542	49,143	84%	73%	84%	98%
15	-	Bauddhaloka Mw	Route Bus was not operated													
16	B 062	Borella-Rajagiriya Road	72	30	2,812	366	3,280	1,602	678	98,060	19,744	120,084	89%	65%	77%	98%
17	A 000	Kollupitiya-Sri Jayewardenepura Road	Route Bus was not operated													
18	-	Baseline Road	1	-	871	12	884	13	-	37,908	552	38,473	52%	-	97%	84%
19		R.A.D Mel Mw	176	2	997	595	1,770	3,099	70	38,798	26,929	68,896	70%	100%	86%	82%
20	A 002	Galle Road	192	6	742	612	1,552	3,599	132	26,225	21,317	51,273	75%	63%	79%	63%
21	-	Kirimandala Mawatha	Route Bus was not operated													
22	B 307	Narahenpita - Nawala – Nugegoda Road	1	2	87	2	92	6	53	2,890	55	3,004	24%	76%	74%	50%
23	-	D.M Colombage Mawatha	Route Bus was not operated													
24	-	Baseline Road	-	-	115	2	117	-	-	6,538	152	6,690	-	-	126%	138%

Table 10.7.5 Passenger Volume (2)

No.	Road Class	Road Name	Number of Buses					Number of Passengers					Average Occupancy Rate			
			20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more	Total	20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more	Total	20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more
25	-	Kirulapone Road	Route Bus was not operated													
26	B 084	Colombo-Horana Road	79	43	724	298	1,144	1,741	1,116	30,505	18,818	52,180	88%	74%	94%	115%
27	A 004	High Level Road	7	14	2,182	183	2,386	69	281	80,168	7,069	87,587	39%	57%	82%	70%
28	A 002	Galle Road	373	47	2,212	861	3,493	7,877	1,293	82,627	42,287	134,084	84%	79%	83%	89%
29	A 001	Kandy Road	9	83	475	937	1,504	231	2,565	22,733	55,420	80,949	103%	88%	106%	108%
30	A 003	Puttalam Road	313	10	1,258	751	2,332	6,542	281	53,828	43,129	103,780	84%	80%	95%	104%
31	A 003	Puttalam Road	276	63	1,319	648	2,306	5,672	1,818	54,985	35,704	98,179	82%	82%	93%	100%
32	A 001	Kandy Road	63	125	938	680	1,806	1,318	4,085	41,982	41,155	88,540	84%	93%	99%	110%
33	A 001	Kandy Road	46	84	2,364	715	3,209	950	2,460	80,328	38,067	121,805	83%	84%	76%	97%
34	-	Kelanimulla Road	-	-	98	-	98	-	-	1,306	-	1,306	-	-	30%	-
35	-	New Kandy Road	3	8	460	57	528	51	212	19,889	3,721	23,873	68%	76%	96%	119%
36	B 240	Kotte – Bope Road	97	38	1,415	141	1,691	2,136	1,096	56,690	7,206	67,128	88%	82%	89%	93%
37	B 240	Kotte - Bope	27	40	1,809	23	1,899	557	1,279	77,278	1,141	80,255	83%	91%	95%	90%
38	B 240	Kotte - Bope	111	21	914	117	1,163	2,296	492	35,397	7,902	46,087	83%	67%	86%	123%
39	B 240	Kotte - Bope	2	1	492	58	553	38	35	18,053	4,699	22,825	76%	100%	82%	147%
40	B 084	Colombo -Horana Road	104	12	741	337	1,194	2,564	421	38,951	21,417	63,353	99%	100%	117%	116%
41	A 004	High Level Road	7	27	2,515	144	2,693	208	689	98,743	6,294	105,934	119%	73%	87%	79%
42	A 004	High Level Road	5	23	1,444	138	1,610	107	683	58,237	7,062	66,089	86%	85%	90%	93%
43	A 002	Galle Road	223	42	2,001	634	2,900	4,323	1,002	54,263	32,138	91,726	78%	68%	60%	92%
44	A 002	Galle Road	395	94	2,310	512	3,311	8,417	2,534	73,650	28,667	113,268	85%	77%	71%	102%
45	A 002	Galle Road	20	24	805	50	899	432	885	31,135	1,907	34,359	86%	105%	86%	69%
46	E 001	Southern Expressway	-	-	86	-	86	-	-	3,892	-	3,892	-	-	101%	-
47	B 216	Kesbewa - Kindelpitiya - Bandaragama Road	42	3	173	60	278	893	79	7,003	3,200	11,175	85%	75%	90%	97%
48	AB 11	New Galle Road	424	23	808	683	1,938	8,666	546	35,803	39,345	84,360	82%	68%	98%	105%

Table 10.7.6 Passenger Volume (3)

No.	Road Class	Road Name	Number of Buses					Number of Passengers					Average Occupancy Rate			
			20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more	Total	20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more	Total	20-29 Seats	30-39 Seats	40-49 Seats	50 Seats and more
1	A 004	High Level Road	Route Bus was not operated													
2	-	Marine Drive	Route Bus was not operated													
3	A 004	High Level Road	65	16	2,520	168	2,769	1,380	457	94,719	8,648	105,204	85%	82%	84%	94%
4	-	Marine drive	Route Bus was not operated													
5	-	Pugoda-Kosgama Road	1	6	57	-	64	19	167	1,526	-	1,712	76%	80%	59%	-
6	B 214	Kelaniya – Mudungoda Road	-	2	567	3	572	-	52	26,847	275	27,174	-	74%	105%	167%
7	-	Sedawatta-Ambatale Road	Route Bus was not operated													
8	B 435	Low level Road	6	15	515	461	997	132	361	20,289	21,083	41,865	88%	69%	88%	83%
9	B 214	Kelaniya - Mudungoda	-	-	428	29	457	-	-	15,448	1,614	17,062	-	-	80%	101%
10	AB 10	Low level Road	5	-	703	83	791	95	-	26,157	4,077	30,329	76%	-	83%	89%
11	B 146	Hanwella - Pugoda - Weke – Urapola Road	4	13	63	146	226	106	412	2,833	6,644	9,995	106%	91%	100%	83%
12	B 084	Horana Road	37	39	647	283	1,006	780	1,314	30,265	23,227	55,586	84%	96%	104%	149%
13	B 084	Horana Road	33	25	625	37	720	688	720	28,818	2,273	32,499	83%	82%	102%	112%
14	B 239	Kottawa – Talagala Road	1	3	281	1	286	50	36	7,158	14	7,258	200%	34%	57%	25%
15	B 084	Colombo-Horana Road	32	14	382	8	436	644	369	18,094	715	19,822	81%	75%	105%	163%
16	-	Palagama Road	-	-	4	-	4	-	-	56	-	56	-	-	31%	-
17	B 123	Galagedra-Horana Road	-	3	112	10	125	-	71	2,893	372	3,336	-	68%	57%	68%
18	B 285	Meepe-Ingiriya Road	-	-	134	1	135	-	-	4,826	83	4,909	-	-	80%	151%
19	-	Menerigama Road	-	16	14	-	30	-	302	385	-	687	-	54%	61%	-

CHAPTER 11 Truck OD Interview Survey

11.1 Objective

The main objective of the Truck OD Interview Survey was to understand the current trip information of freight vehicles regarding their origin and destination, such as export processing zones (EPZs), industrial estates (IEs), ports, and container terminals. The data obtained was used for the travel demand forecast of freight transport.

11.2 Types of the Survey

Under the Truck OD Interview Survey, the following 2 surveys were conducted:

- Traffic Count Survey of Trucks and Freight Vehicles
- Truck OD Interview Survey with Drivers

11.3 Survey Locations

The survey was conducted at 20 major facilities pertaining to freight transport as shown in the Table below. Among those facilities, the survey was conducted at 7 EPZs, 6 IEs, a port and 6 container terminals for 24 hours.

Totally 20 major facilities pertaining to freight transport were surveyed

- 7 EPZs
- 8 IEs
- 1 Port
- 4 Container terminals

Table 11.3.1 Survey Locations

Facility Type	No	Name of Facility	Location	Survey Date
EPZs	1	Katunayake EPZ	Katunayake	30-Apr-2013
	2	Biyagama EPZ	Biyagama	2-May-2013
	3	Horana EPZ	Horana	24-Apr-2013
	4	Mirigama EPZ	Mirigama	30-Apr-2013
	5	Wathupitiwala EPZ	Wathupitiwala	7-May-2013
	6	Seethawake EPZ	Seethawake	7-May-2013
	7	Malwatta EPZ	Malwatta	2-May-2013
IEs	8	Minuwangoda IE	Minuwangoda	2-May-2013
	9	Mahara IE	Mahara	2-May-2013
	10	Kolonnawa IE	Kolonnawa	7-May-2013
	11	Templeberg IE	Templeberg	7-May-2013
	12	Ratmalana IE	Ratmalana	24-Apr-2013
	13	Kaluthara IE	Kaluthara	30-Apr-2013
Port	14	Port of Colombo	Colombo	23-Apr-2013
Container Terminals	15	Ceylon Shipping Lines Ltd	Wellampitiya	9-May-2013
	16	Green Lanka CFS Terminal (Pvt) Ltd	Kelaniya	9-May-2013
	17	McLarens Containers (Pvt) Limited	Welisara	9-May-2013
	18	Mega Containers (Pvt) Ltd	Welisara	21-May-2013
	19	ABC Containers (Pvt) Ltd	Wellampitiya	23-May-2013
	20	Repcon Container Deport (Pvt) Ltd	Kelaniya	23-May-2013

11.4 Preparations for the Survey

The following preparations for the survey were conducted prior to the implementation of the field survey

(1) Selection of Survey Sites

Prior to the survey implementation, each site was visited in order to ensure interview space and the safety of the surveyors. Night time condition was also checked for preparing a generator and lights.

(2) Recruitment of Survey Personnel

Under the survey, Transport Engineers in the field of transport engineering, supervisors who have experience in transport surveys and surveyors from personnel who have GCE qualifications (ordinary level), were recruited to obtain accurate survey results.

(3) Preparation of Survey Forms

The following survey forms were used. Original survey forms are attached as an appendix.

- Form 1: Traffic Count Survey of Trucks and Freight Vehicles

- Form 2: Interview Form for Truck OD Interview Survey with Drivers

(4) Permission and ID card

It was necessary to obtain official permission for conducting the field survey prior to starting the field survey. Specifically from the Ministry of Industry and Commerce (MOIC), Board of Investment (BOI), Port Authority of Sri Lanka and each facility management were visited prior to survey implementation based on the ownership of each facility. In addition, ID cards for the officials were prepared and carried every time the survey was conducted.

(5) Training of Survey personnel

Prior to survey implementation, training of survey personnel was carried out. The detailed description of the survey process, explanation of survey forms, identification for the types of vehicles and safety consideration were instructed by the training.

11.5 Field Survey

11.5.1 Traffic Count Survey of Trucks and Freight Vehicles

(1) Survey Period

The survey was conducted on one weekday (Tuesday, Wednesday or Thursday) for 24 hours (7:00AM to 7:00AM of the following day).

(2) Methodology

The survey was conducted for both directions and the surveyors continuously counted the number of vehicles by hour-band by type of vehicle by direction using manual traffic counters or tally marks. The surveyors recorded the number of vehicles on the survey sheet every hour.

(3) Types of Vehicles

The types of vehicles for the Traffic Count Survey of Trucks and Freight Vehicles are grouped into the following 11 categories. Among these types of vehicles, Types 5 -11 are being grouped only for container trailers:

Type 1	Delivery Van	
Type 2	Pick-up (Single/ Double Cab)	
Type 3	Medium Truck (2 axels)	
Type 4	Large Truck (3 axels or more)	
Type 5	Container	Empty 20 ft. flat bed
Type 6		Empty 40 ft. flat bed
Type 7		20 ft. Container
Type 8		2 ×20 ft. Containers
Type 9		40 ft. Container
Type 10		45 ft. Container
Type 11	Others	

11.5.2 Truck OD Interview Survey with Drivers

(1) Survey Period

The survey was conducted on one weekday (Tuesday, Wednesday or Thursday) from 12th February to 7th March and for 16 hours (6:00 AM to 10:00 PM).

(2) Methodology

The surveyors interviewed the drivers at all entry and exit gates of each facility. The sample vehicles were selected by a random sampling method.

(3) Classification of Survey Items

The following information was obtained from the drivers:

Table 11.5.1 Classification of Survey Items

SQN	Survey Items	Classifications
1	Number of Passengers including Driver	-
2	Address of Origin and Destination	-
3	Facility Type of Origin and Destination	- Port of Colombo - Other Port - Manufacturing Factory - Warehouse/ hardware - Super market/ Market/ Shop - Others
4	Name of Weight Terminal	-
5	Travel Time	-
6	Commodity Type	-
7	Loading Rate (Volume)	- Empty - 25% - 50% - 75% - 100% - 125 % - 150% and more
8	Loading Capacity (Tons)	-
9	Company Information	- Company Name - Telephone number (optional)

(4) Sampling Rate

The result of the Traffic Count Survey of Trucks and Freight Vehicles and Truck OD Interview Survey with Drivers by survey location are shown in the Table below. Total truck and container volumes for 24 hours were 5,126 trucks and 6,523 containers and the number of valid interviewed samples was 2,883 trucks and 3,911 containers at 20 survey locations. The average sampling ratios were approximately 56 percent for trucks and 60 percent for containers.

Table 11.5.2 Sampling Rate by Survey Location

Facility Type	No	Name of Facility	Number of Freight Vehicles		Number of Valid Ineterviewed samples		Number of Valid Ineterviewed samples	
			Truck	Container	Truck	Container	Truck	Container
EPZs	1	Katunayake EPZ	741	95	439	82	59%	86%
	2	Biyagama EPZ	573	65	302	57	53%	88%
	3	Horana EPZ	250	114	195	114	78%	100%
	4	Mirigama EPZ	127	11	89	7	70%	64%
	5	Wathupitiwala EPZ	187	24	145	23	78%	96%
	6	Seethawake EPZ	544	87	361	58	66%	67%
	7	Malwatta EPZ	39	-	39	-	100%	-
IEs	8	Minuwangoda IE	28	7	16	5	57%	71%
	9	Mahara IE	22	4	19	3	86%	75%
	10	Kolonnawa IE	40	-	38	-	95%	-
	11	Templeberg IE	157	25	157	18	100%	72%
	12	Ratmalana IE	173	31	133	4	77%	13%
	13	Kaluthara IE	105	4	35	3	33%	75%
Port	14	Port of Colombo	1,947	3,416	844	2,067	43%	61%
Container Terminals	15	Ceylon Shipping Lines Ltd	57	1,044	52	642	91%	61%
	16	Green Lanka CFS Terminal (Pvt) Ltd	44	641	3	272	7%	42%
	17	McLarens Containers (Pvt) Limited	15	375	4	60	27%	16%
	18	Mega Containers (Pvt) Ltd	12	145	12	141	100%	97%
	19	ABC Containers (Pvt) Ltd	65	306	-	235	0%	77%
	20	Repcon Container Deport (Pvt) Ltd	-	129	-	120	-	93%
Total			5,126	6,523	2,883	3,911	56%	60%

11.6 Data Processing

(1) Zone Coding

After the completion of the field survey, zone coding for Origin and Destination was carried out on the original survey forms based on the zone system of the Home Visit Survey.

(2) Data Input and Error Checking

After the data input, range error and logical error were checked. If a critical error was observed, the data was excluded from the valid samples.

(3) Estimation of Expansion Factor for OD Table

The expansion factor was calculated based on the comparison of the total number of interviewed samples and the number of vehicles. Estimated expansion factors are summarised in the table below.

Table 11.6.1 Expansion Factor by Type of Vehicle

Facility Type	No	Name of Facility	Expansion Factor			
			Truck		Container	
			IN	OUT	IN	OUT
EPZs	1	Katunayake EPZ	2.2	1.3	1.2	1.1
	2	Biyagama EPZ	1.9	2.0	1.0	1.3
	3	Horana EPZ	1.3	1.2	0.9	1.0
	4	Mirigama EPZ	1.4	1.4	3.5	0.8
	5	Wathupitiwala EPZ	1.2	1.4	1.0	1.1
	6	Seethawake EPZ	1.6	1.4	1.7	1.3
	7	Malwatta EPZ	1.1	1.0	-	-
IEs	8	Minuwangoda IE	1.9	1.7	2.0	1.0
	9	Mahara IE	1.1	1.2	2.0	1.0
	10	Kolonnawa IE	1.2	0.9	-	-
	11	Templeberg IE	0.6	1.5	1.4	1.3
	12	Ratmalana IE	1.4	1.2	16.0	5.0
	13	Kaluthara IE	1.6	52.0	1.0	*1
Port	14	Port of Colombo	3.4	1.7	1.3	2.0
Container Terminals	15	Ceylon Shipping Lines Ltd	0.6	3.7	1.3	2.0
	16	Green Lanka CFS Terminal (Pvt) Ltd	11.0	22.0	5.8	1.5
	17	McLarens Containers (Pvt) Limited	*1	1.5	10.3	4.6
	18	Mega Containers (Pvt) Ltd	2.0	0.8	1.0	1.1
	19	ABC Containers (Pvt) Ltd	-	-	3.1	0.8
	20	Repcon Container Deport (Pvt) Ltd	-	-	1.1	1.0

*Expansion factors of Truck and Container were integrated due to lack of interviewed samples.

11.7 Survey Results and Major Findings

(1) Traffic Volume

The results of the Traffic Count Survey of Trucks and Freight Vehicles are summarised as shown in the Table below.

Table 11.7.1 Traffic Volume

Facility Type	No	Name of Facility	Delivery Van/ Pickup			Truck			Flat Bed			Container			All Vehicle		
			IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
EPZs	1	Katunayake EPZ	843	818	1,661	395	346	741	6	8	14	39	42	81	1,283	1,214	2,497
	2	Biyagama EPZ	1,077	536	1,613	323	250	573	1	4	5	29	31	60	1,430	821	2,251
	3	Horana EPZ	90	68	158	177	73	250	11	14	25	37	52	89	315	207	522
	4	Mirigama EPZ	114	146	260	60	67	127	1	-	1	6	4	10	181	217	398
	5	Wathupitiwala EPZ	274	231	505	83	104	187	1	3	4	14	6	20	372	344	716
	6	Seethawake EPZ	768	785	1,553	289	255	544	11	1	12	32	43	75	1,100	1,084	2,184
	7	Malwatta EPZ	72	79	151	20	19	39	-	-	-	-	-	-	92	98	190
IEs	8	Minuwangoda IE	14	10	24	13	15	28	-	-	-	4	3	7	31	28	59
	9	Mahara IE	32	33	65	10	12	22	-	-	-	2	2	4	44	47	91
	10	Kolonnawa IE	33	13	46	22	18	40	-	-	-	-	-	-	55	31	86
	11	Templeberg IE	35	44	79	52	105	157	1	6	7	12	6	18	100	161	261
	12	Ratmalana IE	91	69	160	87	86	173	13	11	24	3	4	7	194	170	364
	13	Kaluthara IE	20	8	28	54	51	105	2	-	2	1	1	2	77	60	137
Port	14	Port of Colombo	201	614	815	1,063	884	1,947	938	238	1,176	580	1,660	2,240	2,782	3,396	6,178
Container Terminals	15	Ceylon Shipping Lines Ltd	6	1	7	24	33	57	69	280	349	438	257	695	537	571	1,108
	16	Green Lanka CFS Terminal (Pvt) Ltd	-	-	-	22	22	44	147	128	275	160	206	366	329	356	685
	17	McLarens Containers (Pvt) Limited	9	7	16	9	6	15	59	132	191	127	57	184	204	202	406
	18	Mega Containers (Pvt) Ltd	-	-	-	4	8	12	20	41	61	55	29	84	79	78	157
	19	ABC Containers (Pvt) Ltd	-	-	-	4	61	65	9	96	105	156	45	201	169	202	371
	20	Repcon Container Deport (Pvt) Ltd	-	-	-	-	-	-	28	30	58	39	32	71	67	62	129

(2) Trip Production (Port of Colombo)

The trip production compositions by vehicle type are shown in Figure below, the component of truck trip production was 27% for Colombo District including CMC, followed by Puttalam District and Gampaha District, rates are about 26% and 24%, respectively. It is noted that 64% of the container vehicles came from Gampaha District.

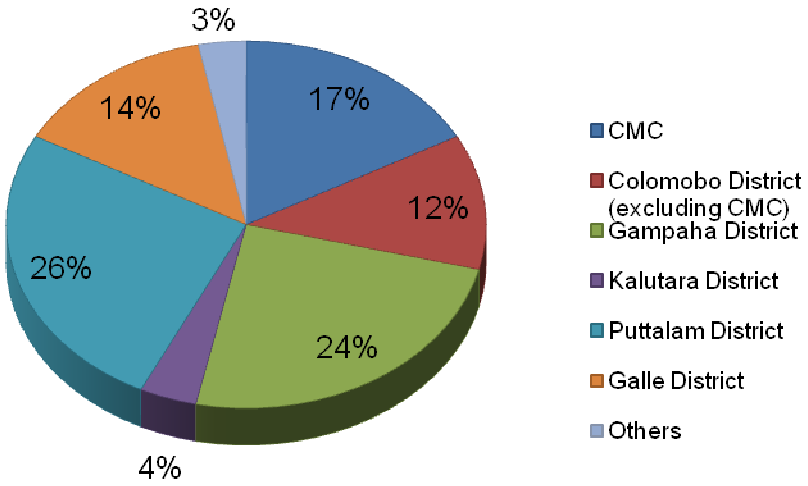


Figure 11.7.1 Trip Production of Trucks

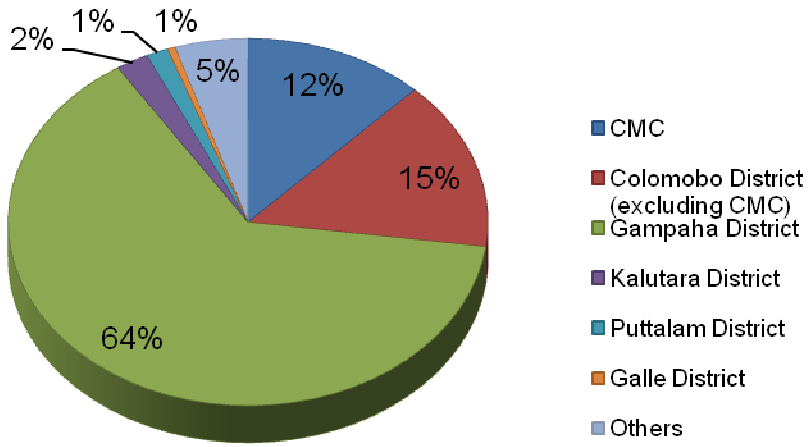


Figure 11.7.2 Trip Production of Containers

(3) Trip Attraction (Port of Colombo)

The trip attraction compositions by vehicle type are shown in the Figure below. The component of container trip attraction was 28% for Puttalam District, followed by Colombo District including CMC and Gampaha District, rates are about 27% and 21%, respectively. It is noted that 76% of the containers came from Gampaha District and Colombo District excluding CMC.

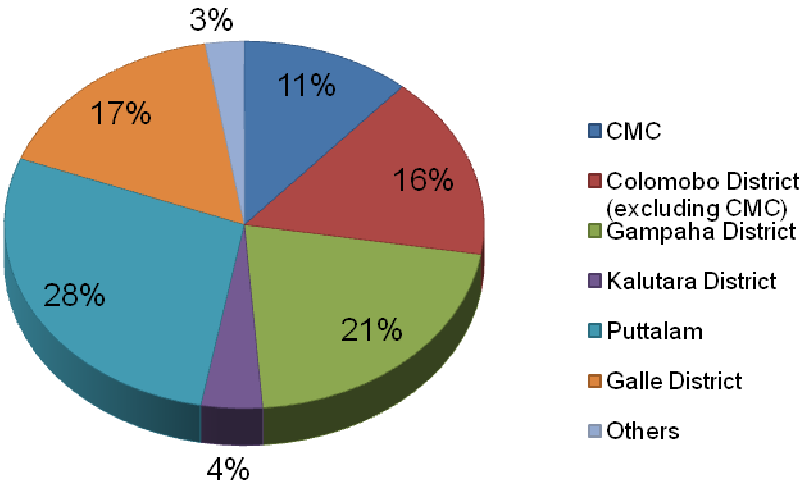


Figure 11.7.3 Trip Attraction of Trucks

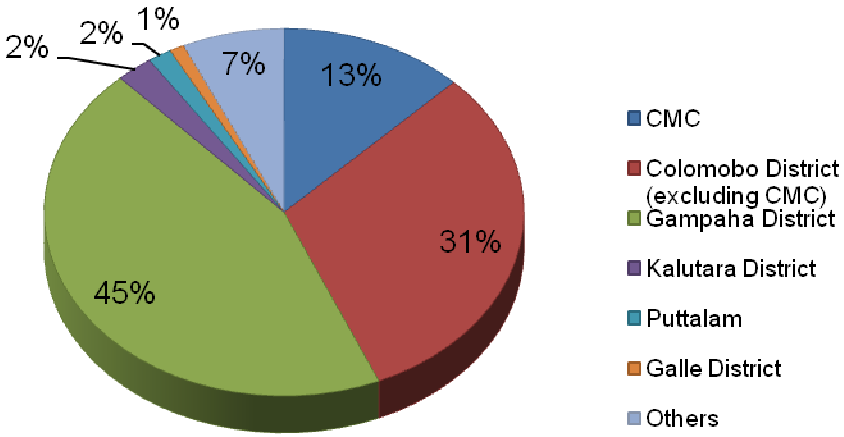


Figure 11.7.4 Trip Attraction of Containers

(4) Hourly Fluctuation

Hourly fluctuations of freight vehicles (delivery van, pickup, truck, flat bed and container) by facility type by direction are shown in the Figures below. The Port of Colombo and container terminals were operated during the night time, however, traffic volumes of freight vehicles were not high compared with day time traffic volume.

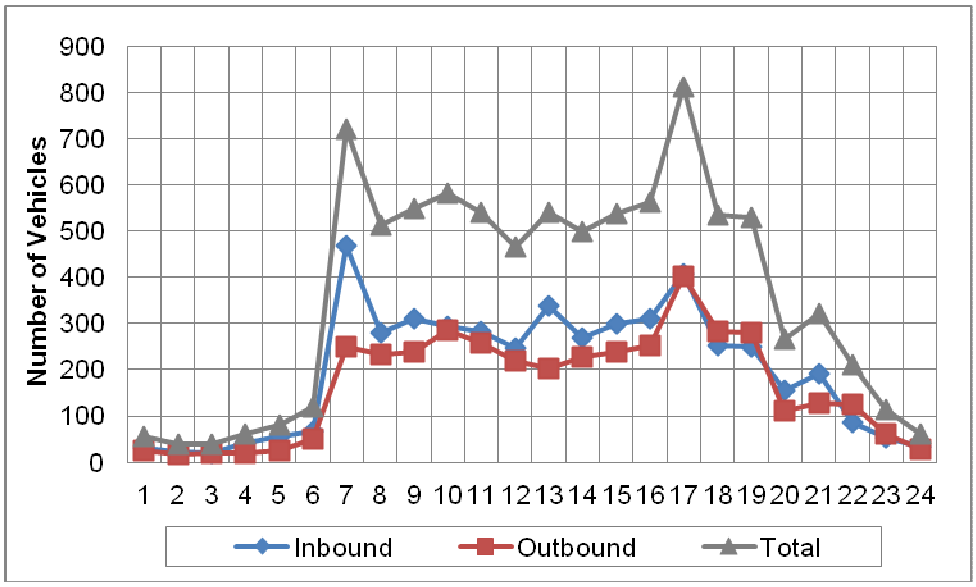


Figure 11.7.5 Hourly Traffic Fluctuation (EPZs)

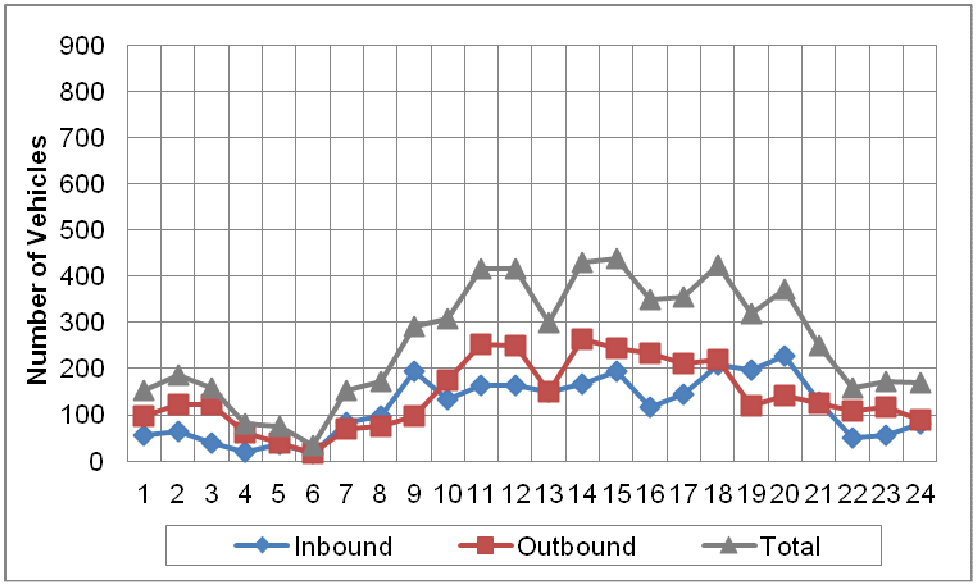


Figure 11.7.6 Hourly Traffic Fluctuation (Port of Colombo)

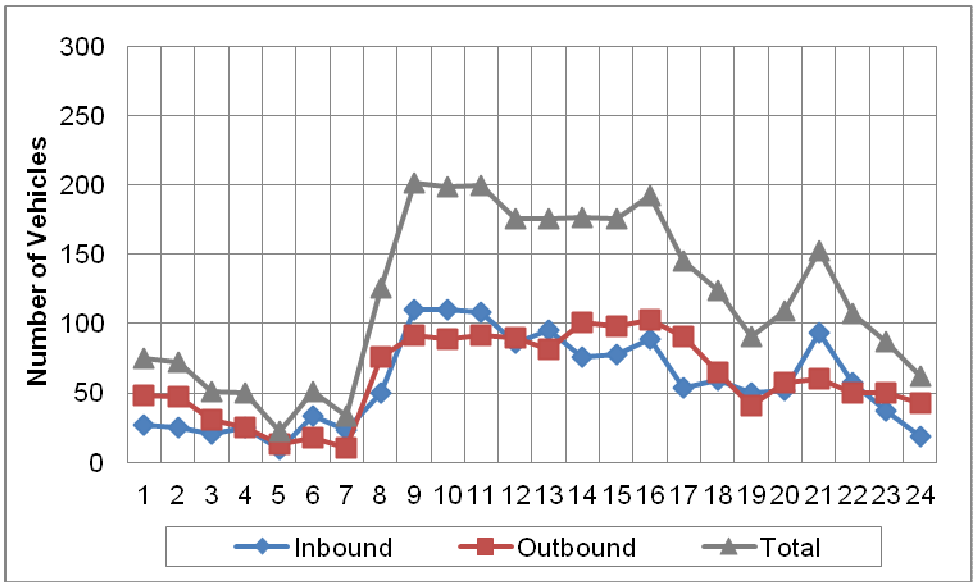


Figure 11.7.7 Hourly Traffic Fluctuation (Container Terminals)

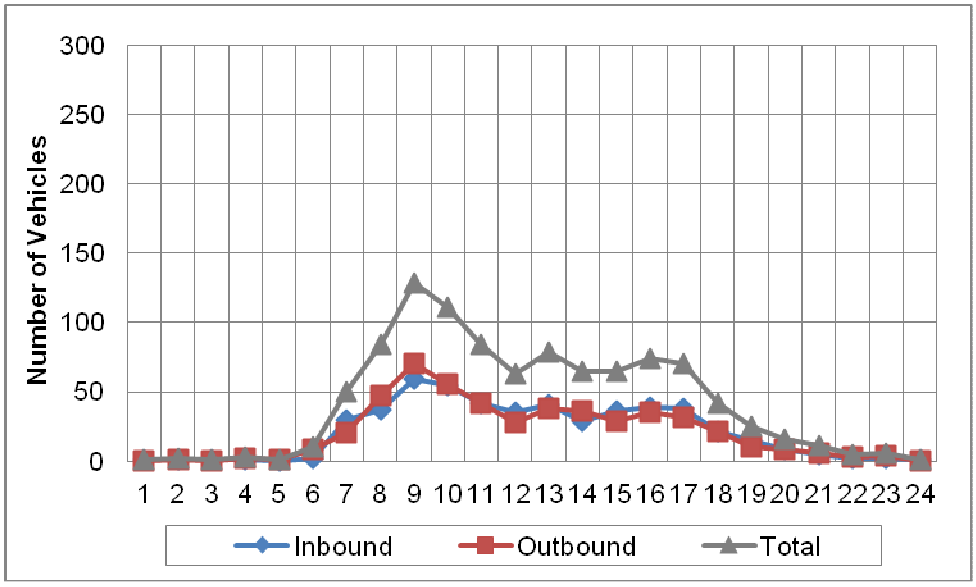


Figure 11.7.8 Hourly Traffic Fluctuation (IEs)

CHAPTER 12 Trip Generation Survey

12.1 Objective

The main objective of the survey was to obtain trip generation rates per unit area, per employee and so on for the selected facility types. The trip rates will be used for the travel demand forecast, especially for Non-Home-Based trips, which were not fully captured in the Home Visit Survey.

12.2 Types of Surveys

Under the Trip Generation Survey, the following 5 surveys were conducted:

- Facility Inventory Survey
- Interview Survey with Business Establishment
- Classified Vehicle Count Survey
- Person Count Survey
- Interview Survey with Facility Users

12.3 Survey Days and Locations

The Trip Generation Survey was conducted at 30 locations. Among those locations, the survey was conducted in the following buildings.

- 10 Government office buildings
- 10 Private office buildings
- 10 in total at Shopping malls, supermarkets and Traditional markets

Table 12.3.1 Survey Locations

Facility Type	No	Name of Facility	Location	Survey Date
Government Office Building	1	Ministry of Transport	Colombo 10	28-May-2013
	2	Ceylon Petroleum Corporation	Sapugaskanda	2-May-2013
	3	Immigration & Emigration	Colombo 08	24-Apr-2013
	4	National Development Bank Building	Colombo 02	28-May-2013
	5	Suwasiripaya	Colombo 10	9-May-2013
	6	Colombo Municipal Council	Colombo 07	30-Apr-2013
	7	Department of Motor Traffic	Werahera, Boralesgamuwa	2-May-2013
	8	Department of Registration of Persons	Colombo 07	14-May-2013
	9	Sethsiripaya	Battaramulla	16-May-2013
	10	Foreign Employment Bureau	Battaramulla	9-May-2013
Private Office Building	1	Ceylon Tobacco Company	Colombo 15	23-Apr-2013
	2	Unilever	Colombo 14	7-May-2013
	3	Orion City IT Park	Colombo 09	30-May-2013
	4	Coca Cola Beverages	Biyagama	14-May-2013
	5	John Keels Head Office	Colombo 02	9-Apr-2013
	6	Dialog Axiata	Colombo 02	10-Apr-2013
	7	Nestlé Lanka	Colombo 10	10-Apr-2013
	8	Sampath Bank Head Office	Colombo 02	23-Apr-2013
	9	Access Tower	Colombo 02	9-Apr-2013
	10	Aitken Spence Tower	Colombo 02	10-Apr-2013
Shopping Malls, Supermarkets and Traditional Market	1	Cool Planet	Nugegoda	22-May-2013
	2	Crescat Boulevard	Colombo 03	15-May-2013
	3	People's Park	Colombo 11	14-May-2013
	4	Arpico Super Centre	Colombo 02	8-May-2013
	5	Odel	Colombo 07	22-May-2013
	6	Colpity Central Market	Colombo 03	14-May-2013
	7	Liberty Plaza	Colombo 03	7-May-2013
	8	Majestic City	Colombo 04	15-May-2013
	9	Unity Plaza	Colombo 04	15-May-2013
	10	Lady J Family Supermarket	Colombo 08	22-May-2013

12.4 Preparation for the Survey

The following preparations for the survey were conducted prior to the implementation of the field survey

(1) Selection of Survey Sites

Prior to the survey implementation, each site was visited in order to ensure interview space to avoid obstructing visitors and employees.

(2) Recruitment of Survey Personnel

Under the survey, Transport Engineers in the field of transport engineering, supervisors who have experience in transport surveys and surveyors from personnel who have GCE qualifications (ordinary level), were recruited to obtain reliable survey results.

(3) Preparation of Survey Forms

The following survey forms were used for the Survey:

- Form 1: Survey Form for the Facility Inventory Survey
- Form 2: Survey Form for the Facility Inventory Survey
- Form 3: Survey Form for the Classified Vehicle Count Survey
- Form 4: Survey Form for the Person Count Survey
- Form 5-1: Interview Form for Employees
- Form 5-2: Interview Form for Visitors

(4) Permission and ID card

It was necessary to obtain official permission for conducting the field survey prior to starting the field survey. Specifically from; the Road Development Authority (RDA), Urban Development Authority (UDA), Ministry of Ports and Highways and each facility management were visited prior to survey implementation based on the ownership of each facility, and ID cards were prepared prior to the survey implementation. The ID cards of the officials/ surveyors were shown every time a survey was conducted.

(5) Training of Survey personnel

Prior to survey implementation, training of survey personnel was carried out. The detailed description of the survey process, explanation of survey forms, identification for type of vehicles and safety considerations were instructed by the training.

12.5 Field Survey

12.5.1 Facility Inventory Survey

The following items were surveyed by direct interviews with facility management to obtain information regarding the facility inventory for each facility.

Table 12.5.1 Survey Items

SQN		Survey Items
1	Building	Name of Building and Companies
2		Layout Maps
3		Net/Gross Floor Areas of Building by Type of use
4		Net and Gross Floor Areas
5		Average Number of Daily Visitors
6	Parking	Type of Parking Lots
7		Parking Capacity by Type of Vehicle
8		Parking Charge System
9		Layout Maps

12.5.2 Interview Survey with Business Establishment

The following items were surveyed by direct interviews with the management of the business establishments in the facilities to obtain general information of each business establishment.

Table 12.5.2 Survey Items

SQN	Survey Items
1	Type of Industry
2	Business Hours (Start – End)
3	Number of Employees by Position Classification
4	Amount of Allowance for Commuting and Payment Method
5	Provision of Parking Lot by Position
6	Parking Cost

12.5.3 Classified Vehicle Count Survey

The surveyors continuously counted the number of vehicles and recorded the number plate coming into and going out of the parking lot during business hours and an additional 1 or 2 hours to capture major vehicle movement of each facility. The types of vehicles for the survey were grouped into the following 11 categories:

Type 1	Motorcycle
Type 2	Three Wheeler
Type 3	Car, Jeep
Type 4	Passenger Van
Type 5	Pick-up (Single/ Double Cab)
Type 6	Medium Truck (2 axels)
Type 7	Large Truck (3 axels and more)
Type 8	Container Trailer
Type 9	Minibus (29 seats and below)
Type 10	Bus
Type 11	Others

12.5.4 Person Count Survey

The surveyors continuously counted the number of persons by employees and visitors coming into and going out at all the entrance gates of the facilities (except people who take out garbage, who take a smoke break, and so on). In order to identify the visitors and employees. The following ideas were adopted at the survey locations.

- Visitor: The visitors were identified at the security check at the entry gates, and it was determined whether the person had a visitor card for entering the building.
- Employee: The Employees were identified when the person used an employee's card for entering the building.

12.5.5 Interview Survey with Facility Users

(1) Methodology

Initially, the survey was conducted by a drop and collect method for employees and a direct interview method was used during the business hours of each facility at visitor pass gates, lobbies and the designated visitor's area of each facility. However, if the necessary sample rates for analysing were not collected by the drop and collect method, then survey method was changed and a direct interview method with employees was used.

The following information was obtained from the facility users.

Table 12.5.3 Classification of Survey Items

SQN		Survey Items	Classifications
1	Common Question	Status	- Visitors - Employees-
2		Gender	-
3		Age	-
4		Address of Origin and Destination	-
5		Facility Type of Origin and Destination	- Home - Work Place - School - Others
6		Mode of Transport	- On foot only - Bicycle - Motor Bike - Three Wheeler - Car, Jeep - Passenger Van - Minibus - Bus - Train - Taxi - Pickup - Truck - Large Truck - Others
7		Trip Purpose	- To Work - To School - Shopping - Business - Private Matters - Others
8		Departure, Arrival and Travel Time	-
9		Travel Cost	-
10		Transfer Point	-
11		Frequency of using the facility	-
A-1	Additional Questions (For vehicle users)	Number of accompanying people	-
A-2		Parking Time	-
A-3		Parking Charge System	- Monthly - Daily - Hourly - Others
A-4		Parking Cost	
A-5		Type of Parking	- Parking at this building - On street - Others

(2) Sampling Rate

The total number of facility users was 114,746 for the inbound direction and 103,964 for the outbound direction and the number of valid interviewed samples was 4,654 for employees and 9,846 for visitors at 30 survey locations. The sampling rate of each facility is shown in the Table below.

Table 12.5.4 Sampling Rate by Survey Location

SQN	Facility Name	Employee			Visitor			Total		Samples		Sampling Rate (%)	
		Inbound	Outbound	Total	Inbound	Outbound	Total	Inbound	Outbound	Employee	Visitor	Employee	Visitor
		A	B	C(A+B)	D	E	F(D+E)	A+D	B+E	G	H	G/(C/2)	H/(F/2)
1	Ministry of transport	908	1,030	1,938	73	77	150	981	1,107	83	15	9%	20%
2	Ceypetco	1,559	1,637	3,196	988	1,043	2,031	2,547	2,680	161	169	10%	17%
3	Dept. of Immigration	454	507	961	6,863	7,102	13,965	7,317	7,609	96	562	20%	8%
4	NDB	1,278	1,080	2,358	603	450	1,053	1,881	1,530	113	77	10%	15%
5	Suwasiripaya	2,525	1,657	4,182	282	350	632	2,807	2,007	265	116	13%	37%
6	Colombo Municiple Council	1,198	1,046	2,244	1,387	1,683	3,070	2,585	2,729	154	108	14%	7%
7	Dept. of Motor Traffic	1,019	742	1,761	9,168	9,385	18,553	10,187	10,127	35	452	4%	5%
8	Dep. Of Regis. Per.	321	277	598	1,736	1,882	3,618	2,057	2,159	128	441	43%	24%
9	Sethsiripaya	4,900	3,507	8,407	1,692	1,965	3,657	6,592	5,472	1,240	653	29%	36%
10	Foreign Employeement	756	579	1,335	1,745	1,568	3,313	2,501	2,147	114	376	17%	23%
11	Ceylon Tobacco	410	193	603	180	177	357	590	370	*2	44	*2	25%
12	Unilever	1,064	1,013	2,077	231	222	453	1,295	1,235	80	39	8%	17%
13	Orion city	3,399	2,304	5,703	1,320	640	1,960	4,719	2,944	358	189	13%	19%
14	Coca cola	453	326	779	82	111	193	535	437	140	91	36%	94%
15	Jhon Keels	461	339	800	279	214	493	740	553	113	108	28%	44%
16	Dialog	82	76	158	603	564	1,167	685	640	6	117	8%	20%
17	Nestle	913	696	1,609	112	106	218	1,025	802	67	50	8%	46%
18	Sampath bank	1,268	1,226	2,494	1,598	1,351	2,949	2,866	2,577	112	117	9%	8%
19	Access Tower	967	776	1,743	581	601	1,182	1,548	1,377	110	185	13%	31%
20	Aitken Spence	3,602	3,291	6,893	406	371	777	4,008	3,662	281	101	8%	26%
21	Cool planet	65	43	108	1,132	1,232	2,364	1,197	1,275	35	448	65%	38%
22	Crescat	468	538	1,006	4,162	4,247	8,409	4,630	4,785	93	554	18%	13%
23	People's park			*1	15,062	12,742	27,804	15,062	12,742	194	1,062		*1
24	Arpico super centre	1,293	1,033	2,326	5,409	4,334	9,743	6,702	5,367	84	605	7%	12%
25	ODEL	457	152	609	3,725	3,560	7,285	4,182	3,712	50	200	16%	5%
26	Colpetty market	331	400	731	2,067	1,867	3,934	2,398	2,267	39	308	11%	16%
27	Liberty Plaza	2,248	1,898	4,146	3,942	3,876	7,818	6,190	5,774	111	479	5%	12%
28	Majectic city	594	531	1,125	10,056	9,018	19,074	10,650	9,549	147	859	26%	9%
29	Unity plaza	426	590	1,016	2,418	1,471	3,889	2,844	2,061	193	674	38%	35%
30	Lady J	126	3	129	3,299	4,265	7,564	3,425	4,268	52	647	81%	17%
Total		-	-	-	-	-	-	114,746	103,964	4,654	9,846	-	-

*1: The inbound and outbound movements of employees were included in the visitor count results.
*2: The interview survey with employees was not permitted by facility management.

12.6 Data Processing

(1) Zone Coding

After the completion of field survey, zone coding for Origin and Destination was carried out on the original survey forms based on the zone system of the Home Visit Survey.

(2) Data Input and Error Checking

After the data were input, range error and logical error were checked. If a critical error was observed, the data was excluded from the valid samples.

12.7 Survey Results

(1) Trip Rates by Number of Employees

Number of trips by facility type is shown in the Table below. Shopping malls, supermarkets and traditional markets had the largest trip rate, followed by private office and government office, trip rates are about 3.95, 3.23 and 2.43 per day, respectively.

Table 12.7.1 Average Trips Rates by Number of Registered Employees

Facility Type	Number of Trips by Employees (All Purpose)			Number of employees	Average Trip Rate
	Inbound	Outbound	Total		
	A	B	C(A+B)	D	E(C/D)
Government Office Building	14,918	12,062	26,980	11,121	2.43
Private Office Building	12,619	10,240	22,859	7,084	3.23
Shopping Malls, Supermarkets and Traditional Market	6,008	5,188	11,196	2,834	3.95

Note: survey location no.23 was excluded

(2) Trip Rates by Gross Floor Area

Number of trips by gross floor area is shown in the Table below. Shopping malls, supermarkets and traditional markets had the largest trip rate, followed by government office and private office. Trip rates are about 0.171, 0.162 and 0.155 per day, respectively.

Table 12.7.2 Average Trip Rates by Gross Floor Area

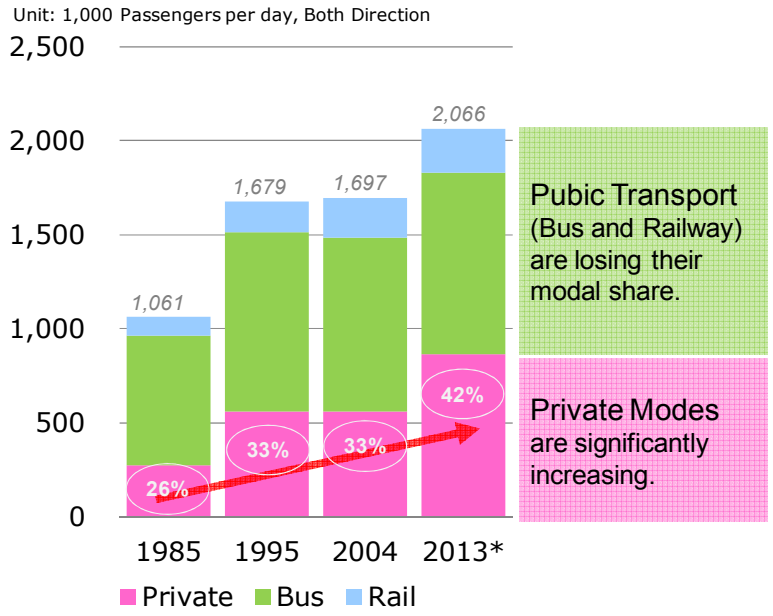
Facility Type	Number of Trips by Employees (All Purpose)			Gross Floor Area (m2)	Average Trip Rate
	Inbound	Outbound	Total		
	A	B	C(A+B)	D	E(C/D)
Government Office Building	14,918	12,062	26,980	166,695	0.162
Private Office Building	12,619	10,240	22,859	147,290	0.155
Shopping Malls, Supermarkets and Traditional Market	6,008	5,188	11,196	65,520	0.171

Note: survey location no.23 was excluded

CHAPTER 13 Transport Demand along Major Transport Corridors

13.1 Historical Trend of Number of Passengers Crossing CMC Boundary

The number of passengers crossing the boundary of the Colombo Municipal Council (CMC) was historically considered as one of the key indices to understand the traffic condition of CMA. Figure 13.1.1 depicts the number of passengers by mode by major survey period. Although the growth from 1995 to 2004 was limited, this might have been affected by the traffic restriction during the Conflict. Except for this, the figure shows a clear trend of increase in the number of passengers, especially in private modes of transport.



* Total passengers at CMC boundary at all survey location was 2.1 million passengers per day (both directions). For comparison purposes, survey locations surveyed in '85, '95 and '04 were selected.

Source: 1985 and 1995, Road Development Authority (RDA) and the University of Moratuwa; 2004, University of Moratuwa; 2013, and CoMTrans Study Team

Figure 13.1.1 Passenger Flow at CMC Boundary

The preliminary estimation of total daily passengers entering and exiting the CMC using 15 corridors (which are made up of 15 roads and 3 railway lines, some corridors were made up of both a road and railway line) along the boundary are shown in Table 13.1.1. The number of railway passengers was adopted from the estimation of the University of Moratuwa for railway passengers in 2009. Bus passenger numbers are calculated using data from the CoMTrans Screen Line Survey. To estimate the passengers in private modes, vehicle occupancy was calculated using data from the Road Side OD Interview Survey 2011 conducted by RDA.

It is estimated that around 2.1 million passengers are crossing the CMC boundary in both

directions daily in which private modes, buses, and railways account for 48%, 45%, and 7% respectively. The busiest corridor is the Colombo – Kandy corridor (i.e. Colombo – Kandy road and railway Main Line) where private mode and bus carry over 400 thousand passengers (or 19% of total crossing passengers). Railway carries over 85,000 passengers on the Main Line (section between Fort station and Ragama station) making up 13% of the combination of Kandy and Negombo corridors. The next busiest corridor is the Colombo – Galle corridor through which 15% of the total passengers enter and exit the CMC every day. The Coast Line railway also carries over 40 thousand passengers, equivalent to 15% of the corridor passengers.

The buses play an important role in passenger transport as they carry over 230,000 passengers on the Kandy Road and over 100,000 passengers on the four other corridors. Several corridors are seen not to have proper bus services as yet.

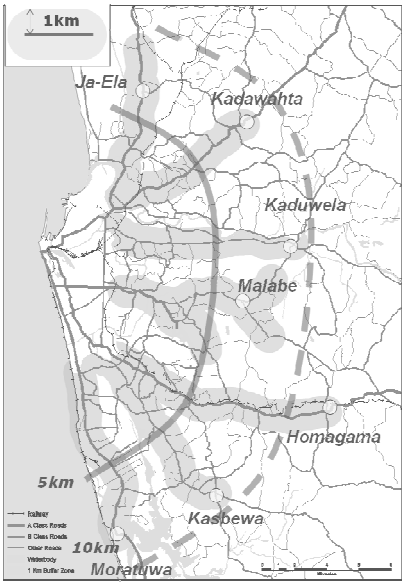
Table 13.1.1 Daily Passengers Crossing the CMC Boundary in Both Directions in 2013

Corridors / Railway Line	Daily Passengers by Mode of Transport						
	Private		Bus		Rail		Total
New Negombo Road	53,601	79%	14,591	21%			8,191
Colombo - Negombo Road	80,479	12%	105,434	15%	85,547	13 %	683,551
Colombo - Kandy Road / Main Line	179,819	26%	232,272	34%			
Sedawatta - Ambatale Road	36,425	98%	821	2%			37,246
Orugodawatta - Ambata Road	45,905	46%	53,901	54%			99,807
Dematagoda - Wellampititya Road	66,676	59%	46,159	41%			112,835
Borella - Rajagiriya Road	42,392	22%	147,035	78%			189,428
Kollupitiya - Sri Jayawardenepura Road	149,670	94%	9,638	6%			159,308
Kirimandala Mawatha	46,537	97%	1,216	3%			47,753
Nawala - Narahenpita - Nugegoda Road	55,788	85%	10,071	15%			65,859
D.M. Colombage Mawatha	21,321	99%	291	1%			21,612
Kirulapone Road	36,547	96%	1,396	4%			37,944
Colombo - Horana Road	64,353	50%	65,540	50%			129,892
Colombo - Ratnapura Road / KV Line	59,446	34%	106,941	61%	7,794	4%	174,181
Colombo - Galle Road / Coast Line	91,170	31%	161,931	54%	44,473	15%	297,575
Total	**1,030,131**	**48%**	**957,237**	**45%**	**137,814**	**7%**	**2,125,182**

Source: For private and bus passengers, CoMTrans Screen Line survey; for railway passengers, University of Moratuwa 2009

13.2 Identification of Seven Radial Transport Corridors

Travel demands on radial corridors from CMC to the outskirts of the city are significant. These corridors are served by railway and roads. Although urban development in the CMA is characterised by spatial fragmentation, ribbon development and scattered residential development, the movement of commuters from the suburbs to the centre of Colombo is still the main flow of travel. New travel demands are largely due to the recent relocation of population in the suburban areas. Based on the Screen Line Survey (SLS) results at the boundary of Colombo Municipal Council (CMC), the following 7 major radial transport corridors are identified. These corridors have higher traffic volume compared with other roads and function as axes of economic activities.



No.	To/from	Roads/Railway
1	Negombo	Negombo Road (A03) Puttalam Line
2	Gampaha	Kandy Road (A01) Main Line
3	Kaduwela	Low Level Road
4	Malabe	Malabe Road (A00)
5	Makubura	High Level Road (A04) KV Line
6	Kasbewa	Horana Road
7	Moratuwa	Galle Road (A02) Coast Line

Figure 13.2.1 Radial Corridors of CMA

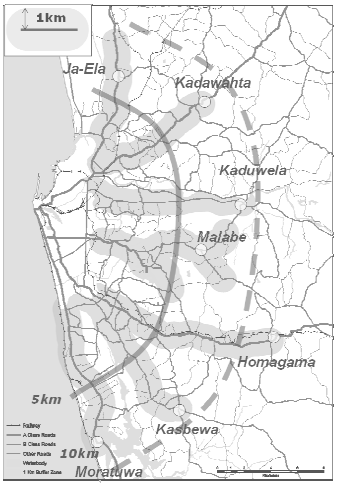
For preliminary reference, the current population along the corridors was estimated based on the results of the Population and Housing Census in 2012 conducted by the Department of Census and Statistics. The estimated population is shown in Figure 13.2.2. For the estimation of population along these corridors, the following assumptions are made.

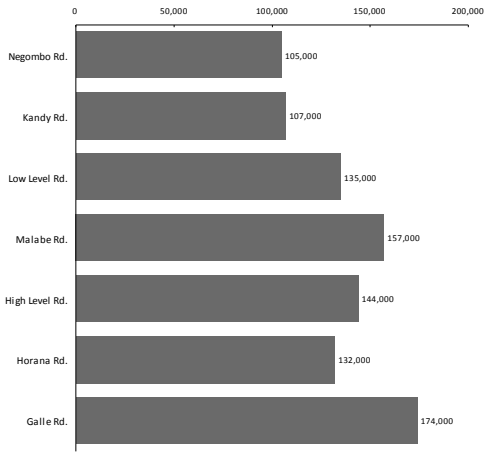
- Suburban area within 10km from CMC boundary
- Buffer area with 1km width on both sides of each road
- Census population data by GN division in 2012

The grey coloured area is the buffer area identified in GIS. The population is calculated by the proportional distribution rate of the buffered area to the GN division area. It covers about 955,000 people along the corridors, while 555,000 people live in CMC and 5,821,000 in the whole Western Province. The identified corridors would have significant passenger demand in the Colombo Metropolitan Region.

Characteristics of commuting passenger demand will be analysed after the person trip survey is

finalised and the transport model is developed based on the socio-economic framework and the various land use development scenarios.





Covered Area and Population 1km from corridor based on 2012 population by GN division

Source: CoMTrans Study Team

Figure 13.2.2 Potential Population for each Corridor

13.3 Traffic Volume of Seven Radial Transport Corridors

13.3.1 Passenger Volume

Occupancy of buses and passenger vehicles were also surveyed as a part of the Screen Line Survey (SLS). The number of passengers crossing the boundary of the CMC was also estimated using SLS. While Malabe Corridor showed the highest volume of vehicles, Kandy Corridor was the highest in terms of the number of passengers followed by Malabe and Galle Corridors.

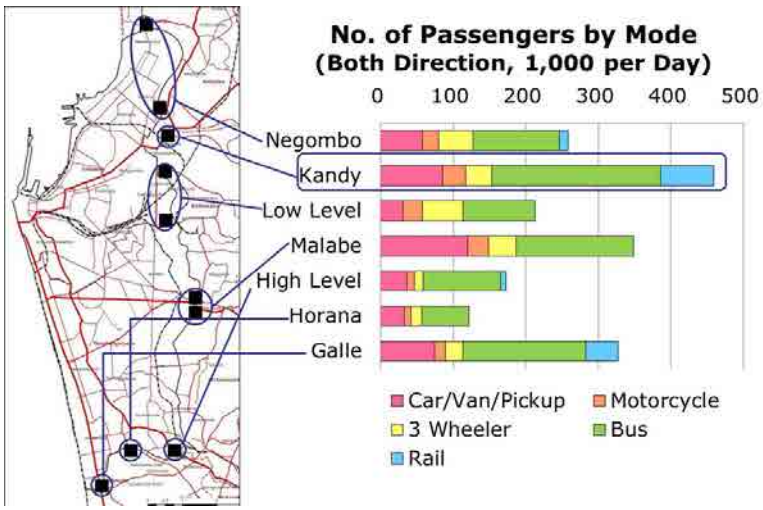


Figure 13.3.1 No. of Passengers by Mode (Both Directions, 1,000 per Day)

13.3.2 Vehicular Traffic Volume

Traffic volume crossing the boundary of the CMC is historically one of the key benchmarks of traffic condition in Colombo Metropolitan Area (CMA) as CMC is a centre of commercial activities. By utilizing the Screen Line Survey (SLS) results, the number of vehicles crossing the boundary of the CMC is estimated. The result showed that Malabe Corridor has the highest number of vehicles followed by Kandy Corridor and Galle Corridor. It is also noteworthy that the share of car/van/pickup is higher in Malabe Corridor.

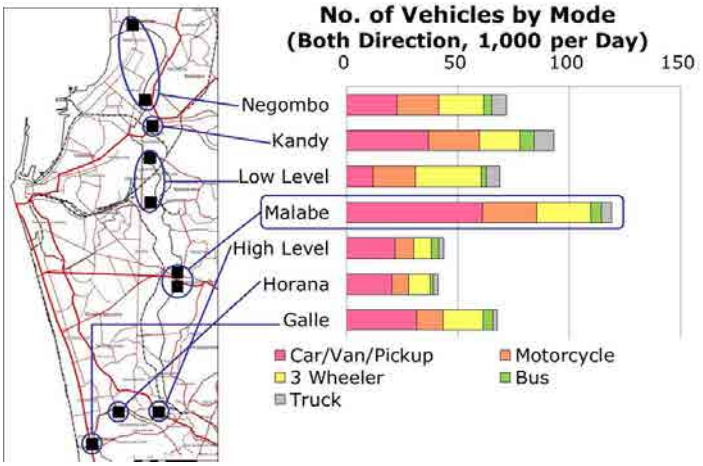
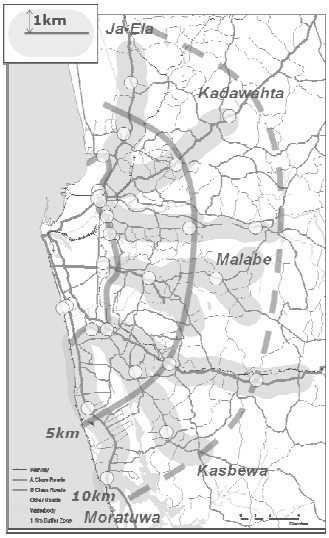


Figure 13.3.2 No. of Vehicles by Mode (Both Directions, 1,000 per Day)

13.4 Traffic Volume on Three Sections

13.4.1 Selection of Locations for Observation

To compare transport characteristics of each corridor, the survey locations of SLS at i) the CMC boundary, ii) 5km from the CMC boundary and iii) 10km from the CMC boundary were chosen. Figure 13.4.1 shows the selected locations of the SLS.



Selected Locations from SLS for the selected Corridors

To/from		CMC Boundary	5km	10km
1	Negombo Ja-Ela	Negombo Road (A03) *Japan Friendship Bridge* + Mattakkuliya Bridge	*Welegoda*	*Welisara*
2	Kadawata	Kandy Road (A01) *New Kelani Bridge*	*Warakanatta*	*Kadawatha*
3	Kaduwela	Low Level Road (Avissawella Rd.) + Wellampitiya Road	*Belagama*	*Kaduwela*
4	Malabe	Malabe Road + Dr.N.M.Perera Mw. + Bauddhaloka Mw.	*Battaramulla*	*Malabe*
5	Homagama	High Level Road (A04) *Nugegoda*	*Maharagama*	*Makumbura*
6	Kesbewa	Horana Road *Nugegoda*	*Boralesgamuwa*	*Piliyandala*
7	Moratuwa	Galle Road (A02) + Duplication Rd. + Marin Drive	*Mt. Lavinia*	*Moratuwa*

Source: CoMTrans Screen Line Survey, 2013

Figure 13.4.1 Selected Locations for SLS

13.4.2 Passenger Volume for Morning Hours of Each Corridor (6 a.m. – 9 a.m.)

Based on the above results of the SLS and the average occupancy for each vehicle type[2], passenger volume in the morning hours (6 a.m. - 9 a.m.) for the direction towards CMC is estimated in order to understand the passenger demands. Table 13.4.1 shows the results of each corridor.

- Roughly 268,100 road transport passengers are coming into the CMC on the 7 corridors.
- Among those corridors, the passengers on Kandy, Malabe, and Galle roads exceeded 45,000 passengers.

Table 13.4.1 Current Estimated Passenger Volume for each Corridor

No.	To/from	Roads	Passenger Demand ('000 persons/3hours from 6 a.m. to 9 a.m.)								
			CMC Boundary			5km			10km		
			Car	MC +3W	Bus	Car	MC +3W	Bus	Car	MC +3W	Bus
1	Negombo	Negombo Road (A03)	*12,800*	*9,000*	*16,900*	*9,900*	*6,000*	*17,100*	*10,300*	*5,800*	*17,000*
			Total: 38,700			***Total: 33,000***			***Total: 33,000***		
2	Kadawata	Kandy Road (A01)	*11,700*	*9,600*	*28,400*	*10,200*	*7,200*	*23,400*	*4,300*	*2,900*	*11,000*
			Total:49,700			***Total: 40,800***			***Total: 18,200***		
3	Kaduwela	Low Level Road	*5,200*	*10,000*	*12,700*	*1,800*	*2,500*	*6,600*	*2,900*	*2,600*	*6,900*
			Total: 27,900			***Total: 10,900***			***Total: 12.400***		
4	Malabe	Malabe Road	*19,600*	*8,400*	*18,800*	*10,600*	*6,200*	*16,000*	*5,500*	*4,500*	*9,400*
			Total: 46,800			***Total: 32,800***			***Total: 19,400***		
5	Homagama	High Level Road (A04)	*7,200*	*2,900*	*17,500*	*6,300*	*4,700*	*17,600*	*5,100*	*3,000*	*13,200*
			Total: 27,600			***Total: 28,600***			***Total: 21,300***		
6	Kesbewa	Horana	*7,800*	*3,600*	*9,300*	*6,300*	*5,200*	*10,300*	*4,600*	*5,500*	*9,500*

[2] This is estimated from the results of the Transport Study in Colombo Metropolitan Region (2011), which applies Motorcycles (1.37), Three-Wheelers (1.20), Cars (1.82), Vans (3.64), Pickups (2.27), Medium Trucks (2.20), Large Trucks (2.00), Container Trailers (2.11), Minibuses (17.60) and Large Buses (40.00).

		Road	***Total: 20,700***			***Total: 21,800***			***Total: 19,600***		
7	Moratuwa	Galle Road (A02)	*24,000*	*7,100*	*25,600*	*10,500*	*4,900*	*25,600*	*6,500*	*5,700*	*23,100*
			Total: 56,700			***Total: 41,000***			***Total: 35,300***		
Total			***268,100***			***208,900***			***152,500***		

Source: CoMTrans Study Team

The number of passengers during the 3 hours in the morning shows the current commuting demand for discussing future transport mode even though some corridors have railway service to accommodate part of the passenger demand.

13.4.3 Vehicular Traffic Volume

(1) Traffic Volume (24 hours)

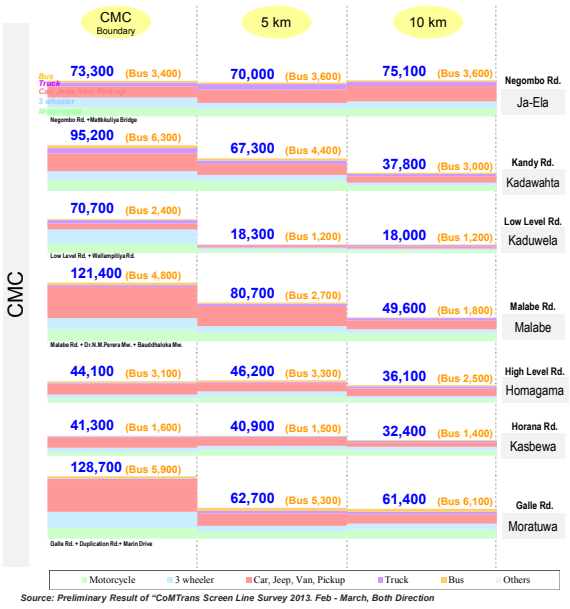
Figure 13.4.2 illustrates the daily traffic volume of both directions and the vehicle composition type for each corridor. The blue number shows the total number of vehicles which includes Motorcycles (Green), Three-wheelers (Sky Blue), Car-Jeep-Van-Pickup (Red), Trucks (Purple), Buses (Orange) and others (Grey). Note that motorcycles and three-wheelers are half of the number of vehicles even at the CMC boundary. Following are the characteristics which can be observed from the result;

- More than 120,000 vehicles move on the Malabe and Galle roads with around 5,000 buses.
- On the Kandy road, nearly 100,000 vehicles move which include 6,000 buses.
- The vehicles on Negombo road have some other alternative route or share the route of new Kelani Bridge to enter the CMC area.
- The High level road carries around 3,000 buses a day, which is more than Horana Road.

(2) Peak Hour Traffic Volume (from 6 a.m. to 9 a.m.)

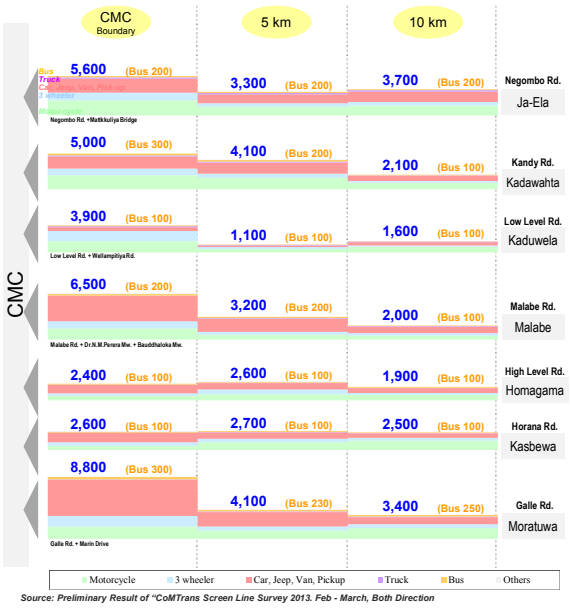
The peak hour traffic volume can be obtained from the SLS counted hourly volume on each corridor. Figure 13.4.3 illustrates the morning peak hour traffic volume only for the direction towards the CMC. Following are the findings;

- The total number of vehicles on Kandy and Malabe roads account for over 5,000 vehicles per hour.
- Roughly 300 buses are travelling on the Kandy and Galle roads during peak hour. To put it simply, 5 buses are passing per minute. Thus, insufficient bus parking space on the curb decreases road capacities.
- Even in the morning peak hour, the ratio of motorcycles and three wheelers is high on the Kandy and Malabe roads.



Source: CoMTrans Screen Line Survey, 2013

Figure 13.4.2 Daily Traffic Volume



Source: CoMTrans Screen Line Survey, 2013

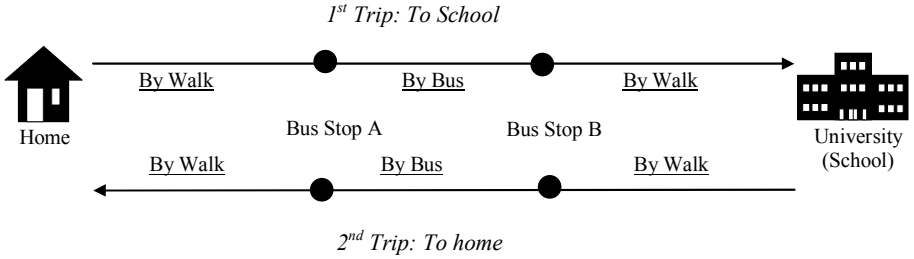
Figure 13.4.3 Peak Hour Traffic Volume

APPENDIX
Technical Report No. 3,
Characteristics of Present Transport Demand

1. TRIP DEFINITION BY EXAMPLES

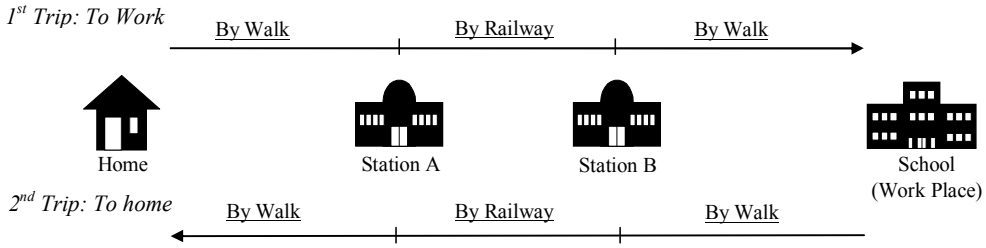
APPENDIX 1: TRIP DEFINITION BY EXAMPLES

(a) Trip of a Student



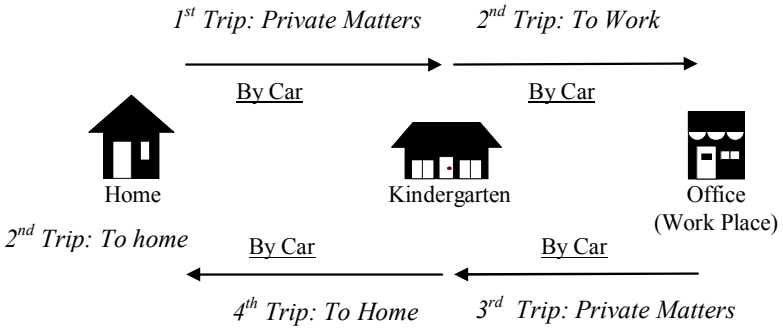
No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	Waking to the bus stop and getting on the bus. Getting off the bus and walking to the university where he studies.	1st Mode: 02.Walking to Bus Stop 2nd Mode: 15.Non A/C Bus(SLTB) 3rd Mode: 02.Walking from Bus Stop	8:00 a.m. / 9:00 a.m.	1.To School
2	Leaving his university after he took some lectures and walking to the bus stop near the university and getting on the SLTB bus. Getting off the bus and walking back to his home.	1st Mode: 02.Walking to Bus Stop 2nd Mode: 15.Non A/C Bus(SLTB) 3rd Mode: 02.Walking from Bus Stop	5:00 p.m. / 6:00 p.m.	6.To Home

(b) Trip of a Teacher



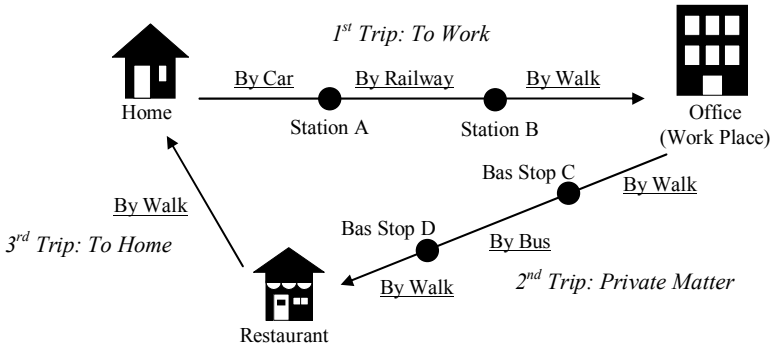
No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	Waking to the railway station and getting on the train. Getting off the train and walking to the school where he works as a teacher.	1st Mode: 02.Walking to railway station 2nd Mode: 17.Railway 3rd Mode: 02.Walking from railway station	8:00 a.m. / 9:00 a.m.	1.To Work
2	Leaving his school (his work place) and walking to the railway station and getting on the train. Getting off the train and walking to his home.	1st Mode: 02.Walking to railway station 2nd Mode: 17.Railway 3rd Mode: 02.Walking from railway station	5:00 p.m. / 6:00 p.m.	6.To Home

(c) Trip of a Farther



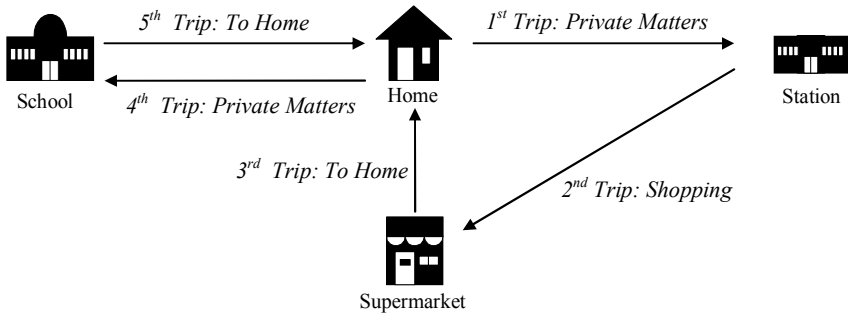
No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	Going to the kindergarten by the car to drop his son on the way to his work place.	1st Mode: 06.Car	8:00 a.m. / 8:30 a.m.	5.Private matters
2	After dropping his son at the kindergarten, he proceeds to his work place by car.	1st Mode: 06.Car	8:40 a.m. / 9:00 a.m.	1.To Work
3	Going to the kindergarten by the car pick his son up.	1st Mode: 06.Car	3:10 p.m. / 3:30 p.m.	5.Private matters
4	Going home by car with his son.	1st Mode: 06.Car	3:40 p.m. / 4:10 p.m.	6.To home

(d) Trip of an Office Worker



No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	Going to the station by the car driven by his wife and getting on the railway at Station A. Getting off at Station B and walking to work place.	1st Mode: 06.Car 2nd Mode: 17.Railway 3rd Mode: 02.Walking from railway station	8:00 a.m. / 9:00 a.m.	1.To Work
2	Leaving his work place and walking to bus stop and getting on the bus (SLTB). Getting off at Bus Stop D and walking to the restaurant.	1st Mode: 02.Walking to bus stop 2nd Mode: 15.Non A/C Bus(SLTB) 3rd Mode: 02.Walking from bus stop	5:00 p.m. / 5:30 p.m.	5.Private matters
3	Going back to home after having dinner by walk.	1st Mode: 01.Walking only	8:00 p.m. / 8:15 p.m.	6.To Home

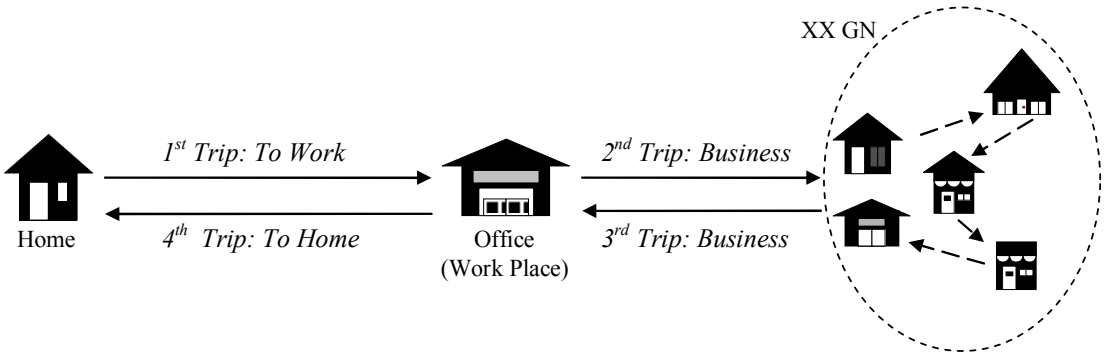
(e) Trip of a Housewife



No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	First she drove the car to the station for dropping her husband .	1st Mode: 06.Car	9:00 a.m. / 9:10 a.m.	5.Private matters
2	After dropping her husband at the station, she went to the supermarket for shopping by car.	1st Mode: 06.Car	9:10 a.m. / 9:30 a.m.	3.Shopping
3	Going back to home by car.	1st Mode: 06.Car	10:30 a.m. / 10:50 a.m.	6.To Home
4	Walking to the school for picking her son up.	1st Mode: 01.Walking only	2:30 p.m. / 2:40 p.m.	5.Private Matters
5	Going back to home with her son by walk.	1st Mode: 01.Walking only	2:50 p.m. / 3:10 p.m.	6.To Home

(f) Trip of a Deliveryman

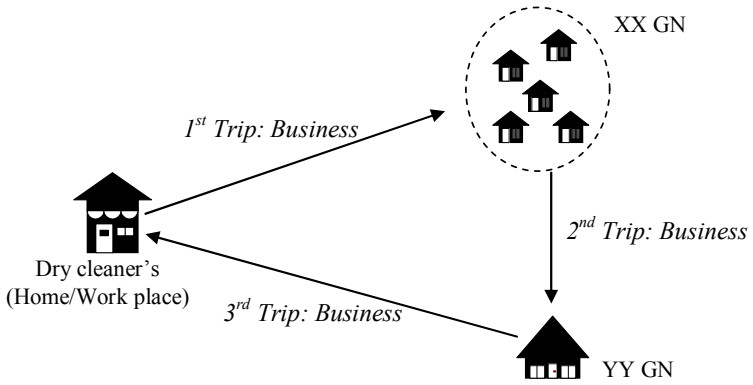
In the case of going to a small area, the same size as a GN Division, and stopping at some places with one trip purpose, such as delivering and collecting bills for newspapers, milk, or road maintenance or reading meters and collecting bills for electricity, gas and water, these trips shall be recorded as two trips. Representative points or famous buildings in that area shall be the origin and destination.



No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	Going to his office by employee transport.	1st Mode: 11.Employee Transport	5:00 a.m. / 6:00 a.m.	1.To Work
2	Going to XX GN division by motorcycle in order to deliver newspaper.	1st Mode: 04.Motorcycle	7:00 a.m. / 7:20 a.m.	4.Business
3	Going back to his office after finishing delivering.	1st Mode: 04.Motorcycle	8:30 a.m. / 8:50 a.m.	4.Business
4	Going back to home by bus.	1st Mode: 02.Walking to bus stop 2nd Mode: 14.Non A/C Bus (Private) 3rd Mode: 02.Walkking from bus stop.	9:30 a.m. / 11:00 a.m.	6.To Home

(g) Example of a Widespread Delivery

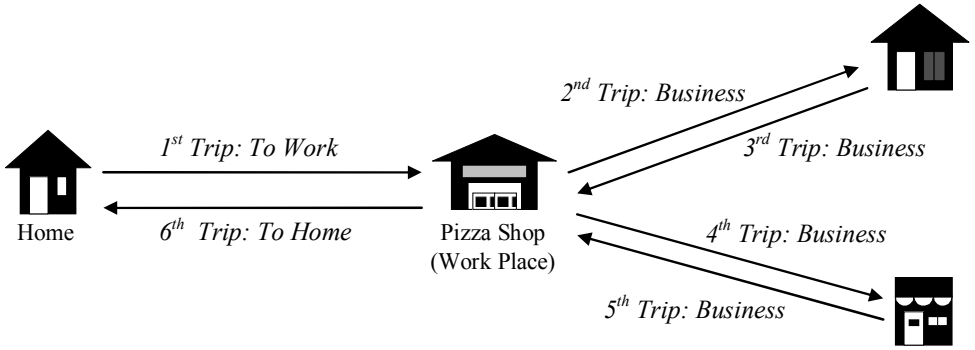
In the case of stopping at some places in a large area with one trip purpose, such as delivering and collecting bills for newspapers, milk, etc. the trips in the small area, which is the same size as a GN Division, shall be un-recorded trips. However, a trip from one GN Division to another GN Division shall be recorded as one trip. Representative points or famous buildings in the small area shall be the origin and destination.



No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	Going to XX GN by Van in order to deliver dry cleanings.	1st Mode: 06.Van	10:00 a.m. / 10:30 a.m.	4.Business
2	Going to YY GN by Van in order to deliver dry cleanings.	1st Mode: 06.Van	1:00 p.m. / 1:20 p.m.	4.Business
3	Going back to work place. (And continuing his work.)	1st Mode: 06.Van	1:30 p.m. / 1:30 p.m.	4.Business *

Note: * If the home is located next to the work place such as an office of a self-employed person, the trip purpose shall be recorded according to the next activity. For example, if the person arrived at office part and continues his/her work, the trip purpose shall be "4. Business". If the person arrived at the office part but did not continue his/her work, the trip purpose shall be "6. To home".

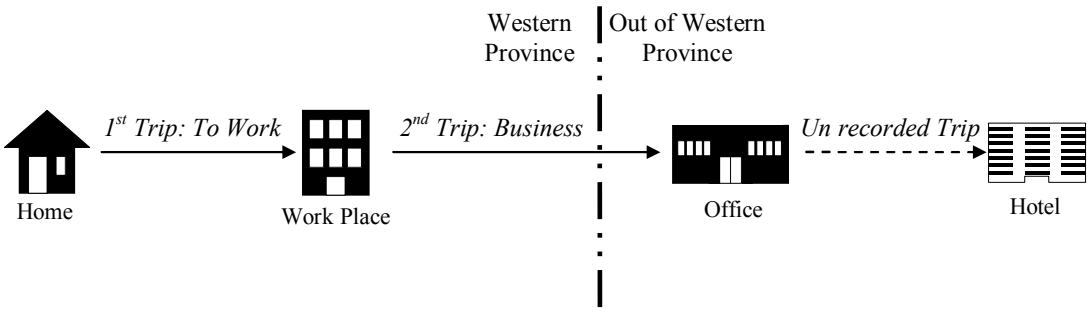
(h) Example of Repeated Round Trips



No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	Going to work place by his own three wheeler.	1st Mode: 05. Three Wheeler (Private use)	9:00 a.m. / 9:30 a.m.	1. To Work
2	Going to Mr. XX's home to deliver pizza by car.	1st Mode: 06.car	11:00 a.m. / 11:30 a.m.	4.Business
3	Going back to work place by car.	1st Mode: 06.car	11:40 a.m. / 12:10 p.m.	4.Business
4	Going to Ms. YY's home to deliver pizza by car.	1st Mode: 06.car	2:10 p.m. / 2:20 p.m.	4.Business
5	Going back to work place by car.	1st Mode: 06.car	2:30 p.m. / 2:40 p.m.	4.Business
6	Going back to home by his own three wheeler.	1st Mode: 05. Three Wheeler (Private use)	4:30 p.m. / 5:00 p.m.	6. To Home

(i) Example of Travelling beyond Survey Area

In the case of traveling to outside of the Western Province, the arrival point and destination point beyond the boundary of the Western Province shall be filled in with the provincial or country name and it is not necessary to record the trips outside of the Western Province. However, if the person comes back to the Western Province within the survey date, the trip from the outside to the Western Province shall be recorded.

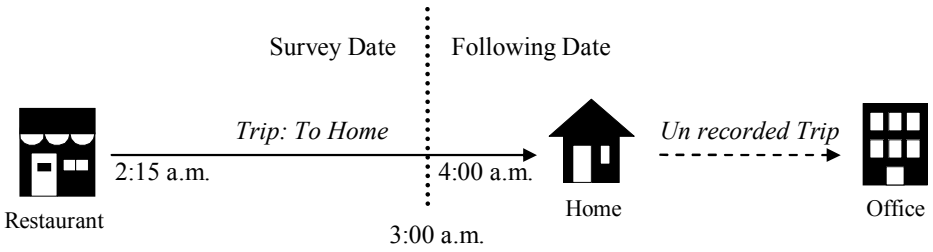


No. of trips	Detail of trip	Mode of transport	Departure time/Arrival time	Trip purpose
1	Going to work place by bus.	1st Mode: 02.Walking to bus stop 2nd Mode: 14.Non A/C Bus (Private) 3rd Mode: 02.Walkking from bus stop.	8:00 a.m. / 8:30 a.m.	1.To Work
2	Traveling to Southern Province for meeting by Van.	1st Mode: 06.Van	9:00 a.m. / 1:30 p.m.	4.Business

(j) Example of Being in the Middle of Travelling at 3 a.m. of the Survey Date or of the Following Day

If the departure time is between 3:00 a.m. of the survey day and 3:00 p.m. of the following day, the trip, of which arrival time is after 3:00 a.m. of the following day, shall be recorded.

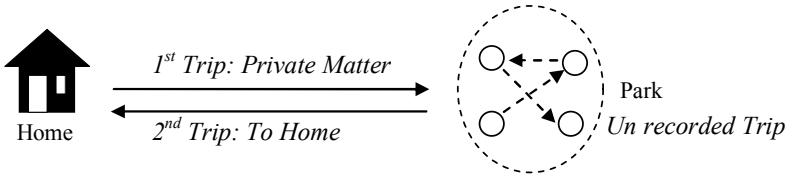
However, the trip of which departure time is before 3:00 a.m. of the survey day and the arrival time is within the survey day does not need to be recorded.



(k) Example of Travelling with Unclear Purpose

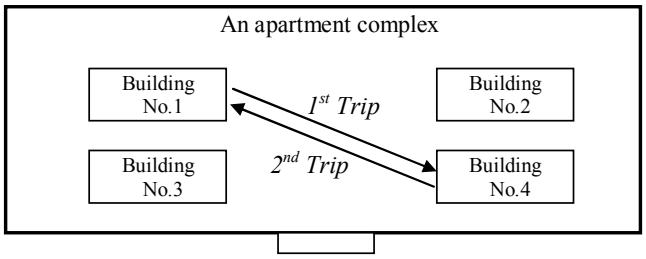
In the case of trips for things such as a walking, jogging, and driving, etc., the farthest point shall be the arrival point.

In the case of trips for things such as recreation, leisure, etseeill the facility name or sight name, and the trips in the facility shall not be recorded.

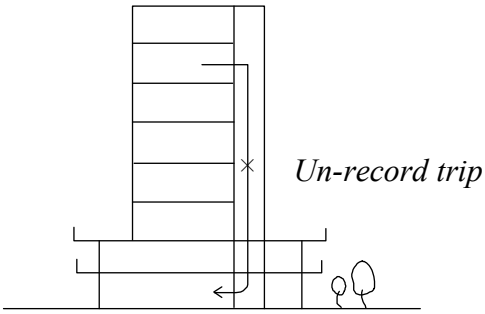


(l) Example of Trips in an Apartment Complex

In the case of trips from one building to another building located in the same apartment complex, it shall be recorded.

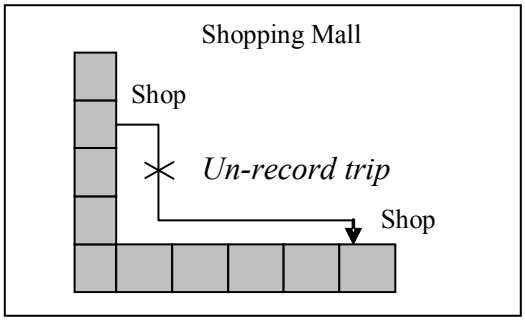


(m) Un-recorded Trips: Example of Trips in the Same Building



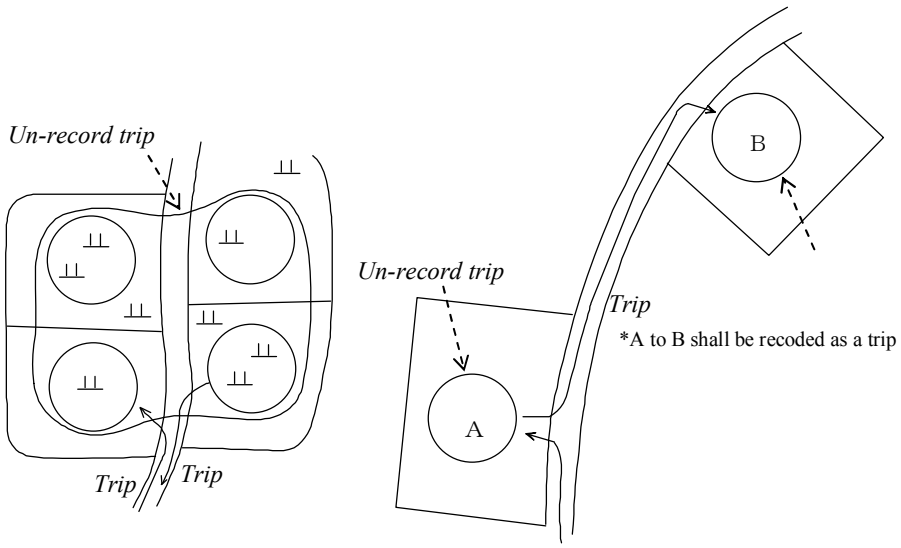
(n) Un-recorded Trips: Example of Trips in the Same Site

In the case of a trip in the same site such as a trip from one shop to another shop in the same shopping mall, it shall not be recorded. However the trip from one building to another shall be recorded as a trip.



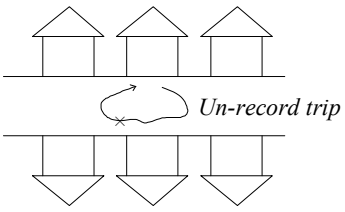
(o) Un-recorded Trips: Example of Continued Trips for Farm Work on a Farm

In the case of a trip for farm work in the same site, it shall not be recorded as a trip. However the trip passing a road shall be recorded as a trip.



(p) <u>Un-recorded Trips: Example of Trip for Playing, Cleaning, Sightseeing at a Nearby Street</u>

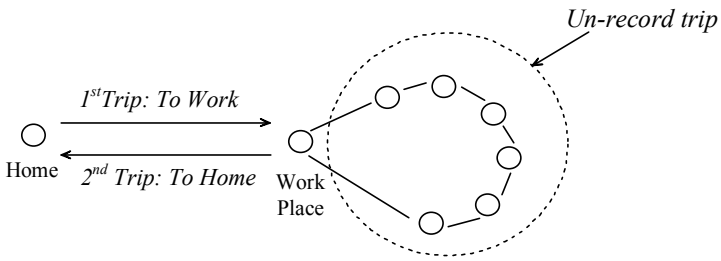
The trip for things such as play, cleaning, sightseeing and loading/unloading at a nearby street shall not be recorded.



(q) <u>Un-recorded Trips: Example of a railway crew, taxi driver, bus driver</u>

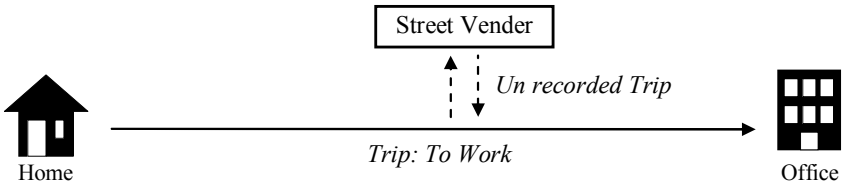
The trips done by a railway crew, taxi driver, or bus driver as a crew member shall not be recorded. The trips that are not trips as a crew member shall be recorded.

However, in the case of the driver under exclusive contract of a private car, every trip shall be recorded. The trip purpose for picking up someone as his/her duty shall be "4. Business."



(r) <u>Un-recorded Trips: Example of a Stop to Buy Newspaper, Cigarettes on the way to destination</u>

A trip to buy things such as a newspaper or cigarettes on the way to destination shall not be recorded as a trip. However in the case of stopping at a supermarket on the way to the destination shall be recorded as a trip.



(s) <u>Un-recorded Trips: Example of a Trip on the River, Lake, Sea</u>

In the case of touring on a river, lake, or sea by boat and coming back to the departure point, it shall not be recorded. However, if the person had landed on an island or the other side of the river, the trip shall be recorded as a trip.

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF TRANSPORT

URBAN TRANSPORT SYSTEM DEVELOPMENT PROJECT FOR COLOMBO METROPOLITAN REGION AND SUBURBS

Technical Report No. 4

Urban Structure and Socio-economic Framework

AUGUST 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ORIENTAL CONSULTANTS CO., LTD.

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CHAPTER 1. Population Status

1.1 The Census Details

1.1.1 Historical Growth

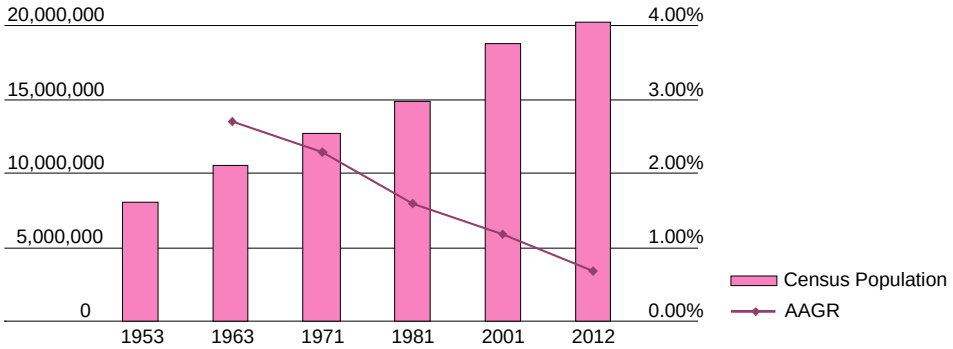
After 1950, the Department of Census and Statistics undertook a census in Sri Lanka in the years of 1953, 1963, 1971, 1981, 2001, and 2012. Population and Average Annual Growth Rates (AAGR) of Sri Lanka, Colombo District, Gampaha District, Kalutara District, and Western Province of the census years are shown in Table 1.1.1, Figure 1.1.1, and Figure 1.1.2.

The population of Sri Lanka was 20,263,723 in 2012. Historically, the AAGR has been slowing down gradually. It was over 2% till 1971, but the latest AAGR from 2001 to 2012 was 0.69%. The population of Western Province was 5,821,710 in 2012 and the AAGR was 0.72%. The AAGR of Western Province has kept pace with that of the country. Within Western Province, the AAGR of Colombo District is 0.23%, which is much lower than in other areas.

Table 1.1.1 Population and Average Annual Growth Rate (1953-2012)

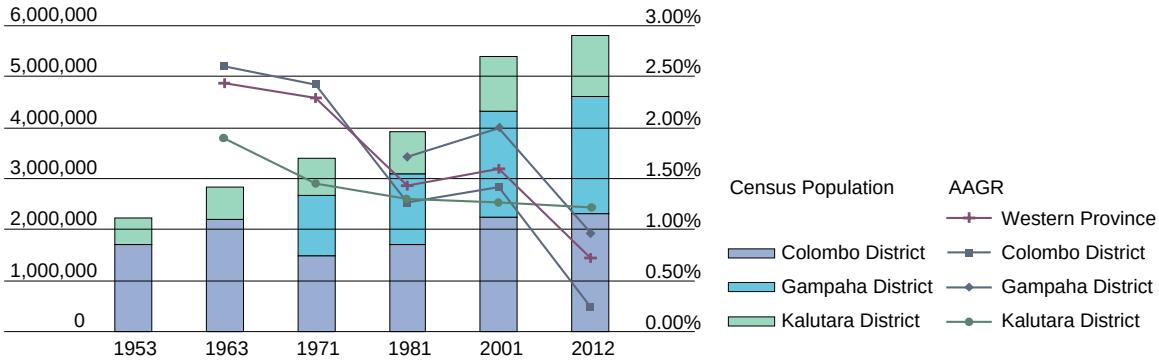
Census Population	1953	1963	1971	1981	2001	2012
Sri Lanka	**8,097,800**	**10,582,100**	**12,689,897**	**14,846,750**	**18,797,257**	**20,263,723**
Western Province	**2,232,276**	**2,838,877**	**3,401,779**	**3,919,807**	**5,381,197**	**5,821,710**
Colombo District	1,708,726	2,207,420	1,498,393	1,699,241	2,251,274	2,309,809
Gampaha District*			1,173,872	1,390,862	2,063,684	2,294,641
Kalutara District	523,550	631,457	729,514	829,704	1,066,239	1,217,260
Average Annual Growth Rate		**'53-'63**	**'63-71**	**'71-'81**	**'81-'01**	**'01-'12**
Sri Lanka		**2.71%**	**2.30%**	**1.58%**	**1.19%**	**0.69%**
Western Province		**2.43%**	**2.29%**	**1.43%**	**1.60%**	**0.72%**
Colombo District		2.59%	2.42%	1.27%	1.42%	0.23%
Gampaha District*				1.71%	1.99%	0.97%
Kalutara District		1.89%	1.45%	1.30%	1.26%	1.21%

Note: * Gampaha district was declared as a new administrative district, separated from Colombo District in 1978.
Source: Census of Population and Housing 2001 and 2012, Department of Census and Statistics



Source: Census of Population and Housing 2001 and 2012, Department of Census and Statistics

Figure 1.1.1 Census Population of Sri Lanka



Source: Census of Population and Housing 2001 and 2012, Department of Census and Statistics

Figure 1.1.2 Census Population in Western Province

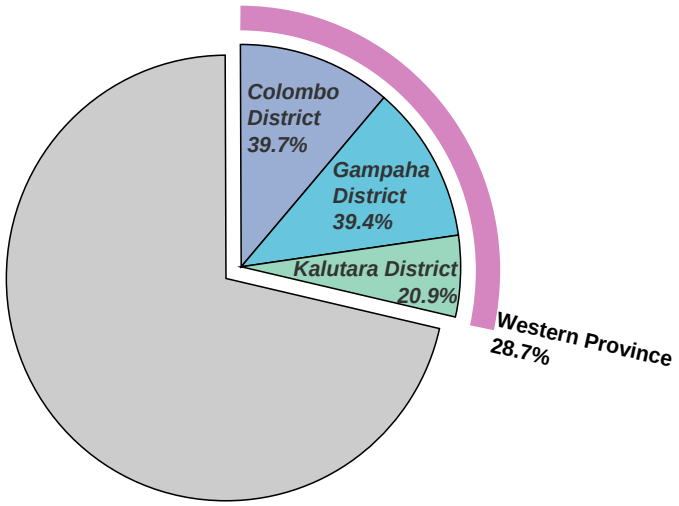
1.1.2 Population Share

Western Province had 28.7% of the total population of Sri Lanka in 2012. The population share has stayed almost the same as in the census of 2001. Within Western Province, 40% of the population is in Colombo District and another 40 % is in Gampaha District, while Kalutara District has only 20%. The population share of Gampaha district is rising gradually, and now it is reaching the same population as Colombo District. The population share is shown in Table 1.1.2 and Figure 1.1.3.

Table 1.1.2 Population Share in Sri Lanka and Western Province (2001 and 2012)

Census Population	2001			2012		
	Population	Share in Sri Lanka	Share in Western P.	Population	Share in Sri Lanka	Share in Western P.
Sri Lanka	18,797,257	100.0%	-	20,263,723	100.0%	-
Western Province	5,381,197	28.6%	100.0%	5,821,710	28.7%	100.0%
Colombo District	2,251,274	12.0%	41.8%	2,309,809	11.4%	39.7%
Gampaha District	2,063,684	11.0%	38.3%	2,294,641	11.3%	39.4%
Kalutara District	1,066,239	5.7%	19.8%	1,217,260	6.0%	20.9%

Source: Census of Population and Housing 2001 and 2012, Department of Census and Statistics



Note: Western Province – Population Share (%) of Sri Lanka
Colombo, Gampaha, and Kalutara District – population share (%) of Western Province

Source: Census of Population and Housing 2012, Department of Census and Statistics. Calculated by CoMTrans Study Team

Figure 1.1.3 Population Share of Western Province (2012)

1.1.3 Population by Age Group and by Gender

Population by age group was published in the census 2001 on a detailed level. However, only preliminarily results are available from the census 2012. Populations by gender and three age groups, which are: less than 15 years, 15 to 59 years, and 60 years and over, according to Grama Niladhari Division (GND) are published by the Department of Census and Statistics.

Population by age group is shown in Table 1.1.3. The population was aging from 2001 to 2012 in Sri Lanka as well as in Western Province. In Western Province, the elderly increased from 0.53 million to 0.77 million, and the population share of the elderly increased from 9.9% to 13.2%.

District wise, Kalutara District shows a relatively high percentage of the population who are over 60 years old. In comparison to the rest of Sri Lanka, Western Province has fewer in the younger generation but more in the working-age and elderly populations.

The percentage of those in the over-60-year population by GND is mapped in Figure 1.1.4. In rural areas and the central area of CMC, the percentage of the over 60-year-old population is high, showing over 15%. Suburban areas show a lower percentage of the aged population.

These population data by age group and gender would be the basis for future population projections, especially for students and the employed population.

In terms of population by gender, the female population was slightly higher than the male population. 48.5% of the Sri Lankan population and 48.8 % of Western Province's population was male. The male population is equally distributed.

Table 1.1.3 Population by Age in Sri Lanka and Western Province (2001 and 2012)

2001	Total	Census Population			Population Share		
		Under 14	15-59	60 and over	Under 14	15-59	60 and over
Sri Lanka	18,797,257	**NA ***	**NA ***	**NA ***	**NA ***	**NA ***	**NA ***
18 District *	**16,929,689**	**4,449,026**	**10,916,791**	**1,563,872**	**26.3%**	**64.5%**	**9.2%**
Western Prov.	**5,381,197**	**1,219,985**	**3,630,374**	**530,838**	**22.7%**	**67.5%**	**9.9%**
Colombo Dis.	2,251,274	482,280	1,552,726	216,268	21.4%	69.0%	9.6%
Gampaha Dis.	2,063,684	476,269	1,392,743	194,672	23.1%	67.5%	9.4%
Kalutara Dis	1,066,239	261,436	684,905	119,898	24.5%	64.2%	11.2%
2012	**Total**	**Census Population**			**Population Share**		
		Under 14	**15-59**	**60 and over**	**Under 14**	**15-59**	**60 and over**
Sri Lanka	**20,263,723**	**5,228,927**	**12,566,467**	**2,468,329**	**25.8%**	**62.0%**	**12.2%**
Western Prov.	**5,821,710**	**1,356,695**	**3,696,417**	**768,598**	**23.3%**	**63.5%**	**13.2%**
Colombo Dis.	2,309,809	516,741	1,484,820	308,248	22.4%	64.3%	13.3%
Gampaha Dis.	2,294,641	536,758	1,467,497	290,386	23.4%	64.0%	12.7%
Kalutara Dis	1,217,260	303,196	744,100	169,964	24.9%	61.1%	14.0%

Note: * 18 Districts are; Colombo, Gampaha, Kalutara, Kandy, Matale, Nuwara Eliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle.

Out of the five Districts in the Northern Province, Jaffna, Kilinochchi and Mullaitivu were not covered during the Preliminary and Final Census. Vavuniya and Mannar were covered partially. In the Eastern Province, Trincomalee and Batticaloa were covered partially. As such, estimates for the Districts which were not covered or partially covered, are based on the information collected during the Listing and Numbering operation of the Census 2001, wherever possible, wherever the Listing and Numbering operation was also not complete the Registrar General's Estimates based on the registration of Births and Deaths, have been used.

Source: Census of Population and Housing 2001 and 2012, Department of Census and Statistics

Note: Expressways/Highways are shown on the map as reference.
Source: Census 2012, by Department of Census and Statistics. Mapped by CoMTrans Study Team

Figure 1.1.4 Share of Aged Population Over 60 years' (2012)

1.1.4 Estimation of 5-year Age Group Population

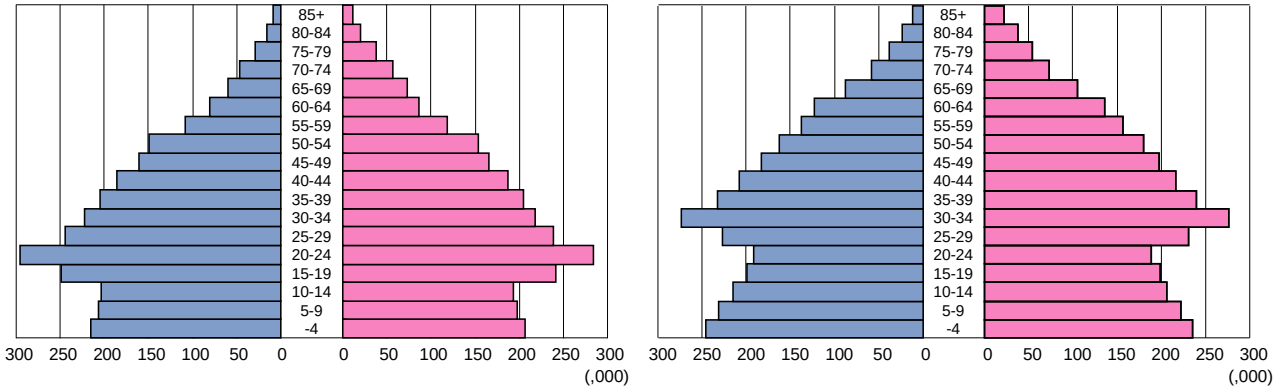
The Census 2001 gives population by each age and sex in 2001. As for the population in 2012, although the detailed results of the census 2012 are not available yet, population by age and sex can be estimated from crude birth rates and crude death rates. The Registrar General's Department published Statistics on Vital Events 2000-2010" in 2011, and the registered number of Live Births and Deaths of Usual Residents by district from 2000 to 2007 are available. The birth rates and death rates up to 2007 are calculated by the CoMTrans Study Team, and the birth rates and the death rates from 2008 to 2011 are assumed to be the same level as in 2007. Thus, by using these rates, the 5-year age group populations are estimated by CoMTrans Study Team.

The 5-year age group populations in 2001 and 2012 are shown in Table 1.1.4, and the Population Pyramids in 2001 and 2012 are shown in Figure 1.1.5.

Table 1.1.4 Population by Sex and 5-year Age Group of Western Province (2001 and 2012)

Population	2001 Census			2012 Estimation		
Age Group	Male	Female	Total	Male	Female	Total
Less than 4	214,669	205,959	420,628	246,027	235,435	481,462
5-9	206,153	197,097	403,250	231,906	223,027	454,933
10-14	203,570	192,537	396,107	214,386	205,915	420,301
15-19	249,063	240,969	490,032	198,305	198,601	396,906
20-24	296,307	284,486	580,793	191,065	189,242	380,307
25-29	243,825	238,584	482,409	227,127	231,172	458,299
30-34	222,523	218,354	440,877	273,075	277,091	550,166
35-39	204,606	205,221	409,827	232,004	240,385	472,389
40-44	185,462	187,408	372,870	207,224	216,659	423,883
45-49	160,929	164,649	325,578	182,153	197,099	379,252
50-54	148,519	152,883	301,402	162,076	180,019	342,095
55-59	108,798	117,788	226,586	136,980	156,143	293,123
60-64	79,783	86,971	166,754	122,136	136,028	258,164
65-69	60,545	72,803	133,348	87,405	104,846	192,251
70-74	46,404	57,317	103,721	58,267	73,137	131,404
75-79	29,825	38,399	68,224	37,915	54,723	92,638
80-84	16,330	21,053	37,383	23,522	37,617	61,139
85 and over	9,085	12,323	21,408	11,675	21,328	33,003
Total	2,686,396	2,694,801	5,381,197	2,843,248	2,978,467	5,821,715

Note: Populations by age group in 2012 are estimated by CoMTrans Study Team
Source: Census of Population and Housing 2001 and 2012, Department of Census and Statistics



Note: Populations by age group in 2012 are estimated by CoMTrans Study Team
Source: Census of Population and Housing 2001 and 2012, Department of Census and Statistics

Figure 1.1.5 Population Pyramids of Western Province (2001 and 2012)

1.2 Migration

1.2.1 External (International) Migration

The Department of Census and Statistics published the Statistics Abstract 2012, and it includes data of Arrivals and Departures by Nationality in 2011. These are shown in Table 1.2.1.

Table 1.2.1 Number of Arrivals and Departures by Nationality (2011)

	Sri Lankan	Asians (Exc. Sri Lankan)	Europeans	North Americans	South Americans	Africans	Australians	Others	Sub Total Foreigners	Total
Arrivals	1,206,135	606,104	470,165	70,780	1,863	9,939	56,475	1,246	1,216,572	2,422,707
Departures	1,235,288	609,429	462,254	69,532	1,754	9,243	54,845	1,225	1,208,282	2,443,570
Differences	-29,153	-3,325	7,911	1,248	109	696	1,630	21	8,290	-20,863

Source: Statistical Abstract 2012, Department of Census and Statistics and Department of Immigration and Emigration

In 2011, a net 29,153 Sri Lankans migrated to outside of the country. On the other hand, a net 8,290 foreigners came into Sri Lanka. This resulted in a total net 20,863 persons departing from the country. The total population of Sri Lanka was almost 20 million; therefore 0.1% net of the total population left the country in the year of 2011.

1.2.2 Internal Migration

Internal migrant population data (from one district to another district) is available only in the "Natural Increase and Net Migration by District from 1971 to 1981", shown in Table 1.2.2. Although it is outdated, it shows out-flow migration from Colombo District and Kalutara District. Annually, almost 10,000 people left Colombo District.

Table 1.2.2 Natural Increase and Net Migration by District (1971-1981)

District	Natural Increase	Migration Increase	Ratio of Migration Increase to Natural Increase
Colombo District	297,784	-96,936	-32.6%
Gampaha District	181,980	35,010	19.2%
Kalutara District	131,783	-31,593	-24.0%
Western Province	611,547	-93,519	-15.3%

Source: Department of Census and Statistics

Although recent reliable migration data are not available, migration can be assumed to be taking place. The difference between the closed population from 2001 to 2012, which only considers the natural increase during this period, and the census population 2012 indicates the estimated migration population.

Table 1.2.3 summarises the population differences.

Table 1.2.3 Annual Estimated Migrations by District from 2001 to 2012

	* Closed Population 2012	Census Population 2012	Estimated Annual Internal Migration	Average Annual Migration Rate
Colombo District	2,516,820	2,309,809	-18,819	-0.81%
Gampaha District	2,334,040	2,294,641	-3,582	-0.16%
Kalutara District	1,216,481	1,217,260	71	0.01%
Western Province	6,067,341	5,821,710	-22,330	-0.38%

Note: *Closed Population is obtained from Census population 2001 and estimated Birth and Death Rates
Source: CoMTrans Study Team

In the whole Western Province, the closed population in 2012 was higher than the actual population in 2012. This implies that migration moved outward. This trend is much more notable in Colombo District, where approximately 19,000 people left annually.

1.3 Spatial Distribution and Growth Trend

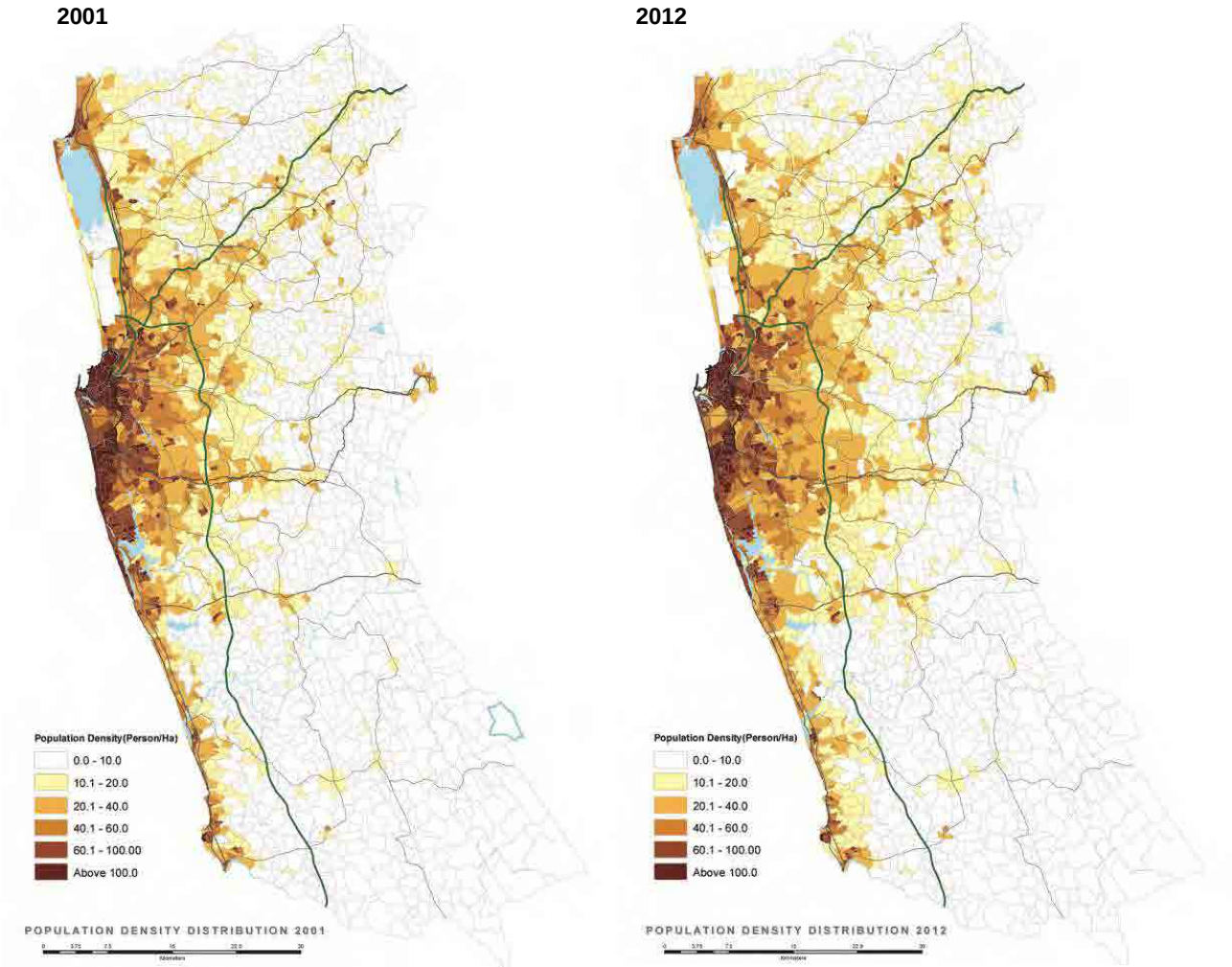
1.3.1 Spatial Distribution

Population Densities in Residential Areas were calculated by the CoMTrans Study Team based on the population by GND in the Census years in the 2001 and 2012 and are shown in Figure 1.3.1. The density maps show populated areas which can be considered as urbanised.

Generally, Populations are concentrated around Colombo, namely the areas of Colombo MC, Dehiwala – Mt. Lavinia MC, Sri jayawardanepura MC, Kollonawa UC, Boralesgamuwa UC, the

west part of Kaduwela MC, west part of Maharagama UC in Colombo District, and Peliyagoda UC, Kelaniya PS, and Wattala UC in Gampaha District. Coastal Areas also have higher population densities as well. In the suburban areas, high density areas are concentrated along major roads, such as Kandy Road, High Level Road, Galle Road, Negombo Road, and Horana Road, and railway lines. Around Negombo and Minuwangoda, which are close to Bandaranayake International Airport, population density is also high.

In 2012, high density areas expanded towards the north and east. Suburbanisation can be seen, especially around the OCH Corridor and the south western part of Gampaha District. Kalutara District still is in a rural condition. Generally, coastal areas and major road corridors are highly populated.

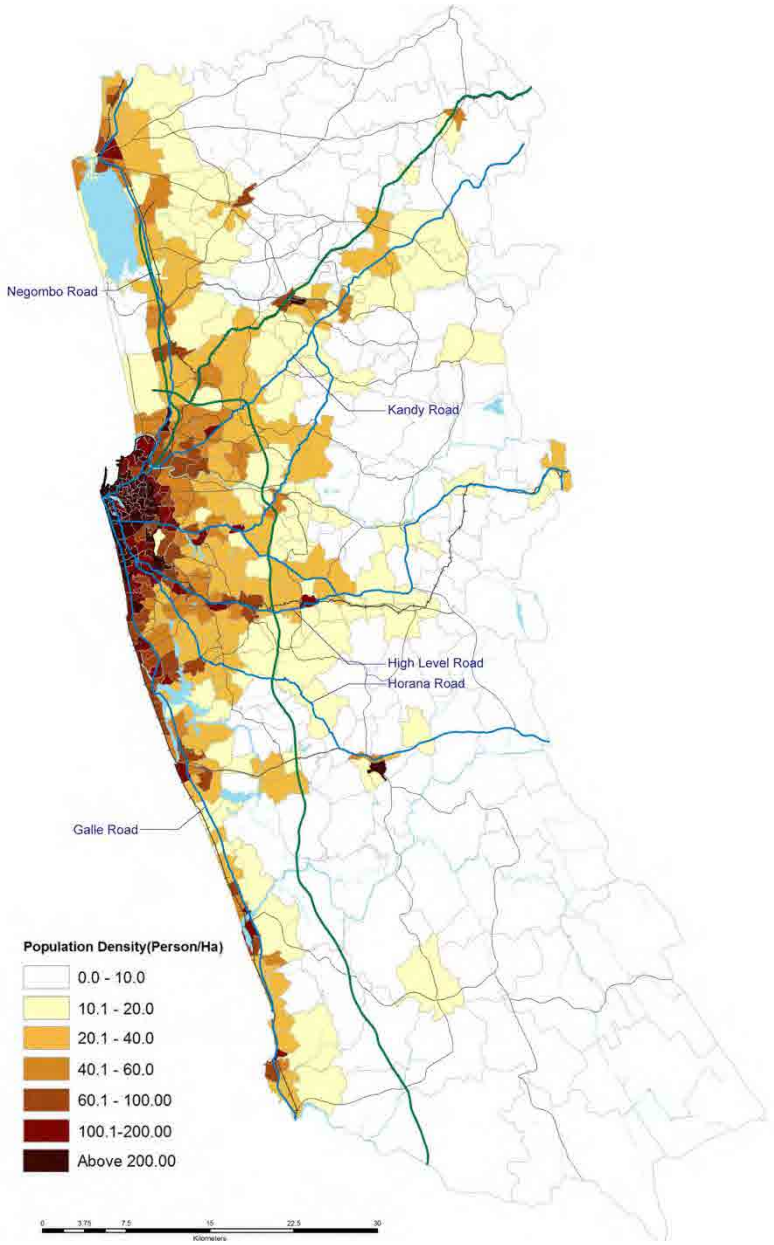


Note: Calculated by CoMTrans Study Team
Expressways/Highways are shown on the map as reference.

Figure 1.3.1 Population Density in Residential Areas in Western Province (2001 and 2012)

Employed Population Densities at Work Place in 2013 are also estimated based on the data from the Department of Census and Statistics, and HVS, and are shown in Figure 1.3.2.

The employed population is highly concentrated in CMC. High Level Road Corridor and Galle Road Corridor, and the areas around major local urban centres, such as Negombo, Minuwangoda, Gampaha, Mirigama, and Horana, also have many employed populations concentrated in them.



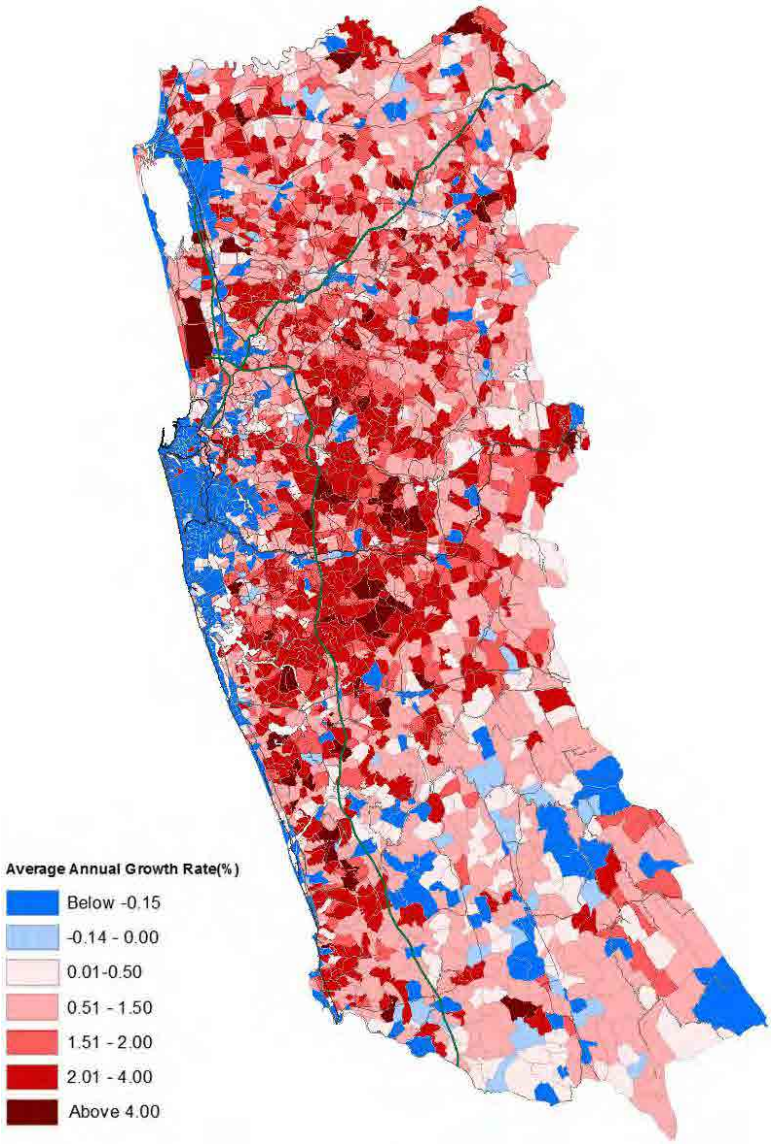
Note: Calculated by the Traffic Analysis Zone (TAZ). TAZ is described in Chapter 3.
Expressways/Highways are shown on the map as reference.

Source: CoMTrans Home Visit Survey 2013

Figure 1.3.2 Employed Population Density at Working Places in Western Province (2013)

1.3.2 Growth Trend

Population changes from 2001 to 2012 are shown in Figure 1.3.3. This more clearly gives an idea of how urbanisation has been progressing in Western Province. It shows that the population in the centre of Colombo is decreasing, and increasing in the suburban areas.



Note: Calculated by CoMTrans Study Team.
Expressways/Highways are shown on the map as reference.

Figure 1.3.3 Average Annual Growth Rate of Population in Western Province from 2001 to 2012

Population decrease occurred in the Colombo MC and some surrounding areas, the coastal strip in the southern part of Western Province, and the centre of Negombo. The population of some rural areas in Kalutara District also decreased.

Population growth was clearly seen in the suburbs of Colombo, including Homagama PS, Maharagama UC, Kaduwela MC, and Biyagama PS. Regional Towns in Western Province, such as Avissawela, the west of Negombo, and the inner costal area of Kalutara district show population increases as well. Especially, major population growth was seen around and outside of the planned OCH area.

1.4 Social Status

As for the Social Status, a comparison between the Population Census of 2001 and HVS 2012 is shown in Table 1.4.1 and Figure 1.4.1. In the Population Census in Sri Lanka, social statuses are based on those who are ten years old and over. In Western Province, 43% of the population is employed and 15% are students. While the employed population of Western Province has increased slightly in number, the share to the total population aged ten years old and over has decreased. Student population by HVS shows a larger number than in the census of 2001. More details of employed and student populations are described in the following sections.

Table 1.4.1 Population by Social Status based on Population Census 2001 and CoMTrans Home Visit Survey 2013

	Employed	Student	Household work	Retired/ Income recipient	Unemployed	Other	Unknown	Total 10 year and over
2001								
Colombo Dis.	855,142	283,252	465,670	122,092	57,089	102,997	38,625	1,924,867
Gampaha Dis.	756,186	263,193	444,734	113,443	68,239	82,264	11,881	1,739,940
Kalutara Dis.	356,837	147,485	227,064	64,345	38,940	46,817	11,023	892,511
Western P.	**1,968,165**	**693,930**	**1,137,468**	**299,880**	**164,268**	**232,078**	**61,529**	**4,557,318**
% to Total W.P.	43.2%	15.2%	25.0%	6.6%	3.6%	5.1%	1.4%	100.0%
Sri Lanka (18 District)*	***5,941,574***	***2,531,798***	***3,311,142***	***271,706***	***531,928***	***1,298,527***	***119,660***	***14,006,335***
*% to Total SL**	*42.4%*	*18.1%*	*23.6%*	*1.9%*	*3.8%*	*9.3%*	*0.9%*	*100.0%*
2013								
Colombo Dis.	836,029	362,051	533,770	168,260	140,154	22,049	498	2,062,811
Gampaha Dis.	772,231	352,192	534,573	141,738	126,041	30,139	232	1,957,146
Kalutara Dis.	377,234	182,424	270,838	71,157	77,959	18,924	34	998,571
Western P.	**1,985,494**	**896,668**	**1,339,181**	**381,155**	**344,155**	**71,112**	**764**	**5,018,528**
% to Total W.P.	39.6%	17.9%	26.7%	7.6%	6.9%	1.4%	0.0%	100.0%

Note: * 18 Districts are; Colombo, Gampaha, Kalutara, Kandy, Matale, Nuwara Eliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle, where the detailed data of Census 2001 available.

2001 - Census of Population and Housing 2001, Department of Census and Statistics
2013– Estimation based on the result of CoMTrans Home Visit Survey 2013.

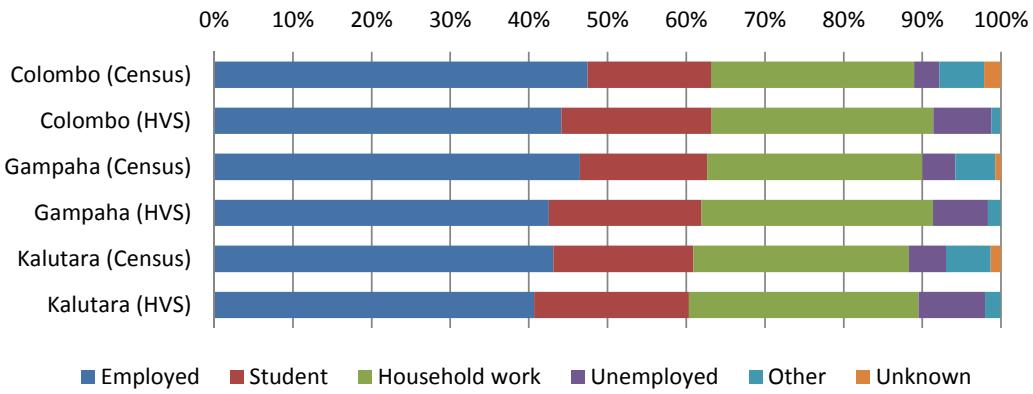


Figure 1.4.1 Population by Social Status based on Population Census 2001 and CoMTrans Home Visit Survey 2013

1.5 Employed Population

1.5.1 Current Status of Employed Population

The data of the employed population is available in the Census 2001, however, the details of the employed population in the latest census of 2012 have not yet been published. Therefore the CoMTrans Study Team has estimated the employed population according to the trends of Labour force Participation Rate and Unemployment Rate. At the same time, from the results of the HVS, it is possible to estimate employed populations as well. The employed populations are shown in Table 1.5.1.

According to the Census 2001, approximately 2.0 million people are employed in Western Province, which is 92% of the total economically active population. This rate was slightly higher than the national level.

The employed population was also estimated from the population of 2012, and the Labour Force Participation Rate and Unemployment is estimated in the "Sri Lanka Labour Force Survey Annual Report 2011" by the Department of Census and Statistics. Applying that rate, the employed population in 2012 is estimated as 2.1 million in Western Province. In this case, the unemployment rate is 3.5% which was the number estimated by the Department of Census and Statistics described in the "Sri Lanka Labour Force Survey Annual Report 2011".

Further, estimations from CoMTrans Home Visit Survey are also available and it is calculated that there are 2.0 million employed people in Sri Lanka.

Table 1.5.1 Employed Population (2001, 2012 and 2013)

	Total Population	10 Years and Over Population	% of 10 Years and Over Population to total	Economically Active Population (Labour Force)	Labour Force Participation Rate	Employed Population	Rate of Employed Population to Labour Force	Unemployed population	Unemployed Rate
2001 (Population Census)									
Colombo District	2,251,274	1,924,867	85.5%	912,231	47.4%	855,142	93.7%	57,089	6.3%
Gampaha District	2,063,684	1,739,940	84.3%	824,425	47.4%	756,186	91.7%	68,239	8.3%
Kalutara District	1,066,239	892,511	83.7%	395,777	44.3%	356,837	90.2%	38,940	9.8%
Western Province	5,381,197	4,557,318	84.7%	2,132,433	46.8%	1,968,165	92.3%	164,268	7.7%
Sri Lanka (18 District)*	16,929,689	14,006,335	82.7%	6,473,502	46.8%	5,941,574	91.8%	531,928	8.2%
2012 (Estimation based on the trend)									
Colombo District	2,309,809	1,949,971	84.4%	906,812	46.5%	880,294	97.1%	26,518	2.9%
Gampaha District	2,294,641	1,928,701	84.1%	827,437	42.9%	794,200	96.0%	33,237	4.0%
Kalutara District	1,217,260	1,006,643	82.7%	464,611	46.2%	448,743	96.6%	15,868	3.4%
Western Province	5,821,710	4,885,316	83.9%	2,196,538	45.0%	2,120,539	96.5%	75,999	3.5%
2013 (Estimation based on CoMTrans Home Visit Survey)									
Colombo District	2,309,809	2,062,811	89.3%	976,183	47.3%	836,029	85.6%	140,154	14.4%
Gampaha District	2,294,641	1,957,146	85.3%	898,272	45.9%	772,231	86.0%	126,041	14.0%
Kalutara District	1,217,260	998,571	82.0%	455,193	45.6%	377,234	82.9%	77,959	17.1%
Western Province	5,821,710	5,018,528	86.2%	2,329,649	46.4%	1,985,494	85.2%	344,155	14.8%

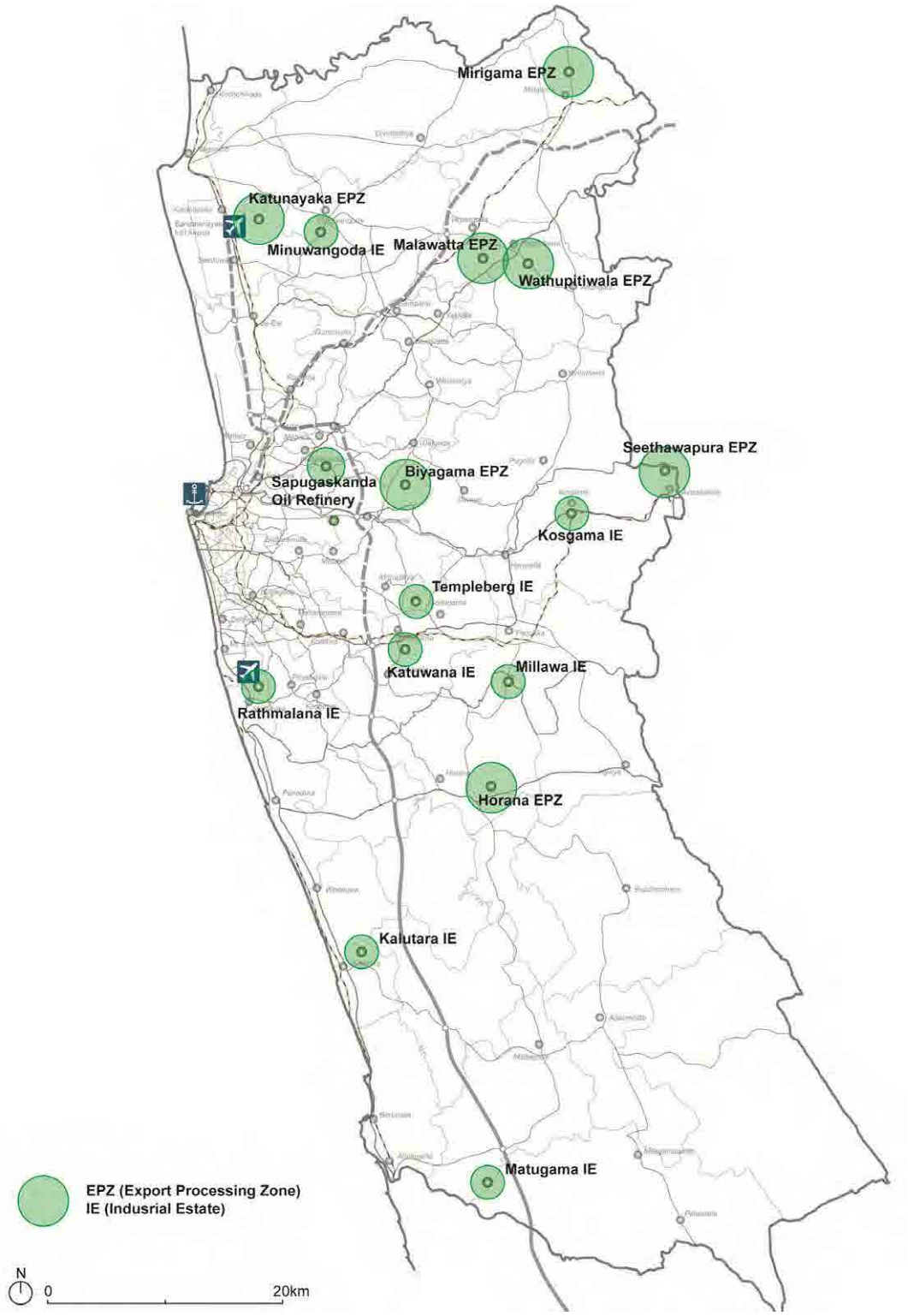
Note: * 18 Districts are; Colombo, Gampaha, Kalutara, Kandy, Matale, Nuwara Eliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle, where the detailed data of Census of Population and Housing 2001 are available.

2012 Estimation based on the trend by CoMTrans Study Team. Total population: Census of Population and Housing 2012, 10 years and over population: estimated by CoMTrans Study Team, Labour Force Participation Rate and Unemployment Rate: Sri Lanka Labour Force Survey Annual Report 2011, Department of Census and Statistics

2013 Estimation based on CoMTrans Home Visit Survey 2013

1.5.2 Current Status of the Employed Population by the Industrial Sector

Figure 1.5.1 shows the locations of EPZ (export processing zones) and other IE (industrial estates). In the suburbs of Colombo, there are a major EPZ located at Biyagama and other IEs such as Katuwana IE located south of Homagama and Templeberg IE located near Athurugiriya. In Gampaha District, fairly many industrial areas are found at Mirigama, Katunayake, Minuwangoda, Mawawatta, and Mathupitiwala. On the other hand, Kalutara District has fewer industrial areas. They affect the number of the secondary sector population.



Source: CoMTrans Study Team

Figure 1.5.1 Locations of Export Processing Zones and industrial Estates

According to the census 2001 and CoMTrans Home Visit Survey 2013, populations by the industrial sector are shown in the following Table 1.5.2 and Figure 1.5.2.

In 2001, there were clear differences between the three districts. In Colombo District, 69% of working populations are engaged in the tertiary sector and the primary sector was only 2%. In Gampaha District, more secondary industries were active; approximately 41% were working for that group. In Kalutara district, 16 % were working for the primary industry, which was lower than the national level but the highest of the three districts. It is very clear that the share of the primary industry of Western Province was much less than that of the national level and it had a higher population share of the tertiary industry.

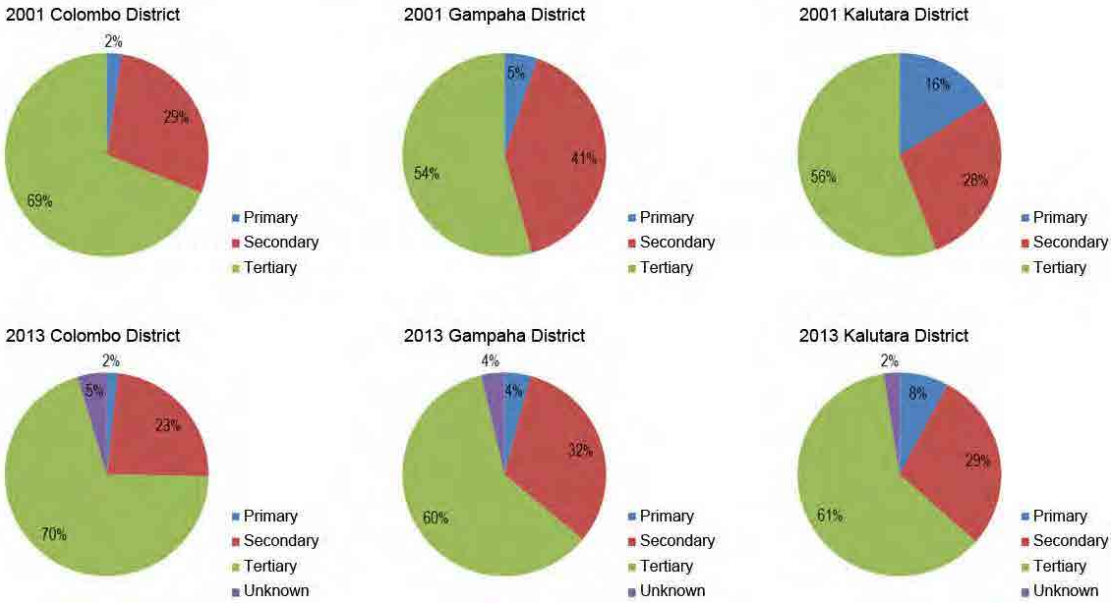
In 2012, the share of the industrial sector is estimated from HVS. The primary sector decreased except in Kalutara District. On the other hand, more than 60% are engaged in the tertiary sector.

Table 1.5.2 Employed Population by Major Industry Sector in Western Province (2001 and 2013)

2001	Primary		Secondary		Tertiary			
	No.	%	No.	%	No.	%		
Colombo District	20,392	2.4%	245,492	28.7%	589,258	68.9%		
Gampaha District	40,055	5.3%	305,194	40.4%	410,937	54.3%		
Kalutara District	57,668	16.2%	99,675	27.9%	199,494	55.9%		
Western Province	**118,115**	**6.0%**	**650,361**	**33.0%**	**1,199,689**	**61.0%**		
Sri Lanka (18 District)*	**1,707,720**	**28.7%**	**1,331,126**	**22.4%**	**2,902,728**	**48.9%**		
2013	**Primary**		**Secondary**		**Tertiary**		**Unknown**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Colombo District	13,327	1.8%	175,955	23.5%	523,821	70.0%	34,912	4.7%
Gampaha District	27,553	4.1%	212,235	31.9%	401,103	60.3%	24,448	3.7%
Kalutara District	24,614	7.9%	89,529	28.6%	190,524	61.0%	7,837	2.5%
Western Province	**65,494**	**3.8%**	**477,719**	**27.7%**	**1,115,448**	**64.6%**	**67,196**	**3.9%**

Note: * 18 Districts are; Colombo, Gampaha, Kalutara, Kandy, Matale, Nuwara Eliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle, where the detailed data of Census 2001 was available.

2001 – Census of Population and Housing 2001, Department of Census and Statistics
2013 – Estimation based on CoMTrans Home Visit Survey 2013



Note: 2001: Census of Population and Housing 2001, Department of Census and Statistics
2012: Estimation based on CoMTrans Home Visit Survey 2013

Figure 1.5.2 Employed Population by Major Industry Sector in Western Province (2001 and 2012)

1.6 Student Population

In the Census 2001, the following details of the student population are available, but the detailed results of census 2012 are not published yet. In the Western Province in 2001, 1,187,674 people were students, which were 22% of the total population, and school students of Grade 1 to GCE Advanced Level were 17.7% of the total population. As for the university students, only 0.6 % of the total population are attending. The rate is slightly higher than the national level, however it was still very low.

The Colombo District and the Gampaha District have more than 370,000 school students in each District, while the Kalutara District has around 200,000 school students. In the Colombo District, there are 20,000 students since many major universities are concentrated in the District. Other educational facilities are also located in the Colombo District. The student populations in Western Province are shown in Table 1.6.1.

On the other hand, the estimated student population is calculated from HVS and it is shown in Table 1.6.2.

Table 1.6.1 Student Population in Western Province (2001)

	Sri Lanka (18 District)*	% to Total Population	Colombo District	Gampaha District	Kalutara District	Western Province	% to Total Population
Total Population	**16,929,689**		2,251,274	2,063,684	1,066,239	**5,381,197**	
Pre School	**382,287**	2.3%	53,700	48,501	24,268	**126,469**	2.4%
School Student **	**3,593,726**	21.2%	373,938	372,318	205,138	**951,394**	17.7%
University	**65,506**	0.4%	20,021	8,743	3,302	**32,066**	0.6%
Vocational / Technical Institution	**74,557**	0.4%	15,226	11,505	5,708	**32,439**	0.6%
Other Educational Institute	**124,291**	0.7%	22,224	15,293	7,789	**45,306**	0.8%
Total Student	**4,240,367**	**25.0%**	**485,109**	**456,360**	**246,205**	**1,187,674**	**22.1%**

Note: * 18 Districts are; Colombo, Gampaha, Kalutara, Kandy, Matale, Nuwara Eliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle, where the detailed data of Census 2001 was available.
** School Student indicates Grade 1 to G.C.E. A/L.

Source: Census of Population and Housing 2001, Department of Census and Statistics,

Table 1.6.2 Estimated Student Population in Western Province (2013)

	Colombo District	Gampaha District	Kalutara District	Western Province	*% to Total Population*
Total population	2,309,809	2,294,641	1,217,260	**5,827,710**	
Kindergarten	5,316	6,739	4,780	**16,834**	*0.3%*
Student (Grade1 - G.C.E(A/L))	464,530	473,349	253,853	**1,191,731**	*20.5%*
Student (grade1 - grade5)	168,094	178,546	97,922	**444,562**	*7.6%*
Student (grade6 - grade8)	112,834	116,168	62,365	**291,367**	*5.0%*
Student (grade9 - grade10)	70,883	70,231	38,259	**179,373**	*3.1%*
Student (G.C.E. (O/L))	53,912	51,151	24,817	**129,880**	*2.2%*
Student (G.C.E. (A/L))	58,807	57,253	30,490	**146,549**	*2.5%*
University Student	22,778	15,924	5,956	**44,659**	*0.8%*
Student (Graduate)	22,367	15,623	5,525	**43,515**	*0.7%*
Student (Post Graduate)	224	176	431	**831**	*0.0%*
Student (Ph.D.)	187	125	0	**313**	*0.0%*
Other Students	11,455	12,520	5,183	**29,158**	*0.5%*
Total Student	**411,039**	**422,834**	**228,143**	**1,062,017**	***18.2%***

Source: CoMTrans Home Visit Survey 2013

1.7 Population by Household Income

Population by household income group is only available from the HVS conducted by CoMTrans Study Team. It is considered that income below 39,999 Rs is Group C, income between 40,000 and 79,999 is Group B and income 80,000 and over is Group A. This classification is defined by the transport mode which people in each income level use. Share of private car users are very high among the Group A people and extremely low among the Group C people. On the other hand, a high percentage of Group C people walk or bicycle for their trips.

The income status is summarised in the following Table 1.7.1.

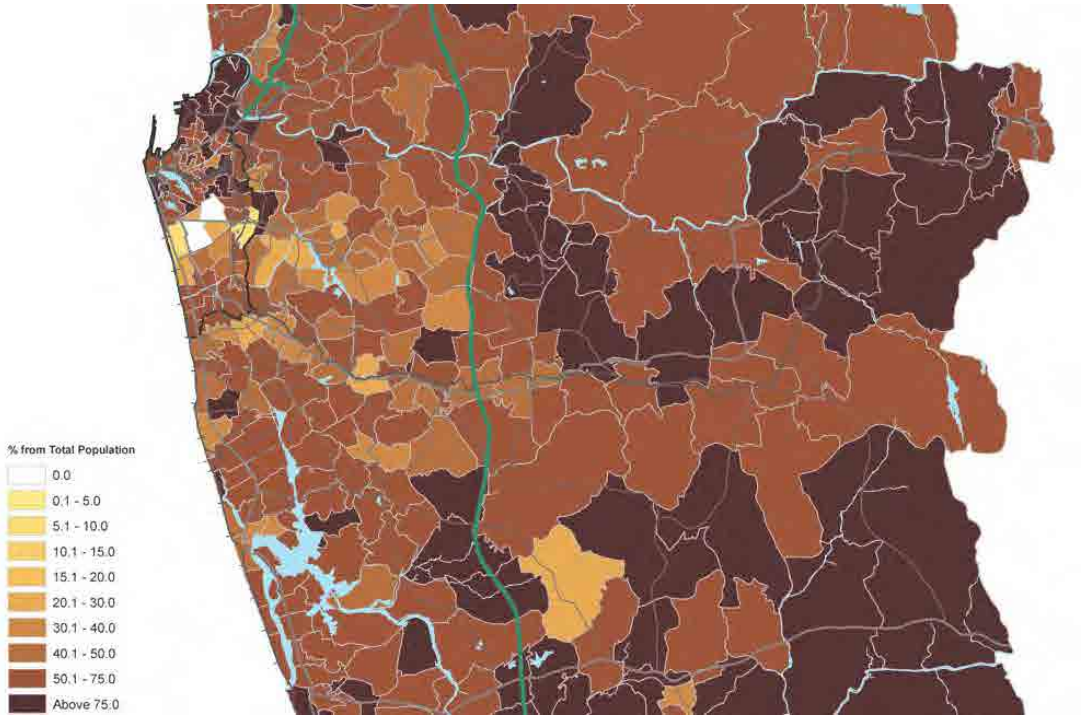
In 2012, more than 60% of the population earned less than 40,000 Rs per month. On the other hand, very few are in the Group A population; it is less than 10 %.

Table 1.7.1 Population by Household Income level in Western Province according to HVS (2013)

Income	Group C	Group B	Group A							Unknown
	Less than Rs. 40,000	Rs. 40,000 - 79,999	**Total of Group A (Rs. 80,000 and Above)**	Rs. 80,000 - 119,999	Rs. 120,000 - 159,999	Rs. 160,000 - 199,999	Rs. 200,000 - 299,999	Rs. 300,000 - 399,999	Rs. 400,000 and Above	
Colombo Dis.	**1,339,059**	**616,243**	**247,922**	**140,430**	**59,631**	**20,116**	**14,050**	**8,009**	**5,686**	**2,758**
Share	*60.8%*	*28.0%*	*11.3%*	*6.4%*	*2.7%*	*0.9%*	*0.6%*	*0.4%*	*0.3%*	*0.1%*
Gampaha Dis.	**1,444,092**	**520,258**	**146,562**	**109,387**	**19,157**	**8,847**	**6,880**	**1,814**	**477**	**3,494**
Share	*68.4%*	*24.6%*	*6.9%*	*5.2%*	*0.9%*	*0.4%*	*0.3%*	*0.1%*	*0.0%*	*0.2%*
Kalutara Dis.	**835,680**	**204,107**	**42,254**	**30,422**	**4,358**	**3,982**	**3,129**	**135**	**228**	**4,556**
Share	*77.2%*	*18.9%*	*3.9%*	*2.8%*	*0.4%*	*0.4%*	*0.3%*	*0.0%*	*0.0%*	*0.4%*
Western Prov.	**3,618,830**	**1,340,608**	**436,736**	**280,239**	**83,145**	**32,945**	**24,059**	**9,957**	**6,391**	**10,808**
Share	*67.1%*	*24.8%*	*8.1%*	*5.2%*	*1.5%*	*0.6%*	*0.4%*	*0.2%*	*0.1%*	*0.2%*

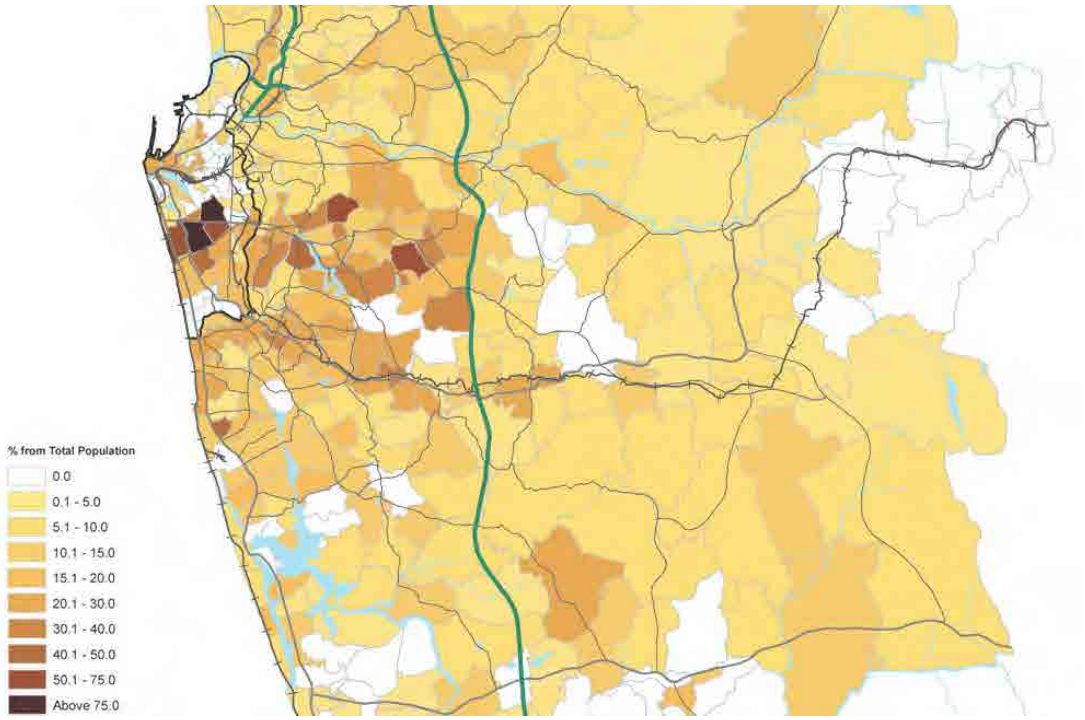
Note: Range is co-related with the HVS
Source: CoMTrans Home Visit Survey

Figure 1.7.1 and Figure 1.7.2 shows the percentage of Group C and Group A population according to TAZ. The percentage of the Group C population is high in the northern part of CMC and in rural areas. On the other hand, the middle of CMC has a high percentage of the Group A population. TAZs along Malabe Corridor have relatively high Group A populations.



Source: CoMTrans Home Visit Survey

Figure 1.7.1 Percentage of Group C Population (2013)



Source: CoMTrans Home Visit Survey

Figure 1.7.2 Percentage of Group A Population (2013)

CHAPTER 2. Economic Activities and Public Finance

2.1 Economic Status

2.1.1 GDP and Foundation of Economic Growth

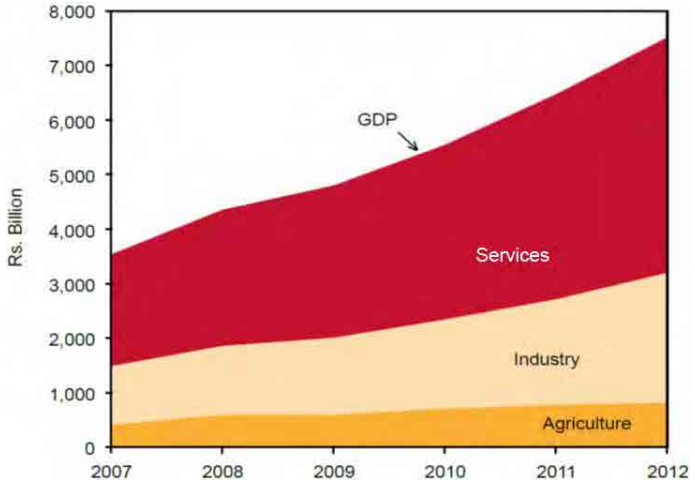
(1) National GDP and Growth

Sri Lanka has continuing high growth of Gross Domestic Product (GDP), especially just after the end of the civil conflict in 2009, it was more than 8% in 2010 and 2011. The Central Bank of Sri Lanka has estimated that GDP growth has dropped to 6.4% in 2012. Although it is lower than the year before, there is a continuation of the benefits arising from the end of the long-running civil conflict. Table 2.1.1 summarises the National GDP, and Figure 2.1.1 shows the changes in the GDP.

Table 2.1.1 Summary of GDP in Sri Lanka (2006 -2012)

Item	2006	2007	2008	2009	2010	2011	2012*
GDP at Constant (2002) Price (Mil.Rs.)	2,090,564	2,232,656	2,365,501	2,449,214	2,645,542	2,863,715	3,047,277
GDP at Current Market Price (Mil.Rs.)	2,938,680	3,578,688	4,410,682	4,835,293	5,604,104	6,544,009	7,582,376
Growth of GDP	7.7%	6.8%	6.0%	3.5%	8.0%	8.2%	6.4%
GDP per Capita at Current Market Price (Rs.)	147,776	178,845	218,167	236,445	271,346	313,576	373,001

Note: * Provisional
Source: Economic and Social Statistics of Sri Lanka 2013, by Central Bank of Sri Lanka



Source: Central Bank of Sri Lanka

Figure 2.1.1 GDP in Sri Lanka

Table 2.1.2 summarises the GDP by industrial sector. In terms of the share of each industrial sector, the primary industry has slightly declined, the secondary industry is growing, and the tertiary industry has kept the same level. Key sector growth of the tertiary industry, which accounts for 57.5% of GDP, grew by 8.5% through the expansion of wholesale and retail trade, tourist arrivals (leaped by 31% to 855,975 in 2011), banking, insurance, and real estate.

Forecast growth is seen to continue in the above sectors as well as stimulating, (a) Construction; through continued and planned infrastructure and tourism-related building, and (b) Services; especially hotels and restaurants benefiting from the tourist boom.

Table 2.1.2 GDP by Sector Origin at Current Market Prices of Sri Lanka (2006 – 2012)

Item	2006	2007	2008	2009	2010	2011	2012*
GDP of Primary Industry (Mil.Rs.)	333,137	418,104	590,114	613,694	717,910	792,457	837,883
GDP of Secondary Industry(Mil.Rs.)	900,479	1,070,737	1,295,470	1,434,701	1,649,268	1,956,659	2,387,659
GDP of Tertiary Industry(Mil.Rs.)	1,705,064	2,089,847	2,525,099	2,786,897	3,236,926	3,794,893	4,356,833
Share of Primary Industry	*11.3%*	*11.7%*	*13.4%*	*12.7%*	*12.8%*	*12.1%*	*11.1%*
Share of Secondary Industry	*30.6%*	*29.9%*	*29.4%*	*29.7%*	*29.4%*	*29.9%*	*31.5%*
Share of Tertiary Industry	*58.0%*	*58.4%*	*57.2%*	*57.6%*	*57.8%*	*58.0%*	*57.5%*

Note: * Provisional
Source: Central Bank of Sri Lanka

(2) Growth Forecast by Sri Lankan Government

The forecast by the Sri Lankan Government is that the economy will continue its trend with high growth and the GDP will increase by 8% continuously to 2015. Table 2.1.3 shows the GDP growth forecast by the Central Bank of Sri Lanka.

Table 2.1.3 GDP Forecast to 2015 by Central Bank of Sri Lanka

Year	2012	2013	2014	2015
GDP Growth Rate (%)	6.5	7.5	8.0	8.3

Source: Central Bank of Sri Lanka

In the view of the Sri Lankan Government, the prime challenge to the continuation of high growth is that, currently, investment is too low to achieve the national development goals. Private investment, in particular, needs to be substantially scaled up. In this respect there are a number of structural impediments to large-scale private investments identified by the World Bank's "Doing Business 2011 Report" that will have to be addressed, they are; the elimination of red tape, strengthening institutions, building human resources capacity, and simplifying procedures.

Mahinda Chintana, which is a development policy framework of Sri Lanka setting out development visions for a ten year period, emphasises the need to improve the business environment more widely. The intention is to capitalise upon the country's strategic

geographical location to develop maritime, aviation, commercial, energy and knowledge hubs as key links between the Eastern and Western global economies.

(3) Growth Forecast by IMF

On the other hand, the International Monetary Fund (IMF) has forecast GDP growth of Sri Lanka in the "World Economic Outlook, April 2013 - Hopes, Realities, Risks". The forecasts are shown in Table 2.1.4. At least until 2018, the GDP growth will stay at a rate of over 6%, which is lower than the forecast by the Central Bank of Sri Lanka.

Table 2.1.4 GDP Forecast to 2018 by IMF

Year	2013	2014	2018
GDP Growth Rate (%)	6.3	6.7	6.5

Source: "World Economic Outlook, April 2013 - Hopes, Realities, Risks", IMF

2.1.2 GRDP of Western Province

The Western Province is the most developed and urbanised region in Sri Lanka and the Gross Regional Domestic product (GRDP) has accounted for nearly 45% of the national GDP over the past five years. The "City Cluster Economic Development – Sri Lanka Case Study" 2010 by the Asian Development Bank, identified Western Province as the main area in Sri Lanka for accelerated economic growth. The study states that the focus should be on: "developing this region to attract Foreign Direct Investment, promote economic and business activities, and develop internal linkages through trade, create a financial hub and develop information technology together with Business Processing Outsourcing (BPO) etc."

In terms of the share, the tertiary industry has had 64%, which is higher than the rate of the National GDP. Table 2.1.5 summarised GRDP of Western Province.

Table 2.1.5 GRDP at Current Market Prices of Western Province (2006 – 2011)

Item	2006	2007	2008	2009	2010	2011*
GDP at Current Price of Sri Lanka (Mil.Rs.)	**2,938,680**	**3,578,688**	**4,410,682**	**4,835,293**	**5,604,104**	**6,544,009**
GRDP at Current Price of Western Province (Mil.Rs.)	**1,472,065**	**1,663,759**	**2,003,055**	**2,216,346**	**2,512,908**	**2,905,159**
Share of Western Prov. to Sri Lanka	50.1%	46.5%	45.4%	45.8%	44.8%	44.4%
GRDP of Primary Industry (Mil.Rs.)	24,730	48,595	62,076	60,955	75,942	93,308
GRDP of Secondary Industry (Mil.Rs.)	488,168	531,248	634,274	732,406	802,790	948,994
GRDP of Tertiary Industry (Mil.Rs.)	959,168	1,083,915	1,306,706	1,422,985	1,634,176	1,862,858
Share of Primary Industry	*1.7%*	*2.9%*	*3.1%*	*2.8%*	*3.0%*	*3.2%*
Share of Secondary Industry	*33.2%*	*31.9%*	*31.7%*	*33.0%*	*31.9%*	*32.7%*
Share of Tertiary Industry	*65.2%*	*65.1%*	*65.2%*	*64.2%*	*65.0%*	*64.1%*

Note: * Provisional
Source: Central Bank of Sri Lanka

The ADB study highlighted the opportunities and benefits to be gained from the competitive advantage of Industry Clusters. The basis for developing and/or consolidating existing industries into industry clusters are already in evidence within the Transport/Storage and Communication Sectors, the IT Sector, and the Textile & Apparel Sector. At a wider scale, the ADB study set out the "Economic Vision" for Western Province as:

- Financial Hub (Banking/Insurance)
- Rubber City (Rubber Products)
- Apparel Hub (Ready Made Garments)
- Tourism Hub (Travel & Leisure)
- Logistics Hub (Shipping and Aviation)
- Knowledge Hub (IT/Education)

Developing the Knowledge Economy (K Economy)

In addition, Western Province is experiencing the development of a range of K economy facilities including centres for Nanotechnology, Biotechnology, Tertiary Education, and Sports. This is a Government commitment to investing in knowledge, especially though the medium of high technology, as part of "The National Science and Technology Policy", approved by the Cabinet of Ministers in 2009.

The recent 'Science, Technology & Innovation Strategy for Sri Lanka, 2011-2015' by the Ministry of Technology and Research, defines a clear road map for the development of the K economy sector as a driver of increased GDP per capita, "by increasing high tech value added exports from the (current) 1.5% to 10% by 2015 through the Advanced Technology Initiative". The strategy identifies the establishment of a network of Science Parks, to include:

- Megapolis - central hub for research and development in Colombo,
- Technopolis / Science & Technology corridors at the regional level, and
- Minipolis at the district level.

The initiative also emphasises the need for a highly educated local technical base through training of Research and Development scientists, the establishment of Research Institutes and providing Science Centres to increase science study and career opportunities.

An Equitable Economy

A development strategy based on economic growth by itself is not sustainable. The Sri Lankan New Development Strategy - Framework for Economic Growth and Poverty Reduction (2006) by the Department of National Planning, Ministry of Finance and Planning states: "Higher economic growth alone is not sufficient to reduce poverty; instead it should focus on pro-poor growth strategies. A sustainable 6-8 per cent growth in real income is targeted over the next five years. This in turn requires raising investment to around 35 per cent of Gross Domestic Product (GDP). Such investments include domestic and foreign investment as well as public investment. The ultimate objective is to ensure that Sri Lanka steadily progresses towards an upper Group B country status within the next ten years".

The following sections describe other economic indicators in Sri Lanka and Western Province.

2.1.3 Consumer Price Index (CPI) and Inflation

The Consumer Price Index shows inflation clearly. The prices have become almost 2.5 times more expensive in the past ten years and have increased by around 7% in recent years. There was a significant increase from 2007 to 2008; CCPI of Transport rose to 240.3 from 178.1, which is a 35% increase. It is assumed that the reason was the increase in petroleum prices. According to the data from the Central Bank of Sri Lanka, the wholesale price index of petroleum products increased 30% in this period. Table 2.1.6 shows the Consumer Price Index, based on the year of 2002. Rates of annual price increase had been more than 10% a few years ago, which is considered to be galloping inflation, however, the rate has been moderate in recent years.

As for the sub-indices, except for the communication prices, the index of which was 109.4 in 2012, many indices indicate almost 200.

It is noted that the index of Transport prices was 313.4 in 2012 compared to a base of 100 in 2002. This was a significant increase from 2007 to 2008; CCPI of Transport rose to 240.3 from 178.1, which is a 35% increase. It is assumed that the reason was the increase in petroleum prices. According to the data from the Central Bank of Sri Lanka, the wholesale price index of petroleum products increased 30% in this period.

Table 2.1.6 Colombo Consumer Price Index (2003 – 2012)

CCPI (2002=100) *		2003	2004	2005	2006	2007	2008	2009	2010	*2011*	*2012*
All Items (Average)		105.8	115.3	128.0	140.8	163.1	199.9	206.8	219.1	*233.9*	*251.5*
Percentage Change		5.8	9.0	11.0	10.0	15.8	22.6	3.4	5.9	*6.7*	*7.6*
Sub-Indices	Food and Non-Alcoholic Beverages	102.6	111.9	124.7	135.8	163.4	213.3	219.2	234.2	*254.7*	*266.8*
	Clothing and Footwear	106.8	112.1	117.9	127.7	140.7	154.8	165.3	176.6	*200.2*	*219.9*
	Housing, Water, Electricity, Gas and Other Fuels	112.0	123.1	146.4	174.2	206.6	226.8	227.5	235.3	*245.6*	*269.3*
	Furnishing, H/H Equipment and Routine Household Maintenance	104.7	109.5	117.6	124.7	134.4	154.1	168.0	176.4	*184.4*	*196.7*
	Health	107.1	107.1	108.0	113.1	115.5	163.2	194.8	227.8	*234.0*	*241.0*
	Transport	106.7	125.4	141.2	156.7	178.1	240.3	238.8	240.7	*257.8*	*313.4*
	Communication	107.8	121.6	121.4	120.5	119.8	100.0	107.0	109.4	*109.4*	*109.4*
	Recreation and Culture	101.7	107.0	113.1	113.6	119.5	128.3	161.8	168.7	*177.9*	*185.1*
	Education	107.9	114.1	119.7	126.3	133.7	141.0	152.0	171.3	*177.2*	*178.0*
	Miscellaneous Goods and Services	111.6	119.3	124.5	131.3	140.5	156.3	168.5	180.7	*187.6*	*195.3*
CCPI (2006/7=100) **							**2008**	**2009**	**2010**	**2011**	**2012**
All Items (Average)							129.2	133.6	141.9	151.5	162.9
Percentage Change								3.5	6.2	6.7	7.6
Sub-Indices	Food and Non-Alcoholic Beverages						144.0	148.5	158.8	172.7	180.9
	Clothing and Footwear						112.5	122.0	130.2	147.6	162.1
	Housing, Water, Electricity, Gas and Other Fuels						114.0	115.1	119.2	124.4	136.4
	Furnishing, H/H Equipment and Routine Household Maintenance						113.0	122.5	128.0	133.8	142.7
	Health						150.4	184.7	233.9	240.3	247.5
	Transport						141.7	138.4	139.7	149.6	181.9
	Communication						82.6	88.2	90.3	90.3	90.3
	Recreation and Culture						116.1	122.7	131.8	139.0	144.6
	Education						110.3	120.7	135.9	140.6	141.2
	Miscellaneous Goods and Services						113.3	122.4	126.3	131.1	136.5

Note: *Colombo Consumer Price Index (2002=100). CCPI in 2011 and 2012 are calculated by CoMTrans Study Team
** The rebased CCPI (2006/07=100) has replaced CCPI (2002=100) from June 2011.

Source: Central Bank of Sri Lanka

The wage rate indices are also constantly rising. In 2012, there was a 22% rise on Average. In the past 10 years, the wage almost tripled. Table 2.1.7 summarises the wage rate indices.

Table 2.1.7 Nominal Wage Rate Index (2003 – 2012)

Wage Rate Indices *	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012**
Workers in Agriculture	1,382.2	1,397.7	1,527.4	1,567.1	1,821.4	2,286.6	2,349.4	3,327.6	3,427.2	4,433.0
Percentage Change		*1.1*	*9.3*	*2.6*	*16.2*	*25.5*	*2.7*	*41.6*	*3.0*	*29.3*
Workers in Industry & Commerce	1,009.4	1,044.1	1,078.4	1,090.7	1,522.4	1,877.5	2,054.0	2,199.0	2,402.1	2,402.1
Percentage Change		*3.4*	*3.3*	*1.1*	*39.6*	*23.3*	*9.4*	*7.1*	*9.2*	*0.0*
Workers in Service	678.0	751.0	779.7	779.7	1,057.1	1,370.8	1,545.8	1,673.3	1,851.8	1,851.8
Percentage Change		*10.8*	*3.8*	*0.0*	*35.6*	*29.7*	*12.8*	*8.2*	*10.7*	*0.0*
All Workers	1,205.2	1,233.0	1,329.7	1,358.2	1,648.8	2,070.4	2,171.4	2,865.3	2,996.1	3,662.0
Percentage Change		*2.3*	*7.8*	*2.1*	*21.4*	*25.6*	*4.9*	*32.0*	*4.6*	*22.2*

Note: * Wage Index (1978 December =100), ** Provisional
Source: Central Bank of Sri Lanka

2.1.4 Household Income and Distribution

The median income, which divides the income distribution into two equal sized groups, was 23,746 Rs. per month in 2009/1010, and the mean income, which is the amount obtained by dividing the total aggregate income of a group by the number of units in that group, was 36,451 Rs. per month. Both income levels increased from the year of 2006/2007 to 2009/2010 by around 10% annually. The income of rural areas grew more than those of urban areas. The household incomes and expenditures in the Western Province were higher but the increase rate was the same as the national level. Similarly, expenditures showed an approximate 10% increase annually. The incomes and expenditures are summarised in Table 2.1.8.

Table 2.1.8 Household Income and Expenditure (2006/07 and 2009/10)

Income / Expenditure per Household (Rs./Month)	2006/07 *			2009/10 **			Annual Increase Rate (06/07-09/10)***		
	Urban	Rural	All Island	Urban	Rural	All Island	Urban	Rural	All Island
Sri Lanka									
Mean Income	41,928	24,039	26,286	47,783	35,228	36,451	4.5%	13.6%	11.5%
Median Income	23,642	16,379	16,735	31,000	23,126	23,746	9.5%	12.2%	12.4%
Expenditure	35,274	21,440	22,952	44,928	29,423	31,331	8.4%	11.1%	10.9%
Western Province									
Mean Income	N/A	N/A	34,282	N/A	N/A	47,118	N/A	N/A	11.2%
Median Income	N/A	N/A	21,686	N/A	N/A	30,600	N/A	N/A	12.2%
Expenditure	N/A	N/A	31,437	N/A	N/A	42,399	N/A	N/A	10.5%

Note: * Excluding the Northern Province and Tricomalee district in the Eastern province, ** Excluding Mannar, Kilinochchi and Mullaitivu districts. *** Calculated by CoMTrans Study Team

Source: Central bank of Sri Lanka

Income distribution and Gini coefficients is shown in Table 3.3.8. Nationwide, the total income share stayed almost the same in the years of 2006/2007 and 2009/2010. The richest 20 % of the households shared more than 50% of the total income. In the urban areas, the top decile households together earned 50.3% of the total income.

The Gini coefficient is commonly used as a measure of inequality of income or wealth; a low Gini coefficient indicates a more equal distribution, while a higher Gini coefficient indicates a more unequal distribution. In the case of Sri Lanka, the Gini Coefficients were around 0.5, which is very high and considered unequal. In the urban areas, it improved to the range of 0.54 to 0.48. The Gini coefficient of Western Province is almost the same as the National level.

Table 2.1.9 Income Share and Gini Coefficients (2006/07 and 2009/10)

Items	2006/07 *			2009/10 **		
	Urban	Rural	Total	Urban	Rural	Total
Income Share by Decile of Household % (Sri Lanka)						
1st Decile	1.5	1.7	1.6	0.6	1.7	1.6
2nd Decile	2.7	3.1	2.9	1.5	3.1	2.9
3rd Decile	3.5	4.2	3.9	2.0	4.1	3.9
4th Decile	4.2	5.1	4.8	3.0	5.1	4.9
5th Decile	5.1	6.2	5.8	3.7	6.3	6.0
6th Decile	6.3	7.5	7.0	5.7	7.3	7.1
7th Decile	7.4	9.1	8.5	7.7	8.9	8.7
8th Decile	9.7	11.3	10.8	9.9	11.1	10.8
9th Decile	13.2	15.2	14.6	15.7	14.6	14.6
10th Decile	46.2	36.5	40.1	50.3	37.7	39.5
Gini Coefficient (Households), Monthly Income						
Gini Coefficient (Sri Lanka)	0.54	0.46	0.49	0.48	0.49	0.49
Gini Coefficient (Western Province)			0.49			0.47

Note: * Excluding the Northern Province and Tricomalee district in the Eastern province.
** Excluding Mannar, Kilinochchi and Mullaitivu districts.

Source:Central Bank of Sri Lanka

2.1.5 Unemployment

In the past ten years, unemployment rates have improved from 8.8% in 2002 to 4.2% in 2011. The latest published data is available on the website of the Department of Census and Statistics, the "Labour Force Survey – Quarterly Report 2012 3rd Quarter" shows the latest unemployment rate at 4.1 %.

The unemployment rate for females was 6.8% and it was 2.7% for males. The youth unemployment rate was higher than the other age groups; unemployment of 15-19 year olds was 15.4% in 2011.

In terms of level of education, educated people have higher unemployment rates. This has also improved from 17% to 8% in the past 10 years. On the other hand, unemployment rates of the uneducated population have been very low, less than 2% in the past 10 years.

The unemployment rates from 2002 to 2011 are shown in Table 2.1.10.

Table 2.1.10 Unemployment Rate of Sri Lanka (2002 - 2011)

Unemployment Rate (% of Labour Force)	2002 (d)	2003 (a)	2004 (b)	2005 (c)	2006 (d)	2007 (d)	2008 (a)	2009 (a)	2010 (a)	2011 (c)	2012 (c)
Total	8.8	8.4	8.3	7.7	6.5	6.0	5.2	5.8	4.9	4.2	4
Male	6.6	6.0	6.0	5.5	4.7	4.3	3.6	4.3	3.5	2.7	2.8
Female	12.9	13.2	12.8	11.9	9.7	9.0	8.0	8.6	7.7	7.0	6.2
Age Group											
15-19	30.1	30.3	28.3	30.8	23.1	21.6	20.6	20.9	20.3	15.5	18.9
20-29	20.1	19.4	19.2	17.2	15.9	15.0	13.2	15.4	13.8	12.3	11.3
30-39	4.0	3.9	4.0	3.8	3.3	3.3	3.1	3.7	3.1	2.7	2.5
40 and above	1.6	1.1	1.3	1.2	1.4	1.3	1.2	1.4	1.0	0.7	0.8
Level of Education											
No School / Grade 0-4	1.8	1.7	2.0	1.8	Ng	1.3	1.1	Ng	Ng	Ng	Ng
Grade 5-9	7.9	7.4	6.9	6.3	5.8	5.2	4.5	5.0	3.6	3.3	3.2
G.C.E (O/L)	13.3	13.0	12.3	11.5	9.9	8.2	7.4	8.5	6.9	5.2	6
G.C.E (A/L) and above	16.8	16.5	16.8	13.8	11.6	11.8	9.9	11.2	11.6	9.0	7.5
Urban and Rural Sector											
Urban Sector	8.4	8.9	8.4	6.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rural Sector	8.8	8.3	8.3	7.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Note: Ng: Negligible, n.a.: Not Available

Unemployed: Persons who are seeking and available for work, but had no employment during the reference period.
Unemployment Rate: The number of unemployed persons as a percentage of the labour force.

(a) Including Eastern Province but excluding Northern Province / (b) Excluding Mullaitivu and Kilinochchi districts / (c) All districts included / (d) Excluding Northern and Eastern Provinces. / Source: Department of Census and Statistics

2.1.6 Tourist Arrivals and Hotels

Visitors to Sri Lanka topped 1 million in 2012 continuing a year on year increase since the peace. It is obvious that since the end of the war in 2009, visitors rapidly increased at the rate of 46% in 2010. Currently, tourism is economically important and tourism accounts for 0.6% of GDP, and is the fifth largest foreign exchange earner. International tourists are attracted to Sri Lanka for its climate, beaches, natural scenery and wildlife, and its renowned World Heritage sites. Especially European tourists choose Sri Lanka as their vacation destination, 445,464 arrived in Sri Lanka in 2012. The increase in the number of tourists from the Middle East is also remarkable. It increased from 10,345 tourists in 2006 to 56,169 in 2012. This was almost a 500% increase in 5 years.

However, the number of hotel rooms did not increase in the past 10 years. Instead, room occupancy rates increased to 77%. The Government is targeting 2.5 million tourists by 2016, and even if that figure is not achieved in the short term, additional and a wider range of

accommodations will be required to meet the current increase in arrivals.

Visitors to Sri Lanka and Hotel Rooms are summarised in Table 2.1.11.

Table 2.1.11 Tourist Arrivals and Establishments Providing Accommodations

Item	2006	2007	2008	2009	2010	2011	2012*
Tourist Arrivals							
Total	**559,603**	**494,008**	**438,475**	**447,890**	**654,476**	**855,975**	**1,005,605**
Increase Rate (%)		**-11.7%**	**-11.2%**	**2.1%**	**46.1%**	**30.8%**	**17.5%**
Europe	242,666	220,021	196,627	196,433	292,378	365,630	445,464
Asia	242,132	202,480	173,042	174,534	244,124	333,841	380,289
North America	35,323	28,355	24,311	24,948	40,216	49,057	59,236
Australasia **	25,127	22,924	21,839	26,068	37,290	46,467	57,776
Middle East	10,345	13,554	16,776	23,741	37,540	56,330	56,169
Africa	3,235	2,712	2,141	1,549	2,308	3,614	5,045
Latin America ***	775	3,962	3,739	617	620	1,036	1,626
Number of Rooms in Accommodation							
Graded Establishments	14,218	14,604	14,793	14,461	14,714	14,653	15,510
Supplementary Establishments	4,989	5,030	5,319	5,946	5,895	6,141	6,632
Annual Room Occupancy Rate (%)	47.8%	46.2%	43.9%	48.4%	70.2%	77.1%	71.2%

Note: * Provisional
Source: Sri Lanka Tourism Development Authority and the Central Bank of Sri Lanka

2.2 Public Finance

2.2.1 Government Finance

Government Finance is summarised in the following Figure 2.2.1 and Table 2.2.1.

The Central Bank of Sri Lanka estimated the revenue of Sri Lanka in 2012 at 987.8 billion Rs, which was almost 3.5 times that of 2003 (284.4 billion Rs). Grants were also increased from 8 billion to 16 billion. Expenditures have been expanding as well. Current expenditures grew from 334.7 billion to 1,094.2 billion, which was 3.2 times as much.

As the scale of the government finance has been growing, the deficit has been increasing constantly. The overall budget had a 133.3 billion Rs. deficit in 2003 and it increased to 3.7 times as much, or 489.0 billion rupees in 2012. Outstanding government debt greatly increased from 1,864 billion Rs in 2003 to 6,000 billion Rs in 2012.

The share of the revenue to the GDP was around 15%, and this is decreasing in recent years and hit 13.0% in 2012. At the same time, share of the expenditure had been 22 to 24% but it decreased to 19.7% in 2012.

Since the growth of the expenditure was smaller than that of revenue, the deficit as a percentage of GDP tends to shrink. The government total debt as a percentage of the GDP was over 100% in 2003 and 2004, but it lowered to less than 80% recently. In terms of percentage to GDP, the finance is being improved.

Table 2.2.1 Government Finance (2003 – 2012)

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Revenue and Grants	**284.4**	**320.2**	**412.4**	**507.9**	**595.6**	**686.5**	**725.6**	**834.2**	**949.9**	**1,003.9**
Revenue	276.5	311.5	379.7	477.8	565.1	655.3	699.6	817.3	934.8	987.8
Grants	8.0	8.7	32.6	30.1	30.5	31.2	25.9	16.9	15.1	16.1
Total Expenditure and Net Lending	**417.7**	**476.9**	**584.8**	**713.6**	**841.6**	**996.1**	**1,201.9**	**1,280.2**	**1,400.1**	**1,492.9**
Current Expenditure	334.7	389.7	443.4	548.0	622.8	743.7	879.6	937.1	1,006.6	1,094.2
Capital Expenditure and Net Lending	83.0	87.2	141.4	165.7	218.8	252.4	322.4	343.1	393.5	398.6
Current Account Surplus(+)/Deficit(-)	**-58.2**	**-78.2**	**-63.6**	**-70.1**	**-57.7**	**-88.5**	**-179.9**	**-119.8**	**-71.9**	**-106.4**
Overall Budget Surplus(+)/Deficit(-)	**-133.3**	**-156.8**	**-172.4**	**-205.7**	**-246.0**	**-309.6**	**-476.4**	**-446.0**	**-450.2**	**-489.0**
Total Financing	**133.3**	**156.8**	**172.4**	**205.7**	**246.0**	**309.6**	**476.4**	**446.0**	**450.2**	**489.0**
Foreign	43.1	37.1	47.8	41.9	100.9	-4.6	230.8	243.8	219.0	286.5
Domestic	79.9	117.2	123.6	163.8	145.1	314.3	245.6	202.2	231.2	202.5
Privatisation Proceeds	10.2	2.4	1.0	–	–	–	–	–	–	-
Outstanding Government Debt	**1,863.9**	**2,139.5**	**2,222.3**	**2,582.6**	**3,041.7**	**3,589.0**	**4,161.4**	**4,590.2**	**5,133.4**	**6,000.1**
GDP at Current Price	*1,822.5*	*2,090.8*	*2,452.8*	*2,938.7*	*3,578.7*	*4,410.7*	*4,835.3*	*5,604.1*	*6,544.0*	*7,582.4*
Revenue, excluding grants as % of GDP	*15.2%*	*14.9%*	*15.5%*	*16.3%*	*15.8%*	*14.9%*	*14.5%*	*14.6%*	*14.3%*	*13.0%*
Total Expenditure and Net Lending as % of GDP	*22.9%*	*22.8%*	*23.8%*	*24.3%*	*23.5%*	*22.6%*	*24.9%*	*22.8%*	*21.4%*	*19.7%*
Overall Budget as % of GDP	*-7.3%*	*-7.5%*	*-7.0%*	*-7.0%*	*-6.9%*	*-7.0%*	*-9.9%*	*-8.0%*	*-6.9%*	*-6.4%*
Government Debt as % of GDP	*102.3%*	*102.3%*	*90.6%*	*87.9%*	*85.0%*	*81.4%*	*86.1%*	*81.9%*	*78.4%*	*79.1%*

Note: Billions of Sri Lankan Rupees

* Provisional

Source:Central bank of Sri Lanka

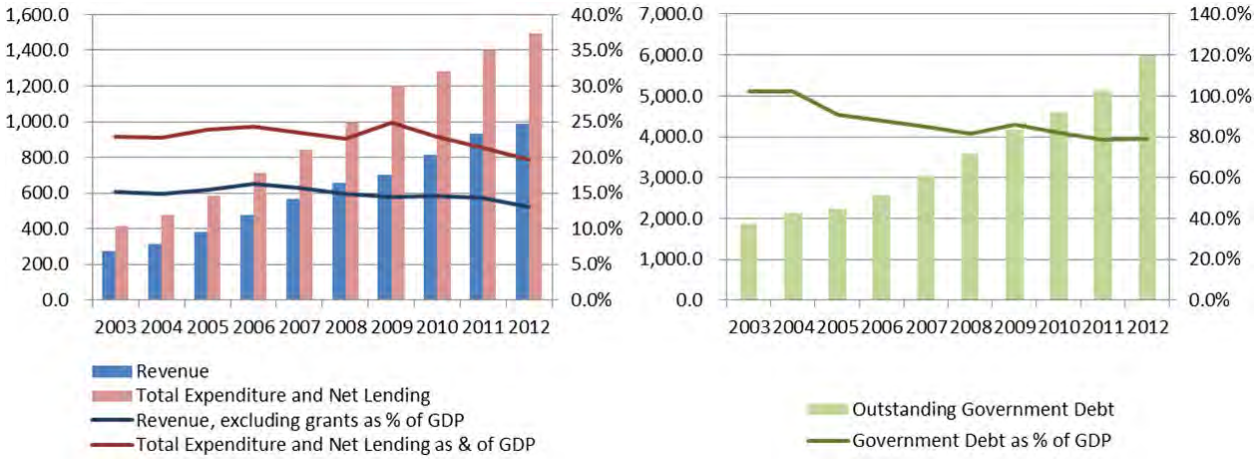


Figure 2.2.1 Revenue and Expenditure in Sri Lanka (2003-2012)

2.2.2 Expenditure in the Transport Sector

Based on the Annual Report by the Ministry of Finance and Planning, expenditures in the transport and communication sector are shown in Table 2.2.2. In this data, figures of the transport and communication sectors are added up.

Both the current and capital expenditures have increased in accordance with the rise in total expenditures. In recent years, more than 15% has been shared by the transport and communication sector in total. Whilst the share of current expenditures in the transport and communication sector has been very low, around 3%, the share of capital expenditures has been high. More than 40% is delegated to the transport and communication sector.

Table 2.2.2 Government Expenditure in the Transport and Communication Sector

Item	2007	2008	2009	2010	2011	2012*
Current Expenditure on All Sectors (Mil. Rs.)	622,758	743,710	879,575	937,094	1,008,244	1,093,192
Transport and Communication Sector (Mil. Rs.)	18,983	29,587	31,068	31,246	31,823	34,995
Share of Transport and Communication sector to All (%)	3.0%	4.0%	3.5%	3.3%	3.2%	3.2%
Capital Expenditure and Lending on All Sectors (Mil. Rs.)	229,273	263,859	330,448	356,519	438,962	481,804
Transport and Communication Sector (Mil. Rs.)	50,995	82,916	139,104	165,505	190,026	204,539
Share of Transport and Communication sector to All (%)	22.2%	31.4%	42.1%	46.4%	43.3%	42.5%
Total Expenditure and Lending on All Sectors (Mil. Rs.)	852,031	1,007,569	1,210,023	1,293,613	1,447,206	1,574,996
Transport and Communication Sector (Mil. Rs.)	69,978	112,503	170,172	196,751	221,849	239,534
Share of Transport and Communication sector to All (%)	8.2%	11.2%	14.1%	15.2%	15.3%	15.2%

Note: *Provisional

Sectorial Classification by the Ministry of Finance and Planning is; 1.General Public Services – 1.1.Civil Administration, 1.2.Defence, 1.3.Public Order and Safety / 2.Social Services – 2.1.Education, 2.2.Health, 2.3.Welfare, 2.4.Community Services / 3.Economic Services – 3.1.Agriculture & Irrigation, 3.2.Energy and Water Supply, 3.3.Transport & Communication / 4.Other

Source: Annual Report 2012, Ministry of Finance and Planning, Sri Lanka

Recurrent and capital expenditures of the major agencies under the Ministry of Transport and Ministry of Private Transport Services, and the Ministry of Highways, Ports and Shipping are shown in Table 2.2.3.

The Department of Sri Lanka Railways, Department of Motor Traffic, Sri Lanka Transport Board, National Transport Medical Institute, Lakdiva Engineering Company (Pvt) Ltd, and National Council for Road Safety are all under the Ministry of transport, and the National Transport Commission is under the Ministry of Private Transport Services. The expenditures have been increasing drastically since 2005, especially capital expenditure. The expenditure of the Department of Motor Traffic has stayed the same in recent years, but the expenditures of the other agencies have been increasing.

Expenditure of the Ministry of Highways, Ports, and Shipping was also drastically increased from the level of 2005. In recent years, the capital expenditure is more than 130 billion Sri Lankan Rupees, which is nearly 4 times larger than the capital expenditure of the Ministry of Transport.

Table 2.2.3 Recurrent and Capital Expenditure of Ministries and Agencies of Transport and Highway Sector (2005, 2010-2014)

Ministries / Agencies	Expenditure	Actual Allocation (Mil.Rs.)				Revised Budget (Mil. Rs.)	Estimated Budget (Mil.Rs.)
		2005	2010	2011	2012	2013	2014
Ministry of Transport	**Recurrent**	**7,609**	**11,871**	**14,173**	**15,844**	**18,781**	**20,066**
	Capital	**6,981**	**14,407**	**33,850**	**32,010**	**29,200**	**39,298**
Department of Sri Lanka Railways	Recurrent	5,512	7,191	8,295	8,648	10,791	11,197
	Capital	2,902	12,164	31,337	30,260	22,151	26,950
Department of Motor Traffic	Recurrent	507	716	1,789	1,529	1,448	1,446
	Capital	21	1,044	1,055	1,020	1,051	1,049
Sri Lanka Transport Board	Recurrent	1,337	3,827	3,938	5,516	6,365	7,245
	Capital	3,993	849	1,243	579	1,920	2,197
Ministry of Private Transport Services *	**Recurrent**	**NA**	**351**	**325**	**235**	**560**	**566**
	Capital	**NA**	**79**	**82**	**66**	**207**	**178**
National Transport Commission **	Recurrent	103	351	281	** 419	** 501	NA
	Capital	39	79	39	** 54	** 147	NA
Ministry of Highways, Ports, and Shipping ***	**Recurrent**	**587**	**254**	**196**	**196**	**217**	**229**
	Capital	**13,960**	**111,831**	**127,470**	**146,682**	**133,016**	**144,770**

Note: * Ministry of Private Transport Services was established in 2010

** Expenditure of National Transport Commission in 2012 is the revised budget allocation, 2013 is the estimated budget allocation, and 2014 is not available.

Source:National Budget Department

CHAPTER 3. Motor Vehicle Registrations and Ownership

3.1 Vehicle Population based on Revenue Licenses

The total number of vehicles based on the revenue licences in Western Province was 1,279,616 in 2012 according to the Motor Traffic Department of the Western Provincial Council. This number is the number of vehicles with a valid vehicle licence which is revised annually. It has grown continuously, and was 2.3 times larger than the revenue licences 10 years ago. Annually, it increased 8.5% on average. Comparing to the population growth, which showed a 0.7% increase annually, the increase rate of vehicle population is much higher.

Based on the revenue licence data, vehicles are classified into ten categories, Motor cars, Three Wheelers (Motor Tricycles), Motor Cycles, Mini Buses, Motor Couches, Dual purpose vehicles, Motor Lorries, Land vehicles, Ambulances, and Others. The number of motor cars increased as well, from 110,799 in 2002 to 244,636 in 2012. The number of motor cars per 100 people also doubled, from 2.0 in 2002 to 4.2 in 2012.

The number of three-wheelers has increased at a very high pace, almost 3.5 times in the past ten years. These remarkable increases in the number of vehicles are causing more and more severe traffic congestion in urban areas.

Vehicle populations from 2002 to 2012 are shown in Table 3.1.1 and Figure 3.1.1.

Table 3.1.1 Total Vehicle Population in Western Province 2002, 2008-2012

Vehicle Type	2002		2008	2009	2010	2011	2012	AAGR*
Motor Cars	110,799		183,687	182,078	200,986	237,233	244,636	8.2%
Three Wheelers	67,591		148,183	154,888	179,124	212,349	237,473	13.4%
Motor Cycles	208,685		421,324	416,527	464,405	508,828	542,858	10.0%
Mini Buses	7,028		6,493	6,461	6,916	6,658	6,530	-0.7%
Motor Coaches	9,296		11,290	10,920	12,090	12,698	13,421	3.7%
Dual Purpose Vehicles	81,720		102,613	100,840	105,831	117,332	125,642	4.4%
Motor Lorries	55,836		82,254	81,866	88,570	92,254	92,355	5.2%
Land Vehicles	11,827		14,969	14,300	14,902	14,922	14,367	2.0%
Ambulances	104		526	445	502	514	487	16.7%
Other	11,610		1,448	1,395	1,743	2,920	1,847	-16.8%
Total Revenue License	**564,496**		**972,787**	**969,720**	**1,075,069**	**1,205,708**	**1,279,616**	**8.5%**

Note: *AAGR: Average Annual Growth Rate from 2002 to 2012, calculated by CoMTrans Study Team

Source: Motor Traffic Department of the Western Provincial Council

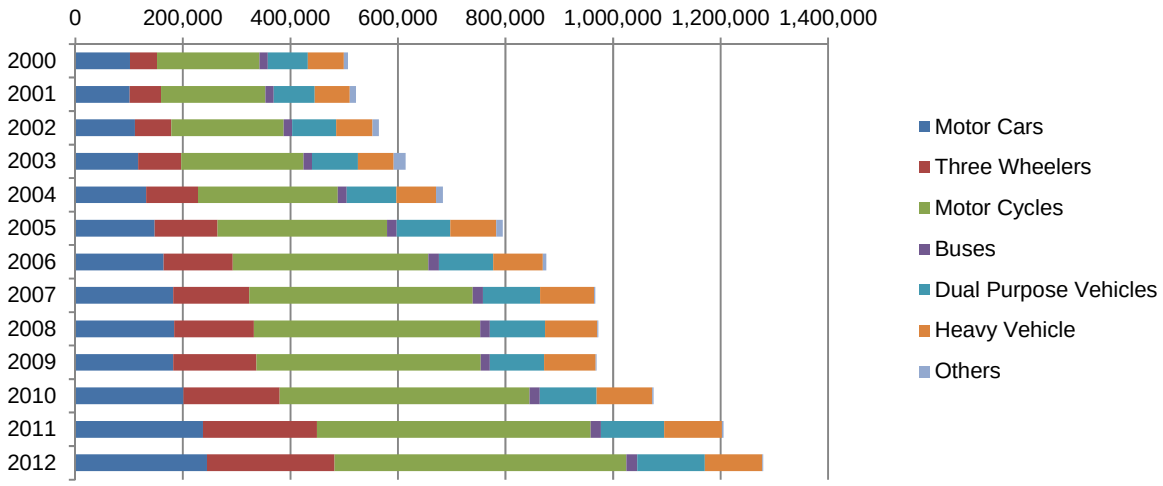


Figure 3.1.1 Vehicle Population in Western Province

3.2 Vehicle Registration in Sri Lanka and Western Province

3.2.1 New Registration of Motor Vehicles

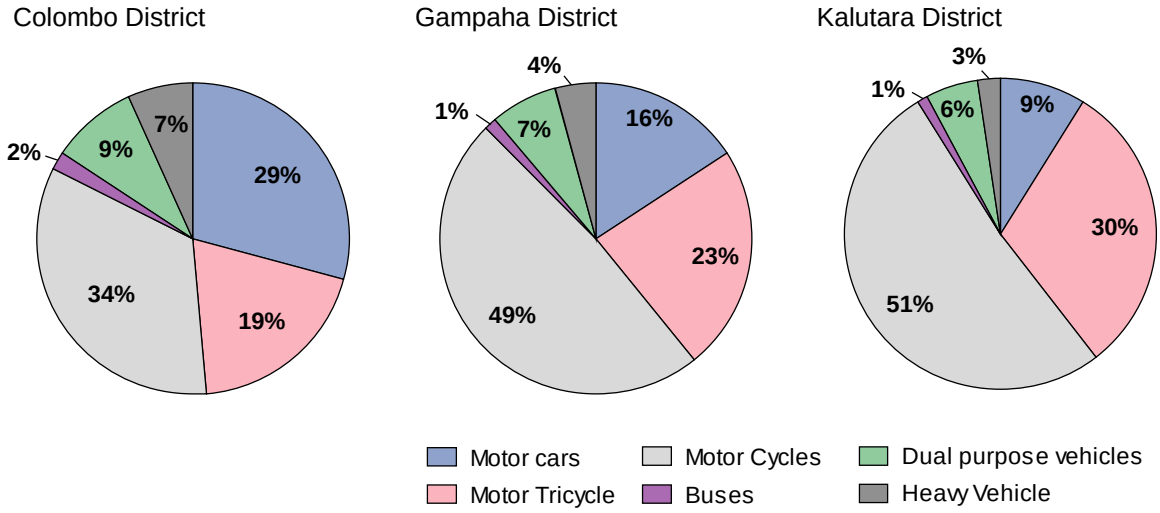
Vehicle registration depends largely on the government tax policy. Although the number of registered vehicles is increasing generally, there were low numbers registered in 2009, and the numbers significantly increased to 525,421 in 2011. Again, it dropped to 397,295 in 2012. More specifically, diesel vehicles were increasing but petrol vehicles were decreasing in this year. Around 30% of the total number of vehicles were registered in Western Province, and of these, around half are in Colombo District. The registered numbers of vehicles are listed in Table 3.2.1.

Approximately 29% of motor cars are in the Colombo District, but fewer motorcycles are registered. On the contrary, almost 50% of registered vehicles in Gampaha and Kalutara District are motorcycles and in these districts there are more tricycles than motor cars. The shares of registered vehicles in the Districts in Western Province are shown in Figure 3.2.1.

Table 3.2.1 New Registration of Motor Vehicles 2005-2012

Class of Vehicle	2005	2006	2007	2008	2009	2010	2011	2012
Motor cars	17,283	27,578	22,603	20,237	5,762	23,072	59,090	32,685
Motor Tricycles	41,085	64,466	43,068	44,804	37,364	85,648	138,446	98,819
Motorcycles	130,696	156,626	182,508	155,952	135,421	204,811	253,331	192,283
Buses	2,069	3,346	2,637	1,180	739	2,491	4,248	3,095
Dual purpose vehicles	6,851	7,245	5,193	2,856	1,280	11,712	33,518	37,398
Lorries	14,262	20,436	18,408	14,038	8,225	11,845	13,594	11,123
Land vehicles-Tractors	15,597	19,040	21,346	24,357	13,951	17,363	20,073	18,450
Land vehicles-Trailers	1,826	1,785	2,129	1,775	1,333	2,301	3,121	3,442
TOTAL in Sri Lanka	**229,669**	**300,522**	**297,892**	**265,199**	**204,075**	**359,243**	**525,421**	**397,295**
Total in Western Province			111,090	86,996	54,044	108,517	182,622	
Total in Colombo District			58,345	45,355	25,575	52,142	90,479	
Total in Gampaha District			36,056	27,988	19,287	38,358	63,389	
Total in Kalutara District			16,689	13,653	9,182	18,017	28,754	

Source: Department of Motor Traffic

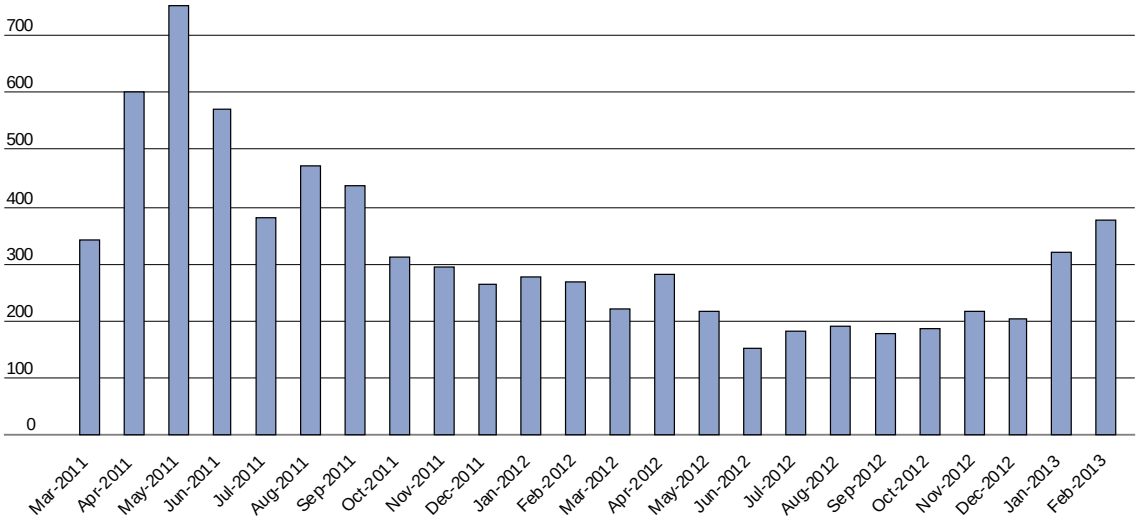


Note: Heavy Vehicles includes Lorries, Land-Vehicle Tractors, and Land-Vehicle Trailers
Source: Department of Motor Traffic

Figure 3.2.1 Share of Registered Vehicles in 2011

3.2.2 Hybrid Cars

Hybrid cars were introduced in Sri Lanka in March 2011, and soon the registration per month hit 751 in May 2011. Then, the registration pace slowed to 200. Recently, over 300 hybrid vehicles have been registered. By the end of 2012, there were approximately 7,000 hybrid cars registered, which is some 1.4 % of the total motor vehicles. The registration number of hybrid cars also depends on the government tax policy. The registration numbers of Hybrid Cars are shown in Figure 3.2.2.



Note: Number of new registered hybrid cars per month
Source: Department of Motor Traffic

Figure 3.2.2 New Registration of Hybrid Cars

3.3 Vehicle Ownership in Western Province

According to the HVS, vehicle ownership by the categories of passenger car, motor cycle, and three-wheeler are estimated as follows.

3.3.1 Passenger Car Ownership

Table 3.3.1 and Figure 3.3.1 show the distribution of passenger car ownership by income level. Clearly, the passenger car ownership grows as income level goes up. The average number of passenger cars owned per household in Group C is 0.05, that of the Group A is 0.89.

Table 3.3.1 Passenger Car Ownership by Household Income Level

Passenger Car Ownership	Group C	Group B	Group A	All
Number of Households Not Owning Cars	976,391	230,669	32,779	1,239,840
Number of Households Owning 1 Car	50,512	83,757	53,753	188,022
Number of Households Owning 2 Cars	1,386	5,722	13,449	20,556
Number of Households Owning 3 Cars	106	156	3,294	3,555
Number of Households Owning 4 Cars	31	0	492	523
Total Households	1,028,426	320,304	103,767	1,452,497
Total Number of Cars	53,727	95,668	92,500	241,895
Average Number of Cars per Household	0.05	0.30	0.89	0.17
Average Number of Cars per Total Number of Households Owning Cars	1.03	1.07	1.30	1.14

Note: Group C: Less than Rs. 40,000 / Group B: Rs.40,000 – Rs. 79,999 / Group A: Rs. 80,000 and above
Source:CoMTrans Home Visit Survey 2013

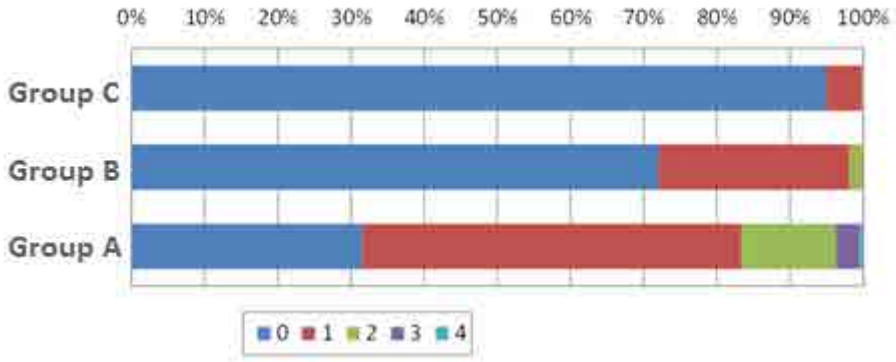


Figure 3.3.1 Passenger Car Ownership by Household Income Level

(1) Motorcycle Ownership

Table 3.3.2 and Figure 3.3.2 show the distribution of motorcycle ownership by income level. Motorcycle ownership grows as the income level goes up from Group C to Group B. However, if the monthly household income goes up from Group B to Group A, motorcycle ownership conversely decreases. This is because if they become rich enough to allow themselves to purchase a car, they shift to that instead of a motorcycle.

Table 3.3.2 Motorcycle Ownership by Household Income Level

Motorcycle Ownership	Group C	Group B	Group A	All
Number of Households Not Owning Motorcycles	770,797	200,266	78,990	1,050,054
Number of Households Owning 1 Motorcycle	245,617	109,023	21,239	375,879
Number of Households Owning 2 Motorcycles	11,414	10,365	2,978	24,757
Number of Households Owning 3 Motorcycles	598	650	559	1,807
Total Households	1,028,426	320,304	103,767	1,452,497
Total Number of Motorcycles	270,239	131,703	28,872	430,814
Average Number of Motorcycles per Household	0.26	0.41	0.28	0.30
Average Number of Motorcycles per Total Number of Households Owning Motorcycles	1.05	1.10	1.17	1.07

Note: Group C: Less than Rs. 40,000 / Group B: Rs.40,000 – Rs. 79,999 / Group A: Rs. 80,000 and above
Source:CoMTrans Home Visit Survey 2013

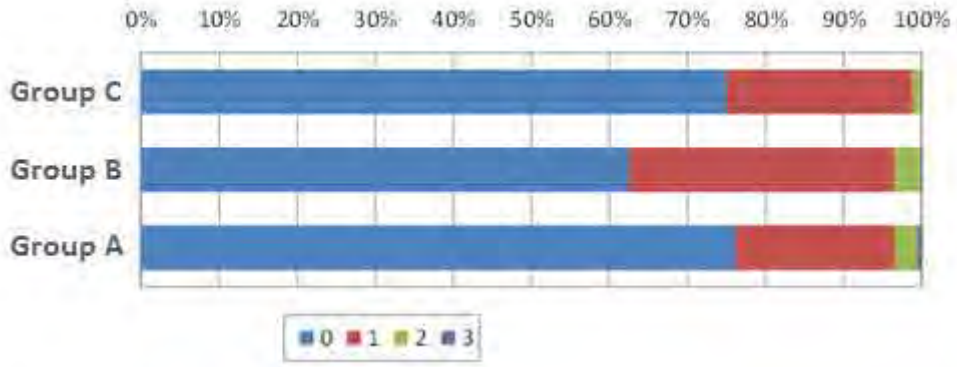


Figure 3.3.2 Motorcycle Ownership by Household Income Level

(2) Three Wheeler Ownership

Table 3.3.3 and Figure 3.3.3 show the distribution of three wheeler ownership by income level. Three wheeler ownership decreases as the income level goes up.

Table 3.3.3 Three Wheeler Ownership by Household Income Level

Three Wheeler Ownership	Group C	Group B	Group C	All
Number of Households Not Owning Three Wheelers	910,992	281,669	98,567	1,291,228
Number of Households Owning 1 Three Wheeler	116,277	37,487	4,975	158,738
Number of Households Owning 2 Three Wheelers	1,127	950	225	2,303
Number of Households Owning 3 Three Wheelers	30	198	0	228
Total Households	1,028,426	320,304	103,767	1,452,497
Total Number of Three Wheelers	118,622	39,982	5,425	164,028
Average Number of Three Wheelers per Household	0.12	0.12	0.05	0.11
Average Number of Three Wheelers per Total Number of Households Owning Three Wheelers	1.01	1.03	1.04	1.02

Note: Group C: Less than Rs. 40,000 / Group B: Rs.40,000 – Rs. 79,999 / Group C: Rs. 80,000 and above
Source:CoMTrans Home Visit Survey 2013

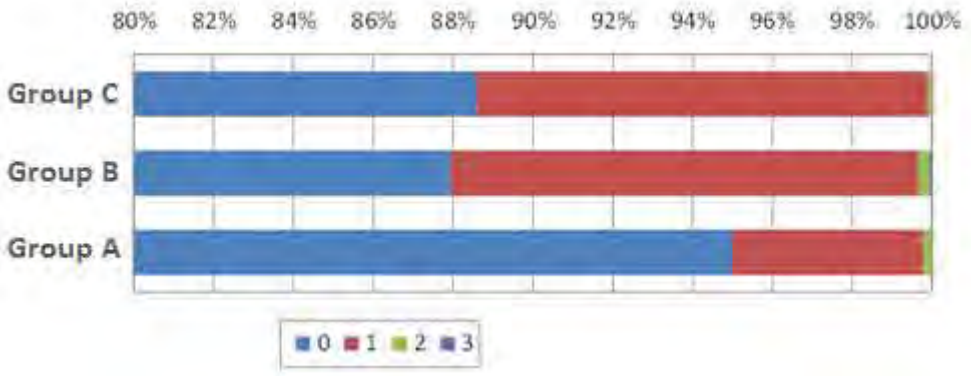


Figure 3.3.3 Three Wheeler Ownership by Household Income Level

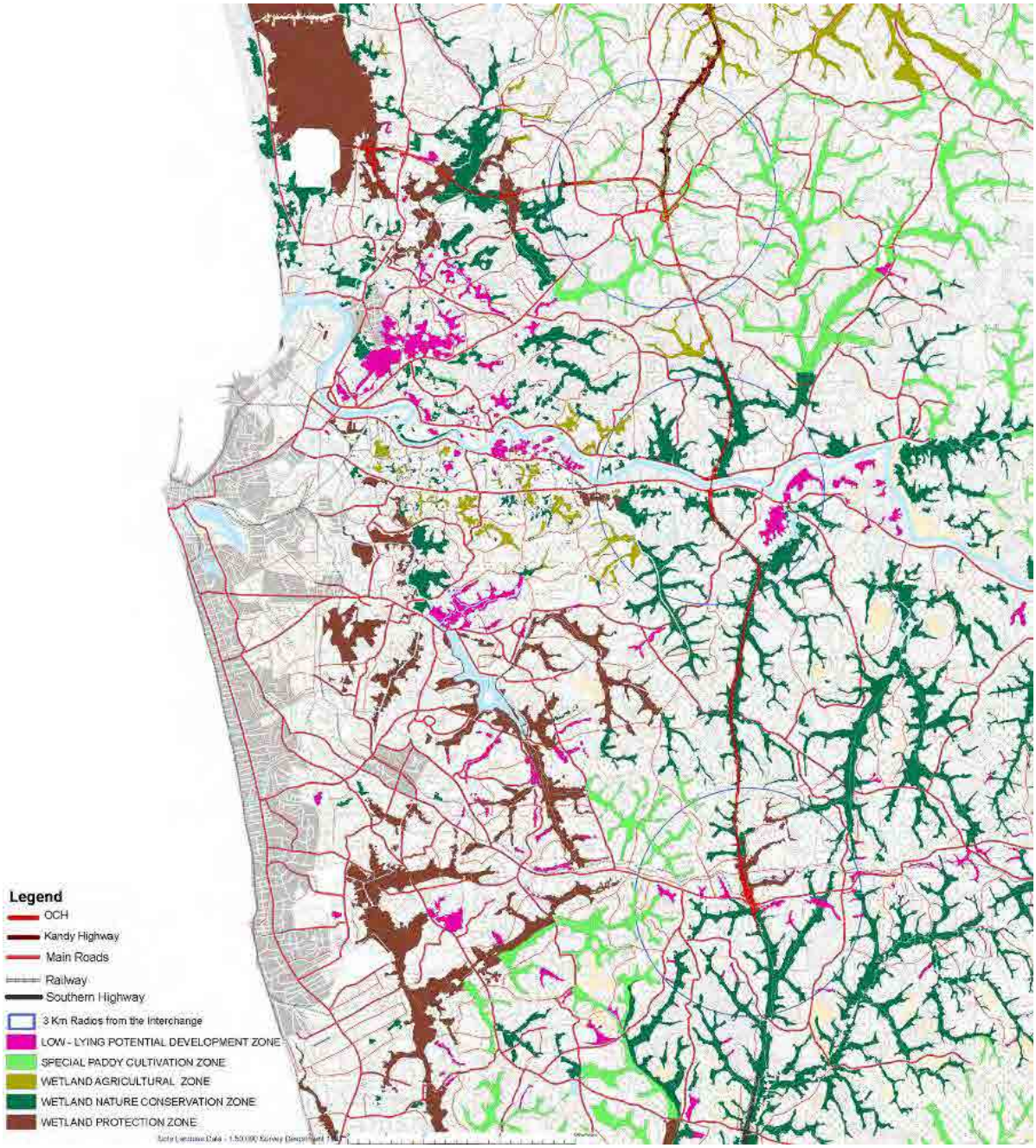
CHAPTER 4. Environmental Issues

4.1 Characteristics of the Natural Land

One of the geographical characteristics of Western Province is low-lying lands, or wetlands. The finger shaped wetlands and higher ground areas in between create an undulating landscape. Although many parts of the lands around CMC are already urbanised, wetlands still remain and preserve the original natural structure. The wetlands have been used as paddy fields, and rice cultivation is still active in many parts of Western Province, except around the Colombo urbanised areas. Except for nationally important projects such as the Outer Circular Highway, development of wetlands is statutorily controlled because wetlands play a very important role in maintaining biodiversity and water retention function for flood control.

These wetland areas in Western Province have been assessed by UDA, SLLRDC and CEA for their importance in terms of environmental protection and development potential, and the "Guidelines for Western Province Wetland Zoning" was formulated in 2006, and the wetlands are designated into the following zones; (1) Wetland Protection Zone, (2) Wetland Nature Conservation Zone, (3) Wetland Agriculture Zone, (4) Special Paddy Cultivation Zone, and (5) Low-lying Potential development Zone. The Wetland Zoning Map of Colombo suburbs is shown in Figure 4.1.1. The map shows the intricate structure of the wetlands.

Additionally, it should be noted that there are regular flood risks, especially in the Kelani River Basin and Kalu River Basin. The effect of flooding must be considered for future land use patterns.



Source: UDA, manipulated by CoMTrans Study Team

Figure 4.1.1 Wetland Zoning in Colombo Suburbs

4.2 Major Contributors to Air Pollution

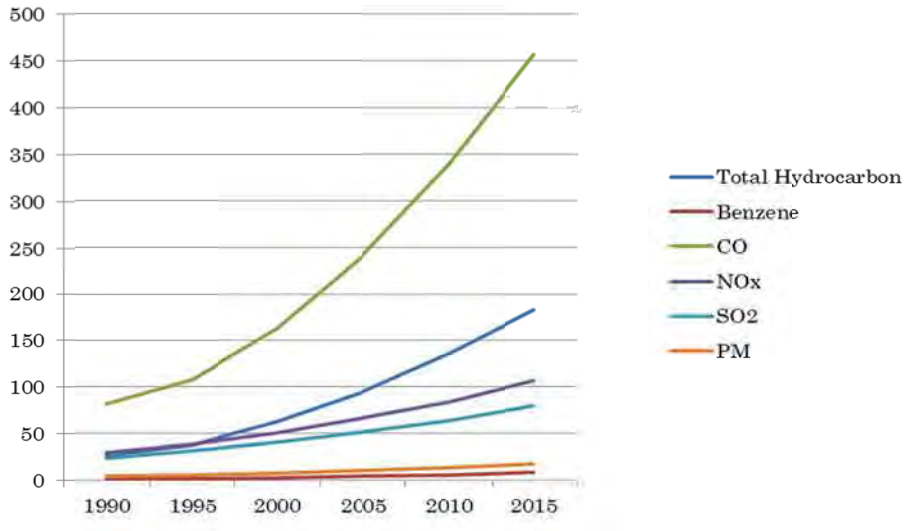
Rapid urbanisation and industrial development are the main factors responsible for air pollution; the major contributors for this pollution are the industries and vehicle fleets. Emissions from motor vehicles is one of the most air polluting sources in Sri Lanka. The ever increasing use of vehicles in the transport sector without proper monitoring, controlling and regulation of emissions together with lack of standards and national interest has resulted in substandard air quality in Sri Lanka, especially in the main urban areas of Colombo, which has resulted in adverse health conditions.

4.2.1 Air Polluting Emissions from the Transport Sector

It is estimated that around 60% of the vehicles in Sri Lanka are concentrated in Western Province. The atmospheric environment in Colombo and its suburbs is deteriorating due to a flow of motor vehicles into the city and its traffic congestion on the roads, such as Kandy Road. Especially, heavy traffic jams occur within a radius of 10 to 15 km, from the Colombo core area extending towards its surroundings. According to an investigation, the density of pollutants such as NO_2, SO_2, and CO is in an increasing trend during the peak period. Thus, it is inferred that the atmospheric conditions along the roads are even worse.

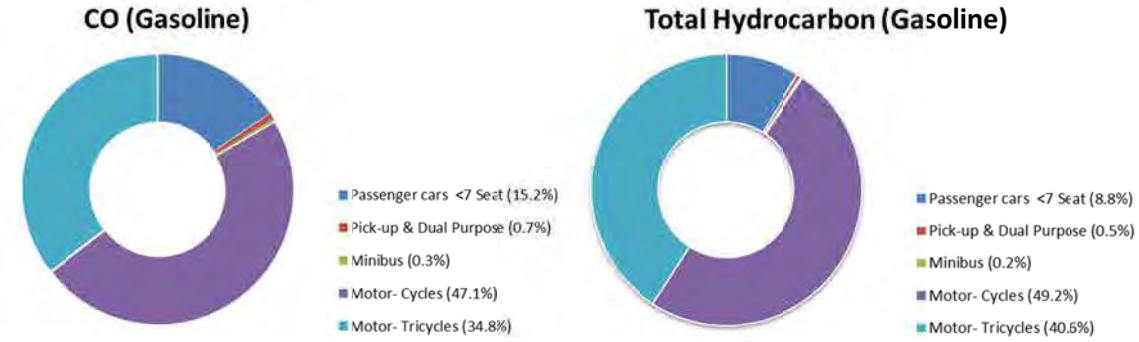
The Air Resource Management Center (AirMac) has calculated the base case emissions from the transport sector, the "Do Nothing Scenario", for the period between 1990 and 2015 is shown in Figure 4.2.1. The emissions are calculated using an emission inventory model. This model, originally developed for IPIECA (International Petroleum Industry Environmental Conservation Association) by Enstrat International Ltd., has the flexibility to be locally customised and accepts local vehicle populations, vehicle field use data inputs include annual mileage, average traffic speeds, local emission factors when they exist, etc., and typical local fuel qualities. It is estimated that each pollutant from the transport sector has increased.

In addition, a breakdown of each pollutant by vehicle type in 2000 is calculated for major emitters such as gasoline engine vehicles (Figure 4.2.2) and diesel engine vehicles (Figure 4.2.3). Among these, gasoline engines are bigger emitters of CO and Hydrocarbon, while NOx and PM are mostly emitted from diesel engines.



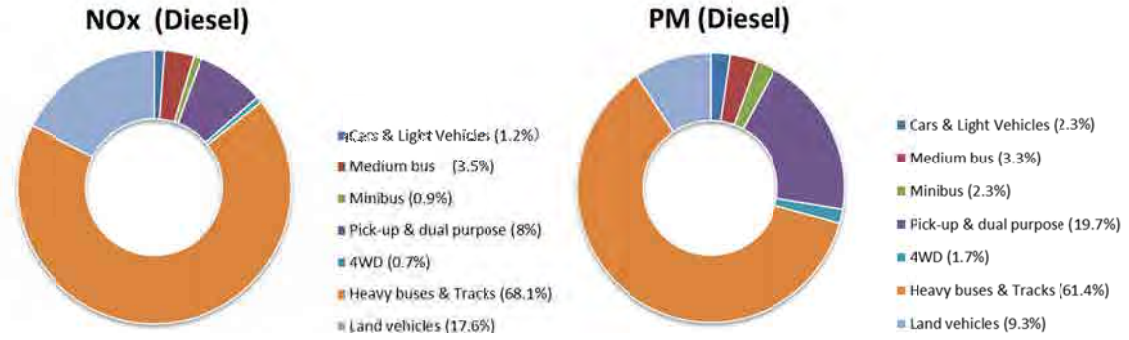
Source: Urban Air Quality Management in Sri Lanka

Figure 4.2.1 Estimated Air Emissions from Transport Sector in Sri Lanka (kt/year)



Source: Urban Air Quality Management in Sri Lanka

Figure 4.2.2 Percentage of Emission by Type of Gasoline Vehicles



Source: Urban Air Quality Management in Sri Lanka

Figure 4.2.3 Percentage of Emission by Type of Diesel Vehicles

The main findings from the emission calculations of the study show:

- Hydro Carbon (HC) emissions have more than doubled between 1990 and 2000, and by 2015 are expected to grow by a factor of 6 to 7 versus 1990.
- The motorcycles and the motor tricycles together contribute about 90% of the HC of gasoline engine vehicles.
- Heavy buses and trucks together contribute to 60 - 70% of the NOx and PM emissions of the diesel engine vehicles.

4.2.2 Ambient Air Quality

Continuous Air Quality Monitoring is currently in operation at Colombo Fort Station of Western Province. Until 2008, the monitoring had been carried out for CO, SO_2, NO_2, O_3 and PM10. However, at present, the Air Quality monitoring is confined to PM10 only. It is learned that, from 2013 onwards, the Air Quality level determination for SO_2, NO_2, CO, PM10, PM2.5 and O_3 will be measured by the Passive Sampling method, which is expected to be monitored for the next ten years in two sites namely, Colombo and Gampaha.

Table 4.2.1shows the maximum concentration observed in the measured data of 2008. CO and NO_2 were within local standards, however, SO_2 and PM10 were occasionally observed to exceed the standard. Further, there are a few industrial zones in Colombo and the Gampaha area which eventually aggravate the pollution levels of the surrounding environment.

Table 4.2.1 Maximum concentration in Colombo in 2008

Emission Factors	Maximum Concentration	CEA Standards	Measured Date
CO	2.86 ppm	26.0	January 4th
SO2	0.104 ppm	0.08	January 2nd
NO2	0.10295 ppm	0.13	November 20th
PM10	146 microg/m3	100	November 7th

There is a lack of data available for PM2.5 in Western Province, which causes greater health risk due to its fine size. In typical cities, PM2.5 accounts for 50 – 60% of the total PM10. However, it is proposed that PM2.5 concentration in the central area of Colombo and along major roads are high enough to present a significant risk to public health based on the data of other similar cities (Bangkok and Santo Domingo).

In order to address the increasing air pollution, Air Mac was launched in 2002 and several major activities were implemented by Air Mac including

- Amendment of the air emission standard for mobile vehicles
- The development of the “Clean Air 2007 Action Plan”
- Implementation of Vehicle Emission Testing.

4.3 Climatic Factors

4.3.1 Climate

The climate of Sri Lanka is categorised as tropical monsoon, having a wet season and short dry seasons. There are four seasons in Sri Lanka namely, 1) First Inter Monsoon season (March – April), 2) Southwest Monsoon season (May – September), 3) Second Inter monsoon season (October – brought by the Northeast Monsoon season) and wet season due to the Southwest Monsoon. The southwestern part of Sri Lanka, including the Study Area, is influenced by the Southwest Monsoon and is classified as a wet area with annual rainfall of around 2,000mm – 3,000mm. According to monthly average rainfall records for Colombo for the 50 years from 1961 to 2010 (Department of Meteorology), May, October and November are observed to be rainy months with around 330 – 350mm of rainfall each, while January and February is observed to be a dry period with around 50mm rainfall. The mean daily maximum temperature in the study area ranges around 29 – 31℃ while the mean daily minimum temperature ranges around 22 - 25 ℃.

4.3.2 Climate Change

In a global context, the mean air temperature and sea level has increased by about 0.6℃ and 0.1m respectively over the 20th century. These phenomena are defined as climate change, which are considered to be caused by natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere, or in land use, which the emission of GHG contributes to (IPCC 2001). In Sri Lanka, there is a trend that annual mean air temperature anomalies have been increasing significantly during the last few decades (Basnayake et al 2002) and the rate of increase of the mean air temperature for the 1961 – 90 period was at a level of 0.016℃ per year (Fernando & Chandrapala 1995). It has been proposed that the increase in temperature is caused by an enhanced greenhouse effect as well as rapid urbanisation generating a heat island effect.

4.3.3 Green House Gas (GHG)

GHG are the main contributors to Global Warming. Emissions from transport represented 22% of global CO2 emissions in 2010 (including emissions from non-fuel combustion) and almost three-quarters of the emissions from transport are from the road sector. According to the International Energy Agency (IEA) report1, the total CO2 emission from fuel combustion in Sri Lanka in 2010 was 13.2 million tonnes and a little higher than half of the total CO2 emissions (6.9 million tonnes), was from the transport system, of which the road sector contributes the most (approximately 94%) of CO2 emission of 6.5 million tonnes (Figure 4.3.1). Although Sri Lanka`s contribution of GHG is very minor at the global level, the portion of CO2 emission from the road sector in the Western part of Sri Lanka is very high, especially in Western Province where 28% of the total population lives.

[1] CO_2 Emissions from Fuel Combustion highlights 2012 edition, International Energy Agency(2012)

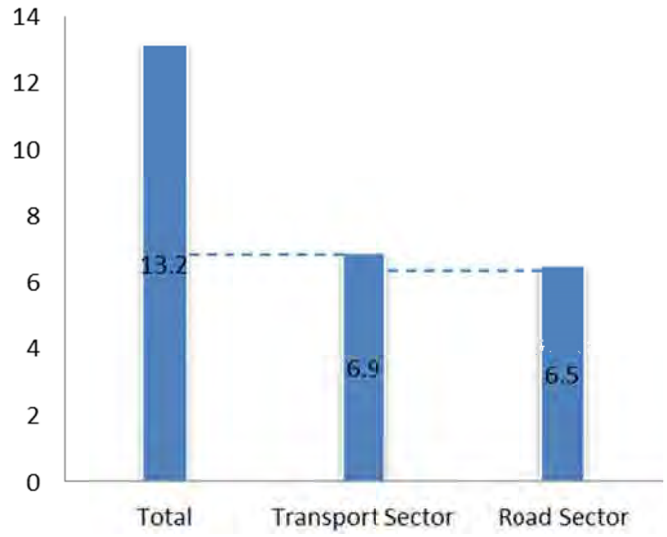


Figure 4.3.1 CO_2 Emission from Fuel Combustion (million ton)

CHAPTER 5. Current Land Use Pattern and Urban Development Characteristics

5.1 Current Land Use Pattern

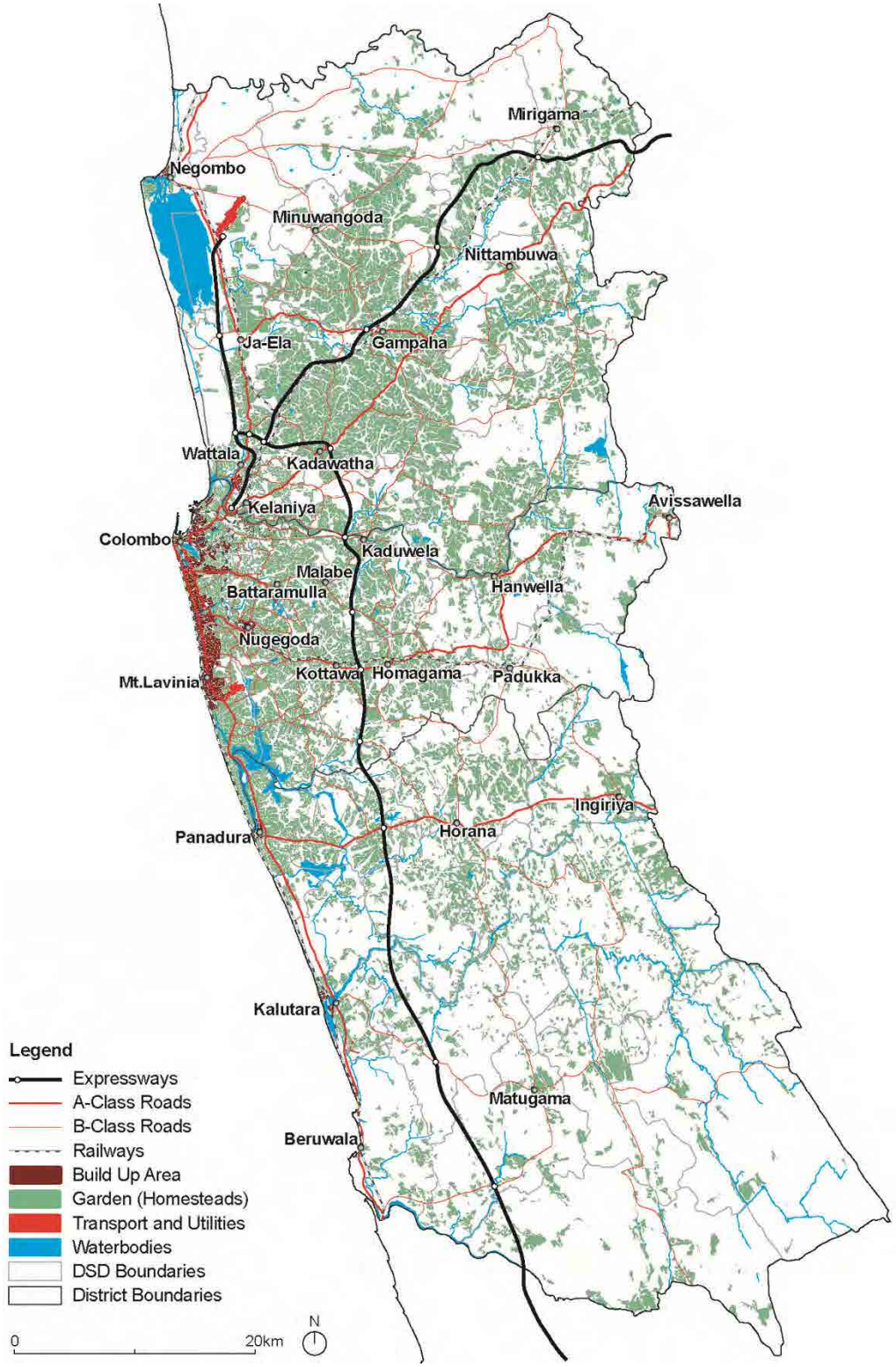
5.1.1 Current Land Use Topographic Maps

There have been no comprehensive land use maps available that cover Western Province.

Simple classifications of Built-up Areas and Gardens (Homesteads) are available in the topographic map made by the Survey Department. However, the maps are outdated as they were prepared based on 1980's data. According to the topographic maps, the Built-up Area is only located in Colombo and the southern coast up to Mt. Lavinia. The classification of Garden means individual dwellings with private gardens, or Homesteads, and it includes very low density residential areas in rural conditions. The gardens spread extensively across the western parts of Colombo District and Gampaha District, but Kalutara District has fewer. The map does not show the density. Therefore urbanised areas cannot be grasped correctly in the map.

Figure 5.1.1 shows the map of the Built-up Areas and Gardens.

On the other hand, there are some Development Plans of local Authorities which have the current land use maps in their local authority's boundaries. However, not all local authorities' Development Plans have been completed. Even worse, the classifications of land use patterns are not unified. Therefore, it is impossible to combine the maps.



Source: CoMTrans Study team, based on the topographic map by the Survey Department.
Expressways/Highways are shown on the map as reference.

Figure 5.1.1 Built-up Areas and Gardens

5.1.2 Expanding Built-up Areas

In the "Colombo Metropolitan Regional Structure Plan" of 1998, there are data regarding general land use patterns in 1981 and 1996 as shown in Table 5.1.1 and Figure 5.1.2. Land Use of urban areas is only classified as Urban Built-up areas and Homesteads, which is the same classifications as the topographic maps.

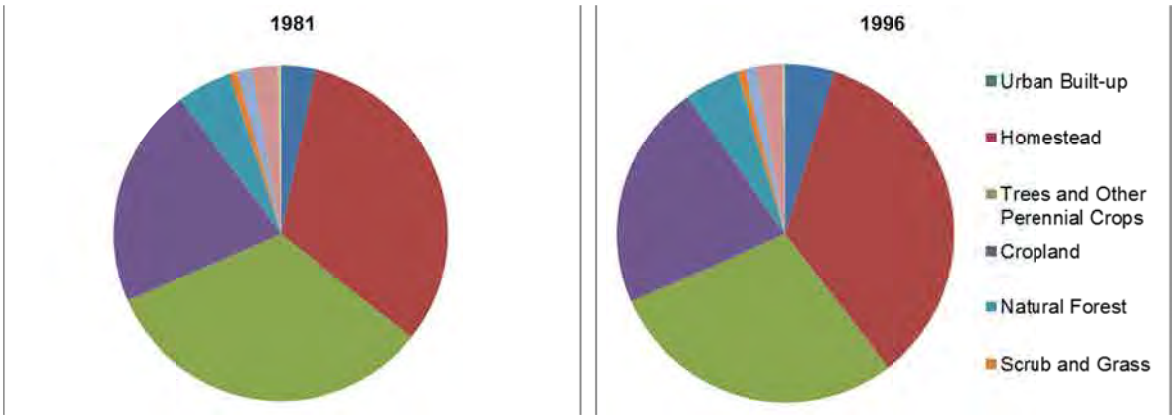
In Western Province, Urban Built-up Land expanded from 3.3% in 1981 to 4.7% in 1996. Generally, the Trees and Other Perennial Crops in 1981 were converted to Urban Built-up and Homesteads by 1996. In addition, according to the plan, the changes in the use of land are due to the following influences of:

- Establishment of Industrial Zones and estates, such as Katunayake, Biyagama, Horana, Ekala, Katuwana, Sapugaskanda, Kelaniya, etc.
- Expansion of tourism activities in Colombo, Negombo, Mt. Lavinia, Beruwala, etc.
- Shifting of the parliament to Sri Jayawardanepura – Kotte together with some administrative functions to the Battaramulla area.
- Development of Housing Schemes in Kesbewa, Homagama, Kaduwela, Bandaragama, Ja-ela, Negombo, Mahara, Kadawatha, Panaluwa, Ranpokunugama, Mattegoda, and Rukmale.

Table 5.1.1 General Land Use Patterns of Western Province (1981 and 1996)

Land Use Category	Percentage Share of Total Land Area							
	Colombo District		Gampaha District		Kalutara District		Western Province	
	1981	1996	1981	1996	1981	1996	1981	1996
Urban Built-up	12.2%	17.6%	1.6%	2.3%	0.9%	1.2%	3.3%	4.7%
Homestead (Residential Area)	21.2%	22.0%	49.8%	52.9%	22.0%	24.8%	32.4%	34.9%
Trees and Other Perennial Crops (Tea, Rubber, Coconut, etc.)	41.2%	35.1%	23.0%	29.5%	37.6%	33.8%	32.7%	28.8%
Cropland (Paddy, Abandoned Paddy, etc.)	16.4%	16.9%	17.7%	17.7%	26.7%	27.4%	21.4%	21.6%
Natural Forest	2.2%	2.2%	1.0%	0.9%	10.4%	10.3%	5.2%	5.3%
Scrub and Grass	1.8%	1.6%	0.7%	0.7%	0.4%	0.5%	0.8%	0.8%
Wetland	1.6%	1.3%	2.5%	2.2%	0.4%	0.4%	1.4%	1.2%
Water	3.3%	3.3%	3.3%	3.3%	1.4%	1.4%	2.5%	2.5%
Barren Land	0.1%	0.0%	0.4%	0.5%	0.2%	0.2%	0.3%	0.2%
Total Land Area (km^2)	**697.9**	**697.9**	**1,398.7**	**1,398.7**	**1,597.6**	**1,597.6**	**3,694.2**	**3,694.2**

Source: Colombo Metropolitan Regional Structure Plan 1998



Source: Colombo Metropolitan Regional Structure Plan 1998

Figure 5.1.2 General Land Use Patterns of Western Province 1981 and 1996

5.2 CoMTrans Land Use Survey

5.2.1 Land Use Survey Area

Due to the lack of comprehensive land use data in Sri Lanka, a land use survey was conducted in the land use survey area for this study. Due to the large area of Western Province, undeveloped lands such as the south-east part of the Province were omitted from the survey. Therefore, areas that are already urbanised and those presumed to be urbanised by the target year of 2035 were considered as the land use survey area.

The Western Province has an area of 3,729 km2, and the land use survey was conducted within an area of 1,732 km2, which is 45% of the Western Province.

The area was chosen based on the following criteria.

1) **Major Road Structure:** In Western Province, especially surrounding Colombo, urbanisation can be seen along the major roads, such as Kandy Road (A1), Galle Road (A2), Negombo Road (A3), High Level Road (A4) and also the areas near the new interchanges of the Southern highway and the proposed interchanges of the new highways are considered. This is one of the most important criteria as many urbanised areas follow the roads. Areas around the interchanges are still in a rural condition, but are expected to be urbanised in the future.
2) **Urban Centres and Economic Centres:** Existing urban centres and economic centres (or employment centres) are also one of the criteria to identify urbanisation patterns. The National Physical Plan gives a hierarchy of the urban centres. By reference to the hierarchy, the urban centres are specified.
3) **UDA Declared Area:** UDA designates areas which have urban characteristics. For those declared areas, UDA prepares Development Plans and directs urban development. The areas can be considered as future urbanised areas.
4) **Existing Land Use Pattern:** As mentioned the above section, the build-up areas and homesteads are mapped, however, the classification is not detailed and the data is outdated.

This is one reference for consideration for future land use.

5) **Population Density:** The Population Density map shows urbanisation patterns in terms of population concentration. Due to the lack of past land use data, it represents urbanised area more clearly.

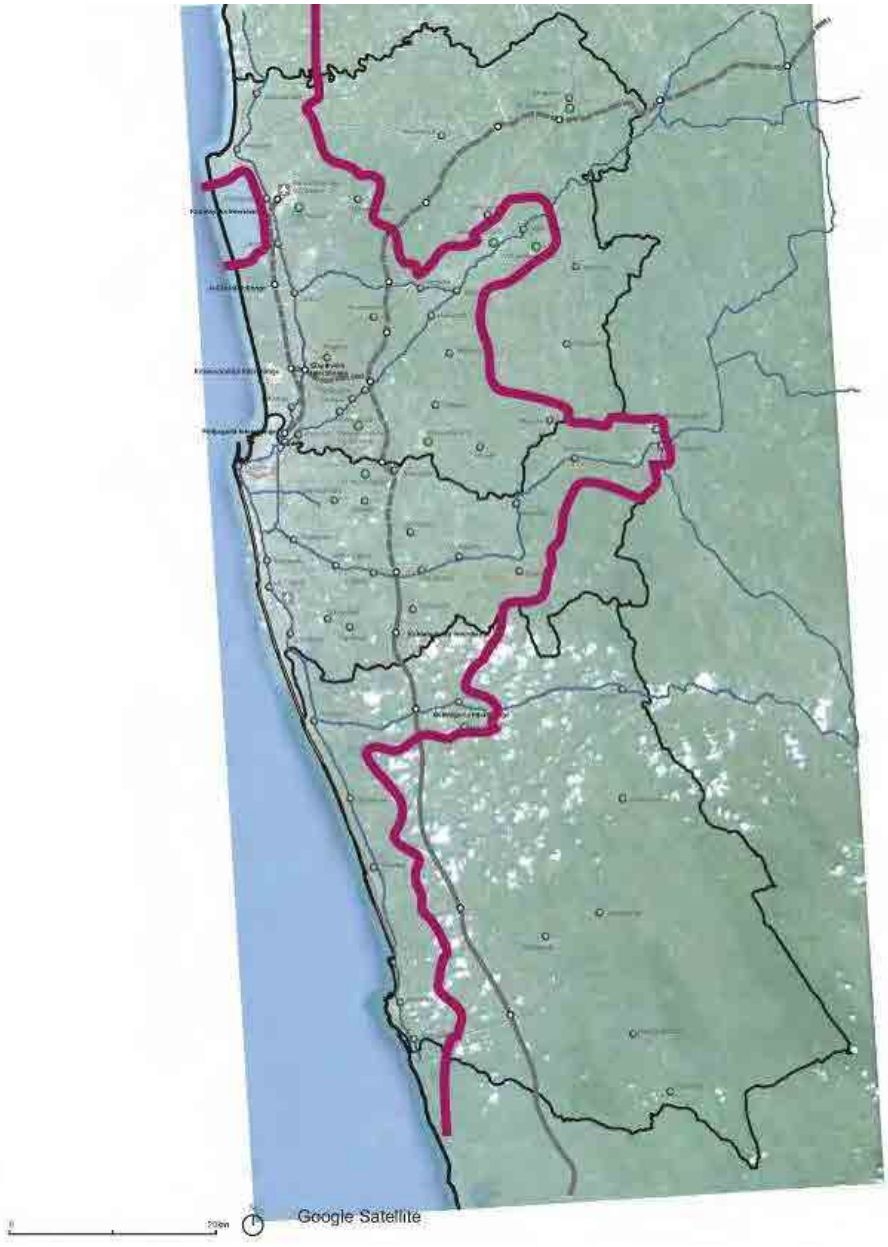
6) **Colombo Metropolitan Regional Strategy (1998):** The plan proposed a future urban structure for 2001, and Urban Development Trend. These are assumptions made by UDA at that time. It can be used for a reference to understand how urbanisation would take place.

7) **Western Region Megapolis Master Plan (2004):** This plan also proposes a future urban structure. Although it was not gazetted, the structure shows the direction of urbanisation as a reference.

8) **3K Township Development Component– Sub-regional Structure Plan and Sub Regional Strategy:** In the planning exercise of the Township Development Component, urbanisation patterns have been considered and proposed. It emphasises the areas around the Outer Circular Highway, and their impact. Since this is the most recent urban planning exercise in the Western Province, it can be a reference to future project development patterns.

By considering the above mentioned criteria, the boundaries of the land use survey area are determined, as shown in Figure 5.2.1.

The area was used especially for the land use survey. It does not define the planning area for the transport master plan of this project.



Source: CoMTrans Study Team

Figure 5.2.1 Area for CoMTrans Land Use Survey

5.2.2 Land Use Classifications and Survey

The land use classifications are shown in the following Table 5.2.1. The Built-up Area is classified in nine categories; Commercial, Residential, Business, Health, Education, Industries/Distribution, Government/Institutions, Transport, and Other. The other non-built-up areas are classified in three categories; Open Land, Wet Land, and Roads. In each category, there are detailed sub-categories to understand the current land use more precisely.

The survey was conducted by visual examination on site and by using satellite imageries. After those examinations, the land uses were mapped in GIS format and the results were obtained. The land use survey was completed at the end of September 2013.

Table 5.2.1 Classification for CoMTrans Land Use Survey

Land Use	Detailed Land Use
1 - Built-up Land	
11- Commercial	111 - Super Market, 112 - Restaurants, 113 - Hotel More than 100 Rooms, 114 - Hotel More than 50 Rooms, 115 - Hotel & Motel, 116 - Shopping Complex, 117 - Market, 118 - Planned Commercial Complex, 119 - Shops/Bakery/Spa/Saloon/laundry, 119.1 - Vehicle Sales Centre, 119.2 - Shops and Houses
12 - Residential	121 - Condominium Scheme, 122 - Housing Scheme More than 100 Houses, 123 - Housing Scheme More than 50 Houses, 124 - Housing Scheme More than 10 Houses, 125 - Individual Private Houses / Dwelling Houses, 126 – Group C Houses, 127 - Government Quarters, 129 - Planned Residential Scheme, 129.1 - Elderly Homes, 129.2 - Hostels & Dormitories
13 - Business	131 – Bank, 132 - Financial Support Institution / Insurance Company, 133 - Offices More than 100 Employees, 134 - Other Business Offices (ex. Professional Offices), 135 - Sales Office
14 - Health	141 - General Hospital (Large Size Hospital), 142 - Specialised Hospital, 143 - Research Institute, 144 - Private Hospital, 145 - Medium Size Hospitals (District Hospitals/Military Hospitals), 147 - Animal Clinics, 148 - Health Care Centres, 149- Small Size Hospitals (Rural Hospital/ Divisional Hospital/ Municipal Council Hospital)
15 - Education	151 - National School With ADV, 152 - National School up to Grade 11, 153 - National School up to Grade 5, 154 - International School / Private School, 155 - Child Education Centres / Child Day Care Centres, 156 - National Universities, 157 - Private Universities, 158 - Technical College, 159 - Other Educational Premises
16 - Industries / Distribution	161 - Manufacturing Plants, 162 – Garments, 163 - Construction Office & Yards, 164 - Logistics & Distribution Centre, 167 – Warehouse, 165 - Premise of Special Services, 166 - Service for Manufacturing
17 – Government / Institutions	171 – Ministries, 172 – Departments, 173 – Corporations, 174 - Court Houses, 175 - Police Station, 176 - Boards / Authorities, 177 - Post Office, 178 - Provincial Admin, 179 - Military Admin Office, 179.1 - Embassy
18 - Transport	181 - Railway Station, 182 - Bus Stands, 183 - Transport Work Shop, 184 – Airport, 185 - Fuel Stations, 186 - Motor Vehicle Yard, 188 – Port, 189 - Bus Depot
19 - Other	191 - Recreational Activities (Cinema / Theatre / Indoor Stadiums), 192 - Utilities (Electricity/Water/Telecommunications/Garbage Disposal), 193 - Conference & Exhibition Centres, 194 – Temple, 195 – Church, 196 – Kovil, 197 – Mosque, 198 - Museum / Library
2 - Land	
21 – Open Land	211 - Playground / Park, 212 – Cemetery, 213 – Parking, 214 - Sport Clubs, 215 - Metal Quarry, 216 - Plantation / Agriculture, 217 - Construction Site
22 – Wet Land	221 – Marshy, 222 - Water Retention ponds, 223 – Lakes, 224 – River, 225 – Streams, 226 - Borrow Pits
23 - Roads	231 - Road A Type, 232 - Road B Type, 233 - Road C Type, 234 - Other Roads

Source; CoMTrans Study Team

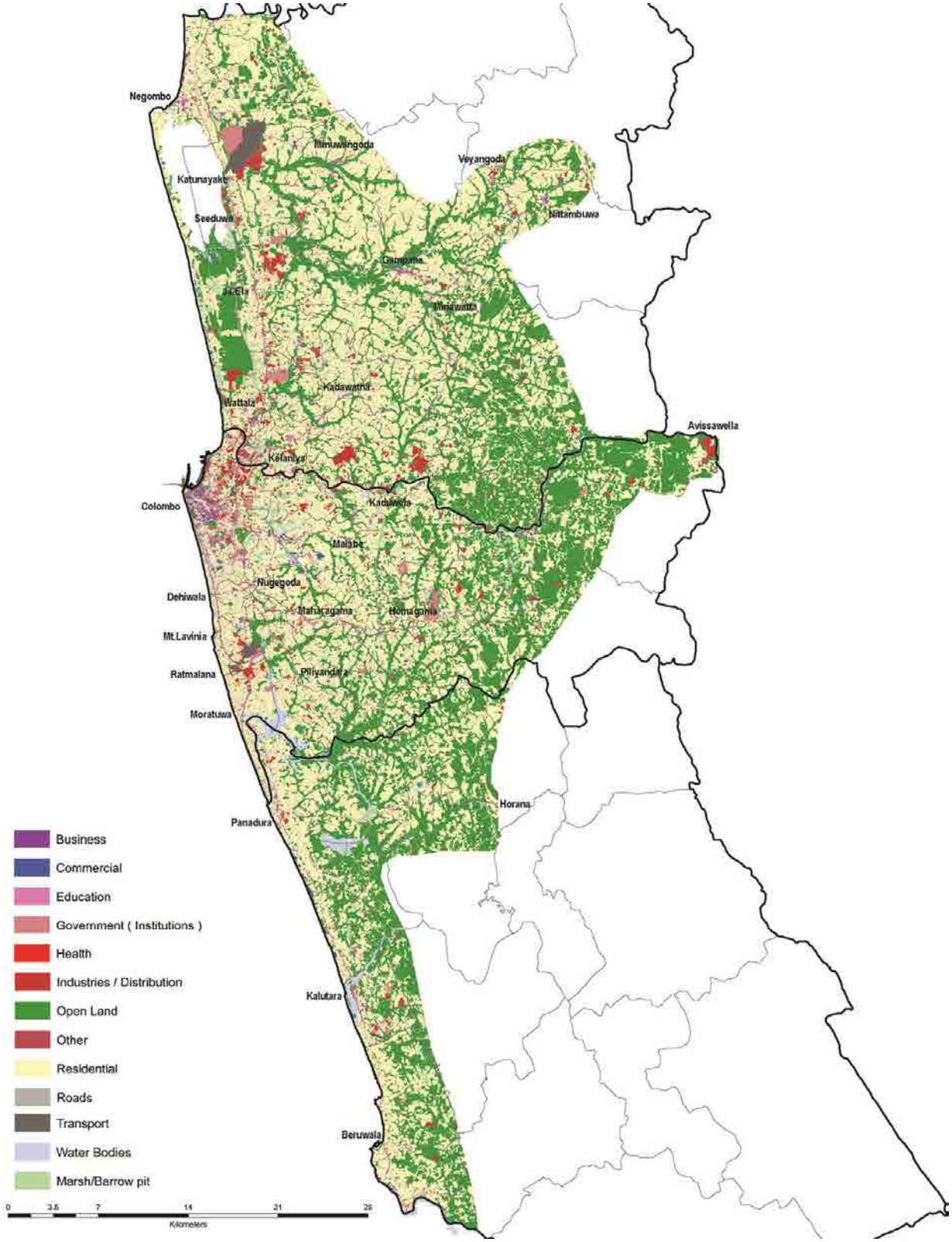
5.2.3 Land Use Pattern and Map in the Survey Area

The build-up area in the land use survey area is approximately 1,000 km^2, and most of the land is used for residential purposes, more than 920 km^2 out of 1,730 km^2. This is 53 % of the total survey area. However, houses in suburban and rural areas have gardens. Therefore, the population density is still low. The Eastern part of the area is still open land, or plantation, agricultural land and forestry. The sum of the residential use and the open land shares almost 90% of the total.

Urban land uses, such as businesses and commercial use are concentrated around Colombo Municipal Council (CMC). Other urban centres, such as Gampaha, Ragama, Negombo, Kaduwela, Maharagama, Nugegoda, and Kalutara have only a small concentration of urban land use. Very thin ribbon development is also typically observed along the major arterial roads, especially Kandy Road, High Level Road, Negombo Road and Galle Road. Except for the centres and ribbon development, commercial and business use areas in the suburbs and rural areas are very small and scattered. Only 7km^2 are used for commercial purposes. The urban land use, except for the residential use, is 108km^2, which is 6.2% of the total survey area.

Educational use or schools are well distributed around the area. At least the opportunity for primary education is provided equally.

The results of the Land Use Survey in Western Province are shown in Figure 5.2.2 and Table 5.2.2.



Source: CoMTrans Study Team

Figure 5.2.2 Land Use Map for Land Use Survey Area (2013)

Table 5.2.2 Land Use Pattern in Land Use Survey Area (2013)

Land Use Classes	Colombo District (km^2)	Gampaha District (km^2)	Kalutara District (km^2)	Total (km^2)	Share of the Survey Area
11- Commercial	3.3	2.0	1.7	7.0	0.4%
12 - Residential	294.4	462.3	165.7	922.4	53.2%
13 - Business	5.6	4.9	1.8	12.3	0.7%
14 - Health	1.4	0.7	0.2	2.3	0.1%
15 - Education	7.2	5.8	2.5	15.5	0.9%
16 - Industries / Distribution	13.6	20.5	2.7	36.8	2.1%
17 - Government / Institutions	5.8	5.3	0.7	11.8	0.7%
18 - Transport	5.8	7.6	0.7	14.1	0.8%
19 - Other Built-up Land	3.3	2.6	1.8	7.7	0.4%
21 - Open Land	181.8	260.7	150.7	593.2	34.2%
22-1 - Wet Land	7.7	8.1	2.9	18.7	1.1%
22-2 - Water Bodies	14.6	7.8	13.5	35.9	2.1%
23 - Roads	21.5	24.8	8.8	55.1	3.2%
Sub Total in the Survey Area	566.0	813.1	353.7	1,732.8	100.0%
Outside of the Survey Area	114.0	589.5	1,292.7	1,996.2	-
Total	680.0	1,402.6	1,646.4	3,729.0	-

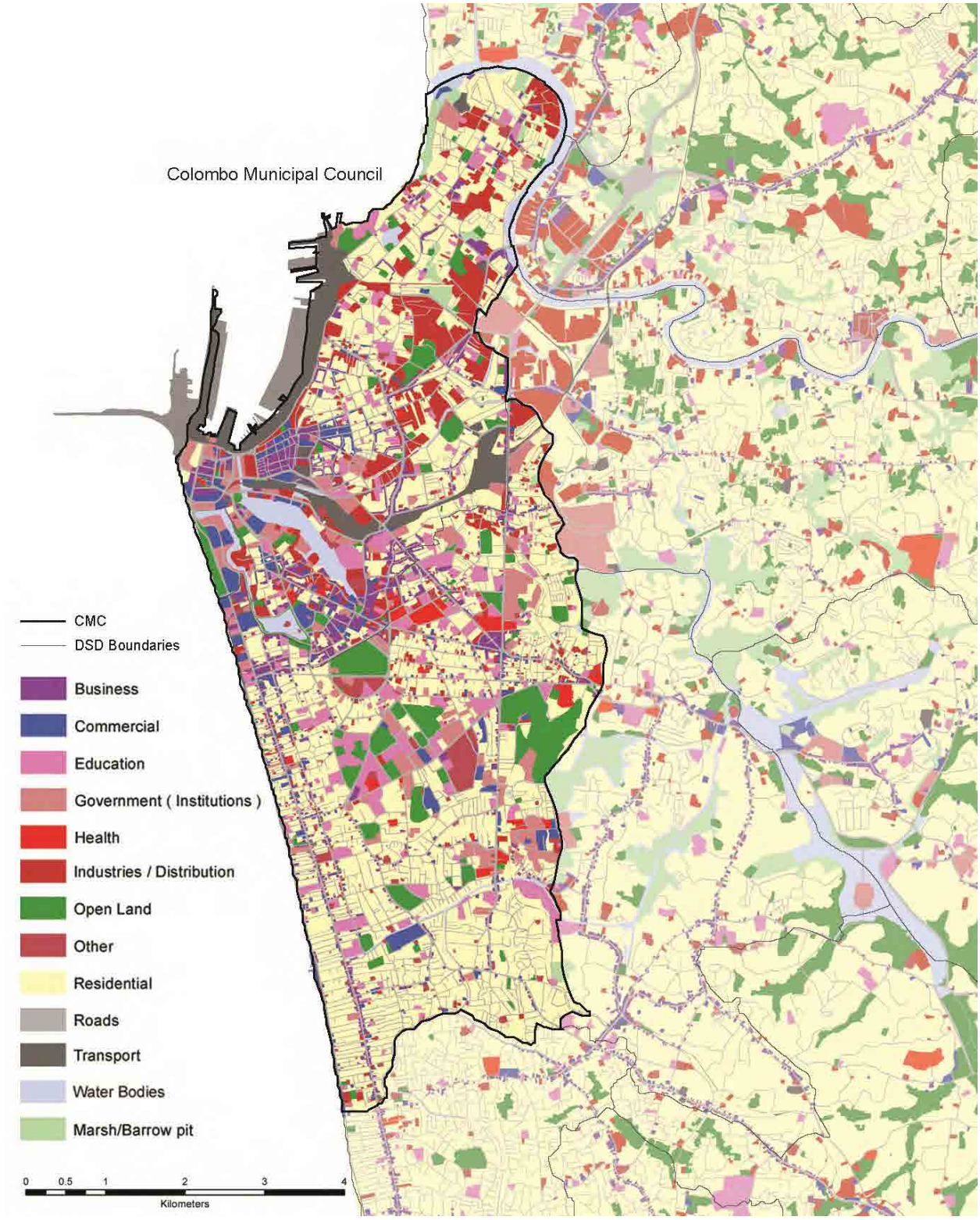
Source: CoMTrans Study Team

5.2.4 Land Use Pattern and Map in Colombo Municipal Council

Land use in Colombo Municipal Council (CMC) is enlarged in Figure 5.2.3 and the extent of each land use is summarised in Table 5.2.3.

In the Colombo Municipal Council Area, business and commercial land use areas are concentrated around Fort, Pettah, Maradana, Kolupittiya, and Borella and along Galle Road. Large scale government and institutional facilities are seen around the Cinnamon Gardens and Maradana area, but many small ones are scattered around the city. Parks and playgrounds are also seen in the Cinnamon Gardens where rich green environments can still be found. The northern parts of the city show that the lands are used in a mixture. On the other hand, residential uses are spread throughout the southern part of the city.

Almost 42 % is residential land use, 3.5% are dedicated to commercial use and 4.5% to business use. It is supposed that outside of CMC there is more residential use than in CMC. Other remarkable uses are educational facilities and government/institutions. Each occupies more than 5% of the CMC, while only less than 1% of the total land use survey areas are occupied by those uses. It can be concluded that CMC has many government offices and schools.



Source: CoMTrans Study Team

Figure 5.2.3 Land Use in Colombo Municipal Council (2013)

Table 5.2.3 Land Use Pattern in Colombo Municipal Council Area (2013)

Land Use Classes	Colombo DSD (km^2)	Thimbirigasyaya DSD (km^2)	Colombo Municipal Council (km^2)	Share (%)
11- Commercial	0.7	0.7	1.4	3.5%
12 - Residential	5.4	11.5	16.9	41.9%
13 - Business	1.1	0.7	1.8	4.5%
14 - Health	0.1	0.4	0.5	1.2%
15 - Education	0.7	1.7	2.4	6.0%
16 - Industries / Distribution	2.2	0.5	2.7	6.7%
17 - Government / Institutions	0.7	1.3	2.0	5.0%
18 - Transport	2.5	0.2	2.7	6.7%
19 - Other Built-up Land	0.3	0.7	1.0	2.5%
21 - Open Land	0.8	1.8	2.6	6.5%
22-1 - Wet Land	0.3	0.1	0.4	1.0%
22-2 - Water Bodies	1.5	0.3	1.8	4.5%
23 - Roads	1.6	2.5	4.1	10.2%
Total	17.9	22.4	40.3	100.0%

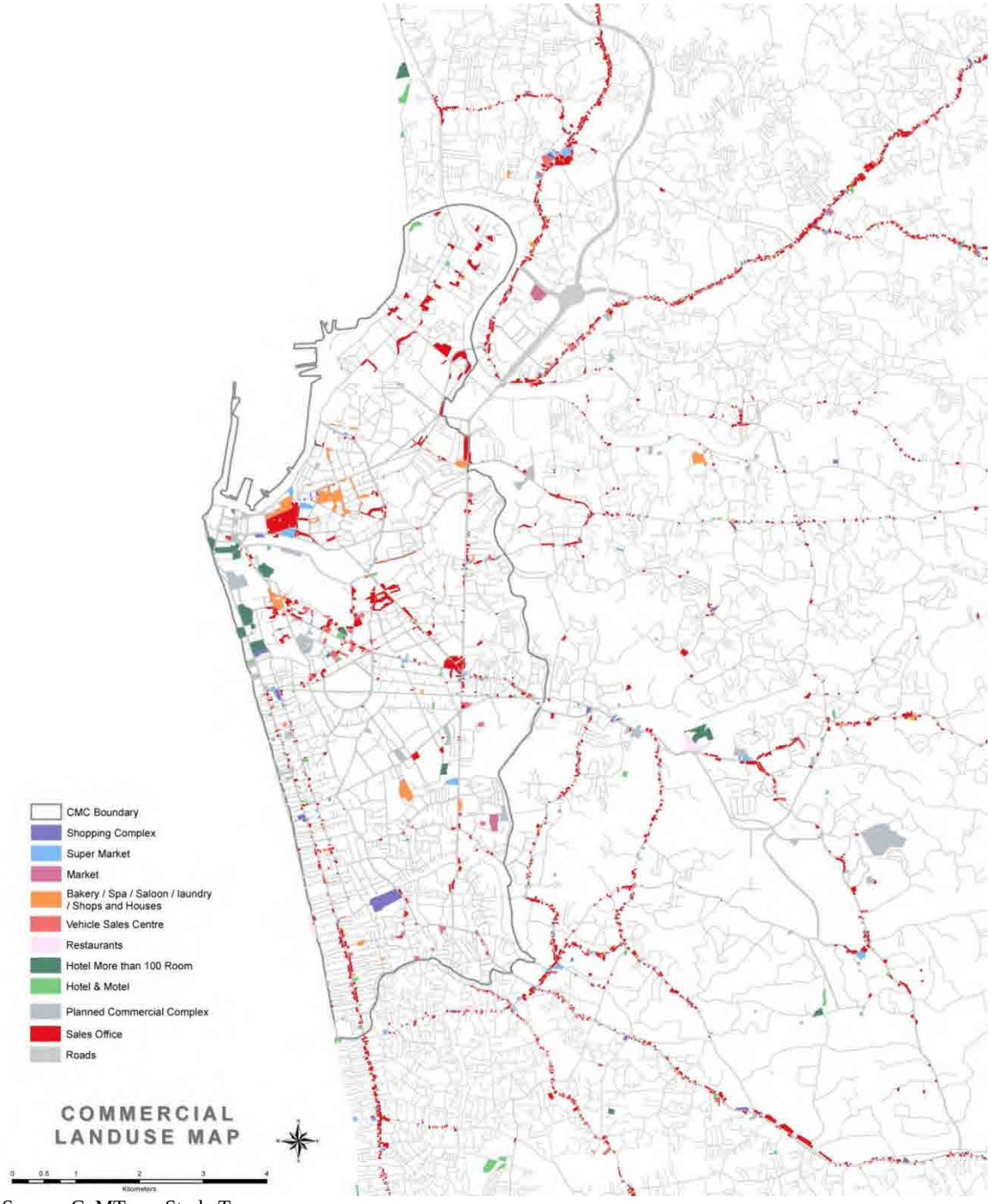
Source: CoMTrans Study Team

5.2.5 Detailed Land Use Patterns by Land Use Class

The following maps (Figure 5.2.4, Figure 5.2.5, Figure 5.2.6, Figure 5.2.7, and Figure 5.2.8) are detailed land use maps around CMC by the land use categories of Commercial, Residential, Business, Education, and Industry/Distribution.

(1) Commercial Land Use

In the centre of Colombo, the Pettah area has high-density commercial uses. Union Place and Borella also have many commercial uses. In the suburban areas, the ribbon type of concentration of commercial uses is very clearly shown.

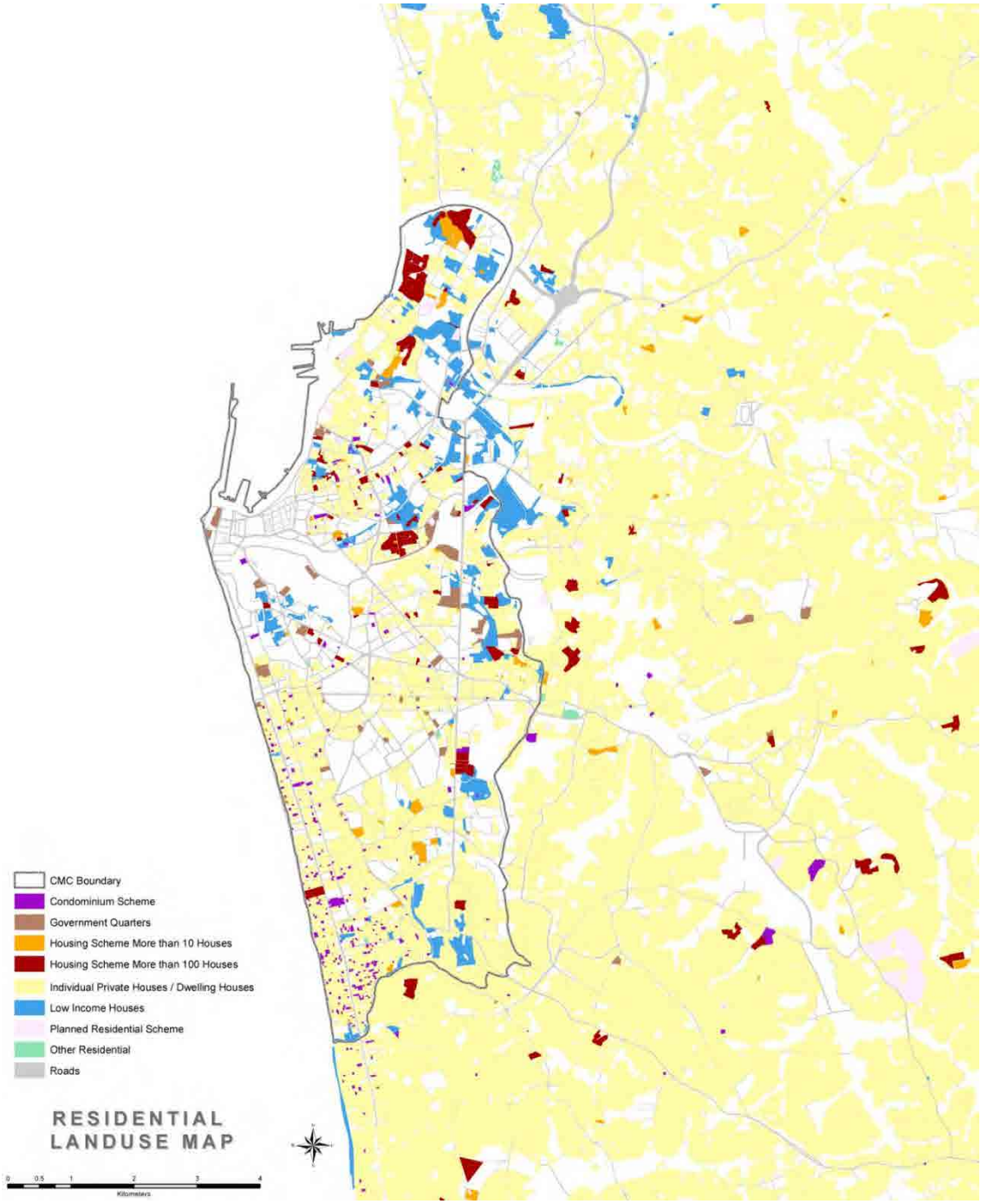


Source: CoMTrans Study Team

Figure 5.2.4 Land Use Map of Commercial Uses in CMA (2013)

(2) Residential Land Use

While individual private houses are spread everywhere, there are other types of residential buildings which are found in CMC; Condominiums are in the coastal area and Group C Houses are in the north of CMC. Some larger Housing Schemes are found in the suburbs.

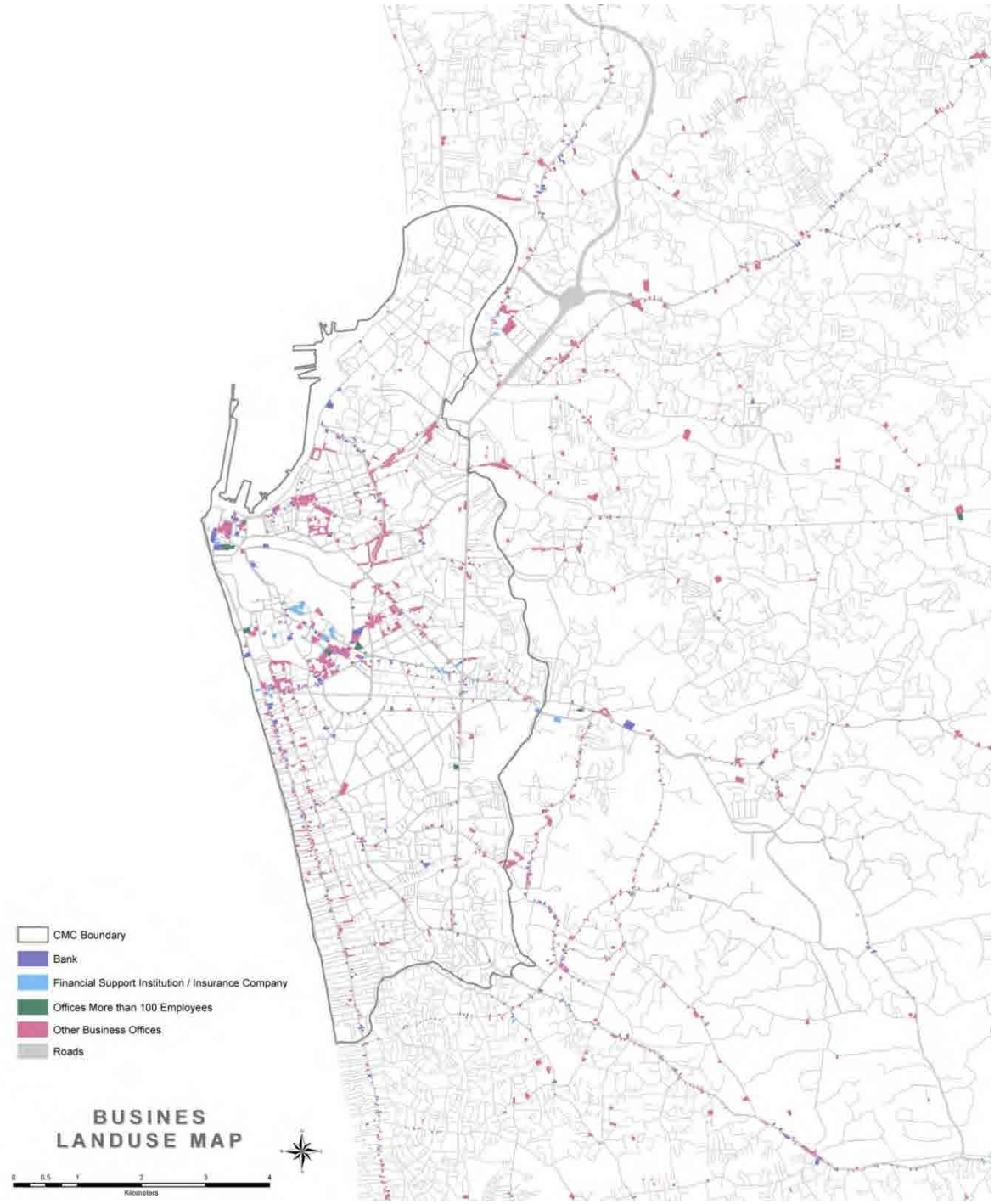


Source: CoMTrans Study Team

Figure 5.2.5 Land Use Map of Residential Uses in CMA (2013)

(3) Business Land Use

The concentrations of businesses are found in Fort, Union Place and Kollupitiya. It is also found that most of the businesses are along the major roads.

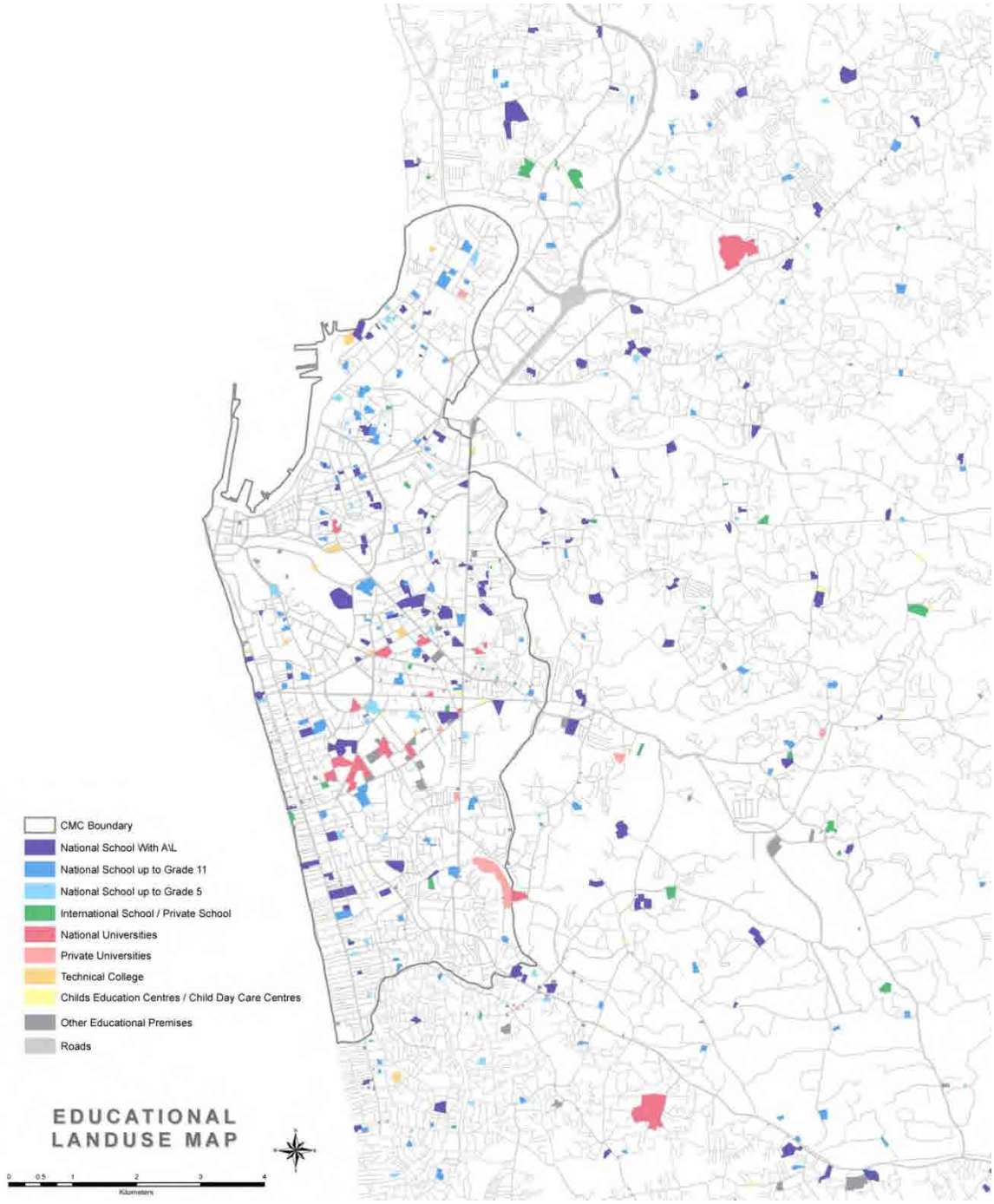


Source: CoMTrans Study Team

Figure 5.2.6 Land Use Map of Business Uses in CMA (2013)

(4) Education Land Use

The public schools are equally distributed in the province. The Universities are found in Colombo, Kelaniya, and Sri Jayawardenapura Kotte. Due to the concentration of private schools, CMC has relatively many schools.

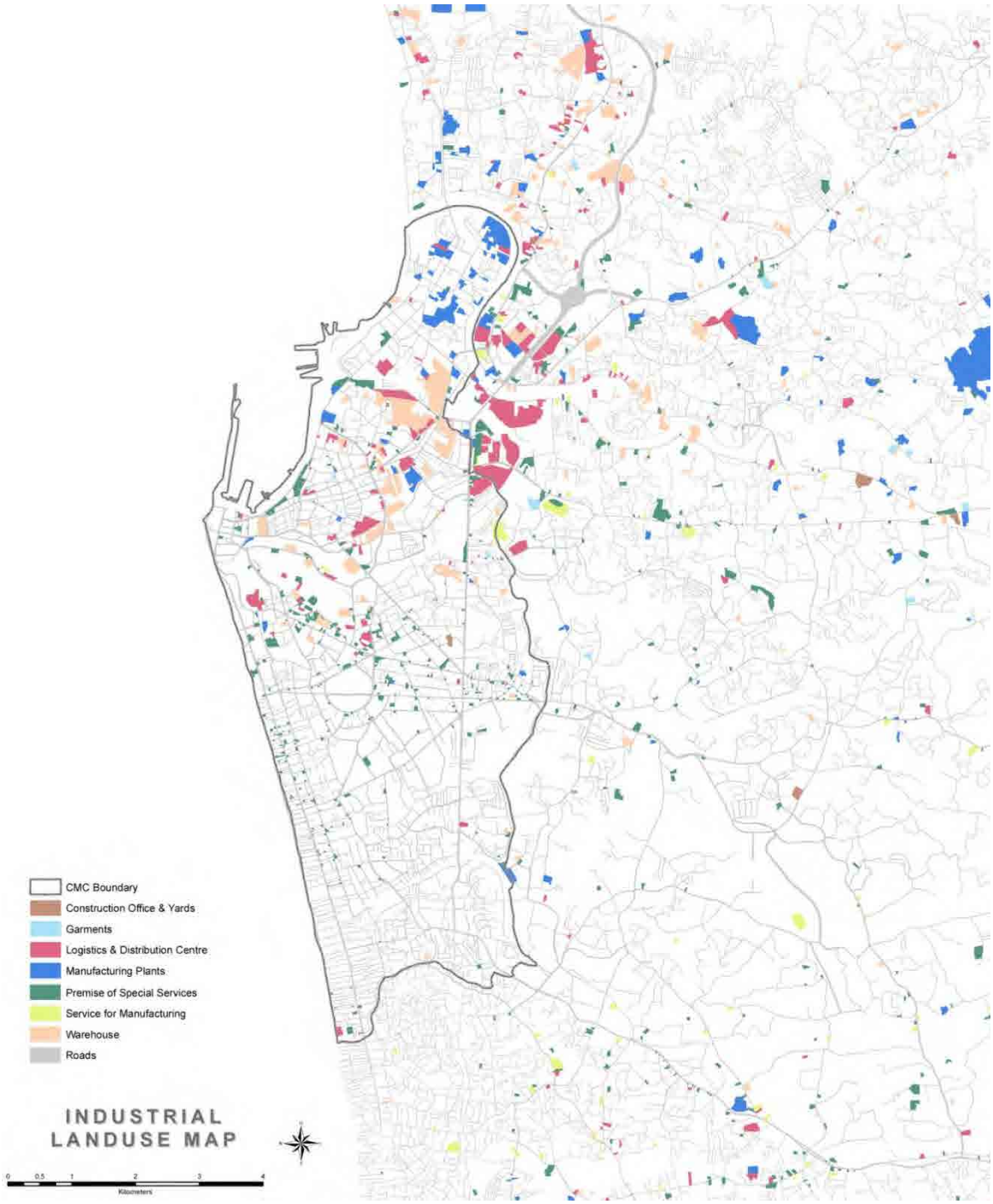


Source: CoMTrans Study Team

Figure 5.2.7 Land Use Map of Education Uses in CMA (2013)

(5) Industry

The northern part of CMC and the surroundings has fairly many industries, warehouses and logistic functions. No large industrial estates are found around CMC.



Source: CoMTrans Study Team

Figure 5.2.8 Land Use Map of Industry/Distribution Uses in CMA (2013)

Table 5.2.4 Land Use Patterns in the Survey Area by DSDs of Colombo District

Land Use Classes	Colombo DSD	Dehiwala DSD	Hanwella DSD	Homagama DSD	Kaduwela DSD	Kesbewa DSD	Kolonnawa DSD	Maharagama DSD	Moratuwa DSD	Padukka DSD	Rathmalana DSD	Sri Jayawardanapura Kotte DSD	Thimbirigasyaya DSD	Total
11- Commercial	0.7	0.1	0.2	0.2	0.6	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.7	**3.3**
12 - Residential	5.4	6.6	30.9	62.0	54.2	38.1	15.5	26.0	12.2	13.8	7.3	10.9	11.5	**294.4**
13 - Business	1.1	0.1	0.4	0.7	0.8	0.3	0.3	0.3	0.2	0.1	0.2	0.4	0.7	**5.6**
14 - Health	0.1	0.1	0.1	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.1	0.4	**1.4**
15 - Education	0.7	0.2	0.3	0.5	0.6	0.5	0.3	0.6	0.7	0.1	0.6	0.4	1.7	**7.2**
16 - Industries / Distribution	2.2	0.1	2.2	1.8	1.3	1.0	1.4	0.6	1.1	0.2	1.0	0.2	0.5	**13.6**
17 - Government / Institutions	0.7	0.1	0.2	1.5	0.8	0.0	0.9	0.0	0.0	0.0	0.1	0.2	1.3	**5.8**
18 - Transport	2.5	0.0	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.1	1.8	0.1	0.2	**5.8**
19 - Other Built-up Land	0.3	0.1	0.2	0.3	0.3	0.3	0.2	0.3	0.2	0.1	0.1	0.2	0.7	**3.3**
21 - Open Land	0.8	0.3	62.9	46.8	21.3	15.1	2.5	6.7	1.3	20.7	1.1	0.5	1.8	**181.8**
22-1 - Wet Land	0.3	0.0	1.2	1.1	1.6	0.1	2.0	0.0	0.0	0.0	0.0	1.3	0.1	**7.7**
22-2 - Water Bodies	1.5	0.2	1.1	0.4	2.6	3.4	1.1	0.3	2.2	0.0	0.2	1.3	0.3	**14.6**
23 - Roads	1.6	0.5	1.3	3.6	3.6	2.3	1.1	2.1	1.0	0.5	0.6	0.8	2.5	**21.5**
Sub Total in the Survey Area	17.9	8.4	101.2	119.0	87.8	61.4	26.0	37.4	19.2	35.7	13.1	16.5	22.4	**566.0**
Outside of the Survey Area	0.0	0.0	44.7	0.0	0.0	0.0	0.0	0.0	0.0	69.3	0.0	0.0	0.0	**114.0**
Total	17.9	8.4	145.9	119.0	87.8	61.4	26.0	37.4	19.2	105.0	13.1	16.5	22.4	**680.0**

Source: CoMTrans Study Team

Table 5.2.5 Land Use Patterns in the Survey Area by DSDs of Gampaha District

Land Use Classes	Attanagalla DSD	Biyagama DSD	Divulapitiya DSD	Dompe DSD	Gampaha DSD	Ja-Ela DSD	Katana DSD	Kelaniya DSD	Mahara DSD	Minuwangoda DSD	Mirigama DSD	Negombo DSD	Wattala DSD	Total
11- Commercial	0.1	0.1	0.0	0.1	0.2	0.1	0.3	0.1	0.1	0.1	0.0	0.6	0.2	2.0
12 - Residential	35.5	38.6	8.4	43.6	56.9	36.3	60.7	13.0	55.1	62.4	9.2	19.9	22.7	462.3
13 - Business	0.4	0.4	0.0	0.1	0.7	0.5	0.6	0.5	0.2	0.4	0.0	0.6	0.5	4.9
14 - Health	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.7
15 - Education	0.5	0.3	0.0	0.3	0.6	0.7	0.7	0.5	0.5	0.4	0.1	0.6	0.6	5.8
16 - Industries / Distribution	1.0	4.6	0.2	1.2	0.5	3.0	3.7	1.6	0.9	0.5	0.1	0.3	2.9	20.5
17 - Government / Institutions	0.1	0.1	0.0	0.0	0.1	0.6	3.0	0.1	0.0	0.0	0.0	0.1	1.2	5.3
18 - Transport	0.2	0.1	0.0	0.1	0.2	0.2	6.0	0.2	0.0	0.0	0.0	0.2	0.4	7.6
19 - Other Built-up Land	0.2	0.3	0.0	0.1	0.3	0.5	0.2	0.2	0.2	0.2	0.1	0.2	0.1	2.6
21 - Open Land	18.2	13.6	5.7	66.6	27.9	14.9	25.1	2.6	32.9	22.9	5.8	2.7	21.8	260.7
22-1 - Wet Land	0.1	0.1	0.0	0.1	0.0	1.2	1.1	0.9	0.1	0.2	0.0	0.4	3.9	8.1
22-2 - Water Bodies	0.4	0.5	0.0	1.4	0.7	0.4	1.4	0.7	0.1	0.7	0.0	0.5	1.0	7.8
23 - Roads	1.5	1.6	0.5	2.2	2.5	2.7	3.5	1.5	2.6	2.5	0.3	1.2	2.2	24.8
Sub Total in the Survey Area	58.2	60.3	14.8	115.8	90.7	61.4	106.3	21.9	92.7	90.3	15.6	27.4	57.7	813.1
Outside of the Survey Area	96.1	0.0	190.4	66.4	0.0	0.0	2.8	0.0	1.6	42.9	170.6	18.7	0.0	589.5
Total	154.3	60.3	205.2	182.2	90.7	61.4	109.1	21.9	94.3	133.2	186.2	46.1	57.7	1,402.6

Source: CoMTrans Study Team

Table 5.2.6 Land Use Patterns in the Survey Area by DSDs of Kalutara District

Land Use Classes	Bandaragama DSD	Beruwala DSD	Dodangoda DSD	Horana DSD	Kaluthara DSD	Madurawala DSD	Mathugama DSD	Millaniya DSD	Panadura DSD	Other DSDs *	Total
11- Commercial	0.1	0.7	0.0	0.0	0.5	0.0	0.0	0.0	0.4		1.7
12 - Residential	26.8	38.6	3.2	28.7	31.1	0.1	2.6	7.5	27.1		165.7
13 - Business	0.2	0.2	0.1	0.2	0.8	0.0	0.0	0.0	0.3		1.8
14 - Health	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0		0.2
15 - Education	0.3	0.7	0.0	0.2	0.7	0.0	0.0	0.1	0.5		2.5
16 - Industries / Distribution	0.4	0.6	0.0	0.3	0.7	0.0	0.0	0.1	0.6		2.7
17 - Government / Institutions	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.1		0.7
18 - Transport	0.0	0.2	0.0	0.0	0.4	0.0	0.0	0.0	0.1		0.7
19 - Other Built-up Land	0.2	0.4	0.0	0.2	0.6	0.0	0.0	0.0	0.4		1.8
21 - Open Land	23.7	26.2	8.0	32.7	33.1	0.2	4.9	12.8	9.1		150.7
22-1 - Wet Land	1.3	0.2	0.0	0.1	0.8	0.0	0.1	0.0	0.4		2.9
22-2 - Water Bodies	3.1	1.6	0.2	0.1	3.3	0.0	0.5	0.1	4.6		13.5
23 - Roads	1.3	2.3	0.2	1.2	2.0	0.0	0.1	0.3	1.4		8.8
Sub Total in the Survey Area	57.4	71.7	11.7	63.7	74.8	0.3	8.2	20.9	45.0		353.7
Outside of the Survey Area	0.0	0.0	101.1	49.1	2.9	62.6	126.2	61.2	0.0	889.6	1,292.7
Total	57.4	71.7	112.8	112.8	77.7	62.9	134.4	82.1	45.0		1,646.4

Note: * Other DSDs are Agalawatta, Bulathsinhala, Ingiriya, Palindanuwara and Palindanuwara (km2)

Source: CoMTrans Study Team

5.3 Current Urban Centres and Urbanised Areas

5.3.1 Current Urban Centres

Urban structure and characteristics can be understood from the existing structure plans, namely the Colombo Metropolitan Regional Structure Plan (1998) and the Regional Structure Plan of the Western Region Megapolis (2004), and the land use. The result of the land use survey describes the urban structure pattern more precisely.

Urban Centres are places where urban activities are concentrated. In other words, they are centres of commercial, business, and other urban related activities which serve residents living in certain areas. The Existing urban centres are shown in Figure 5.3.1, which is a map updated by the CoMTrans Study Team based on the Colombo Metropolitan Regional Structure Plan 1998.

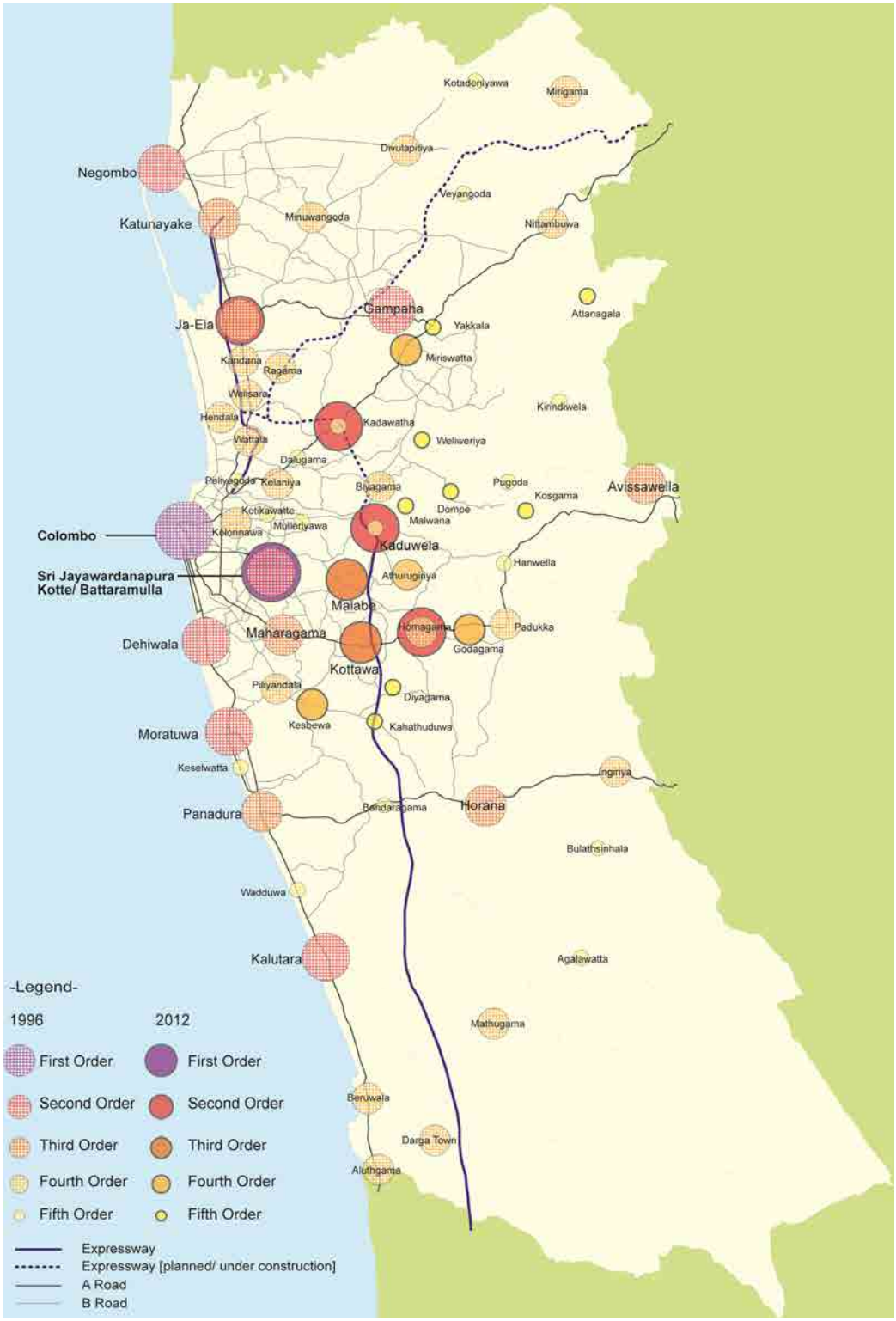
The National Physical Plan 2006 described a clear hierarchy in a structured manner. Urban Centres are classified in the following five categories. Each category indicates its extent of the area providing services and ideal population range. At the same time, specific urban facilities are identified. They are shown in Table 5.3.1.

This idea of urban centres in the Sri Lankan urban planning context have been applied to the development plans of the nation as well as each local authority, and is one of the basic concepts to consider regarding urban structures. More specifically, the land use zoning plan which is prepared in the development plans marked the commercial uses of urban centres. This is the major idea to lead the ideal urban structure in a region.

Table 5.3.1 Hierarchical Structure and General Characteristics of Urban Centres

Hierarchy	**First Order** National Urban Centre	**Second Order** Regional Urban Centre	**Third Order** Major Urban Centre	**Fourth Order** Secondary Urban Centre	**Fifth Order** Divisional Urban Centre
Radius of Influence	100-350 km	50-100 km	10-50 km	5-10 km	2-5 km
Population in Service Area	5,000,000-20,000,000	1,000,000-5,000,000	100,000-1,000,000	10,000-100,000	1,000-10,000
Administrative Facilities	Central Government Offices	Prov. Council Offices, Regional Office (Central Gov.)	District Offices (Central and Prov. Gov.)	DSD and Local Authorities' offices	PS sub units, and GN Offices
Educational Facilities	University, Polytechnics, Vocational Agencies, etc.	Technical College, Vocational Training Centre, etc.	Senior Secondary School, Technical College, etc.	Junior Secondary School, Vocational School, etc.	Primary Schools, etc.
Health Facilities	Specialised Hospitals, Teaching Hospitals, etc.	Provincial Hospital, Teaching Hospitals, etc.	Base Hospital, District Hospital, etc.	Peripheral Hospital, Rural Hospital, etc.	Dispensary, etc.
Commercial Facilities	Import/Export Centres, Shopping Complexes, etc.	Permanent Markets, Super Markets, etc.	Central Markets, Gov. Stores, Specialised Shops, etc.	Co-operative Shops, General Stores, etc.	Pola (Farmers'/ Weekly Market), and Retail shops
Socio-Cultural Facilities	Art Gallery, Museum, etc.	Public Library, Crematorium, etc.	Cultural Centre, Library, etc.	Community Hall, etc.	Civic Centres, etc.
Recreational Facilities	Central Urban Park, Botanical Gardens, etc.	Urban Park, Zoo, Night Clubs, etc.	Community Park, Cinemas, etc.	Local Parks, Open Space, Cafés, Bars, etc.	Mini Park, Kiosks, etc.
Transport Facilities	International Airport, Railway Terminal, Central Bus Terminal, etc.	Domestic Airport, Railway Station, Bus Terminal, etc.	Railway Station, Bus Stand, etc.	Railway Platforms, Bus Shelters, etc.	Bus Stop
Roads	Expressways, A Class Roads	B & C Class Roads	District Roads (C Class)	D & E Class Roads	Local Roads
Financial Facilities	Stock Exchange, Bank Head Offices, etc.	Regional Bank Offices	Bank Branches	Rural bank	Co-op Credit Society

Note: abr. from National Physical Plan (2006)

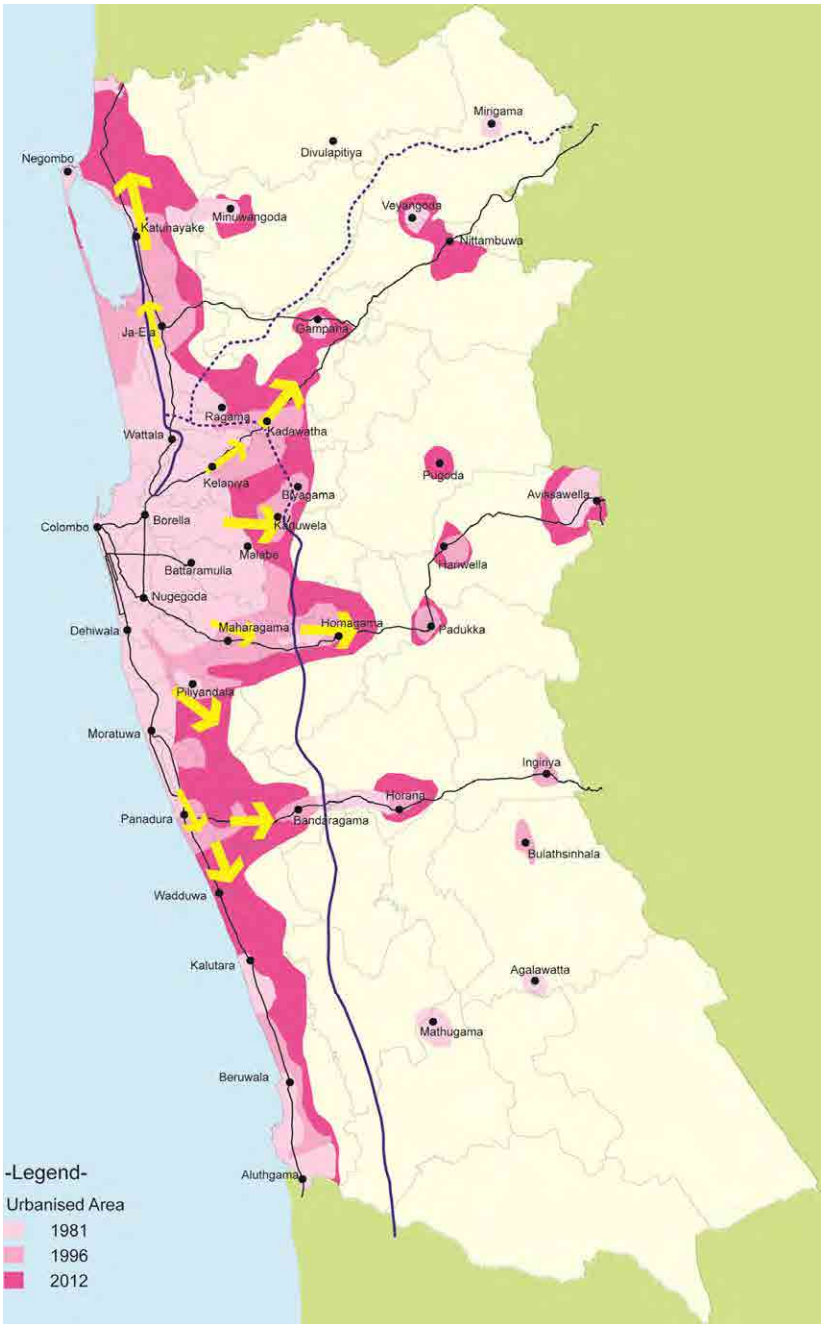


Note: Updated by CoMTrans Study Team based on the map 2.14 "Existing Functional hierarchy of Urban Centres 1996", Colombo Metropolitan Regional Structure Plan 1998

Figure 5.3.1 Functional Hierarchy of Urban Centres

5.3.2 Urbanised Areas

The study of Colombo Metropolitan Regional Structure Plan 1998 shows the urbanised areas in 1981 and 1996. In addition, the present urbanised areas can be found from the current population density and the land use pattern. Figure 5.3.2 shows urbanised areas in 1981, 1996, and 2012.



Note: Updated by CoMTrans Study Team based on the map 2.12 "Spatial Distribution Pattern of Urban Centres", Colombo Metropolitan Regional Structure Plan 1998

Figure 5.3.2 Urbanised Areas in 1981, 1996 and 2012

The urban areas in 1981 were concentrated in the western part of Western Province around CMC and its surroundings, and some local urban centres such as Katunayake, Gampaha, Mirigama, Avissawella, Homagama, Horana, Kalutara, and Beruwala. By 1996, expansion of the urbanised areas was notably observed along Negombo Road, Kadawatha and Nittambuwa on Kandy Road, around Kaduwela, along High Level Road, along Horana Road, and along Galle Road. By 2012, the urbanised areas were extended north to Negombo, and south to Kalutara. The coastal area became continuously urbanised. More expansion towards the east was also observed on High Level Road and Kandy Road, and towards Kaduwela. Urbanisation was also found on Horana Road, and around other local urban centres.

The urbanised areas were formed around CMC and the coast line in a stripe shape. This is considered as the basis of the current basic urban structure.

5.4 Urban Development Characteristics

The following are the major urban characteristics. At present, urban development is becoming notable in Western Province, and the following characteristics are becoming issues for creating effective urban development as well as transport systems.

The urban development characteristics are illustrated in Figure 5.4.1.

(1) Low Density Urban Sprawl and Scattered Residential Development

The current urban settlement pattern, especially in the suburbs, is consuming land at a much faster rate than the rate of population growth when compared with other nation's cities. Residential areas cover many parts of Western Province, which contributes to its low density. The main reasons are mentioned below:

- People tend to build houses with a garden, and this causes the spread of the residential areas.

- Responding to the demand for housing, many housing developments undertaken by the private sector are seen in the suburban areas. Many of them are developed on privately owned coconut fields or forestry tracts in rural areas. These developments are occurring due to land availability without any planning direction. As a result, residential developments are scattered around in the suburban areas. These developments cause inefficient spread of urban areas and become obstacles for future urban development.

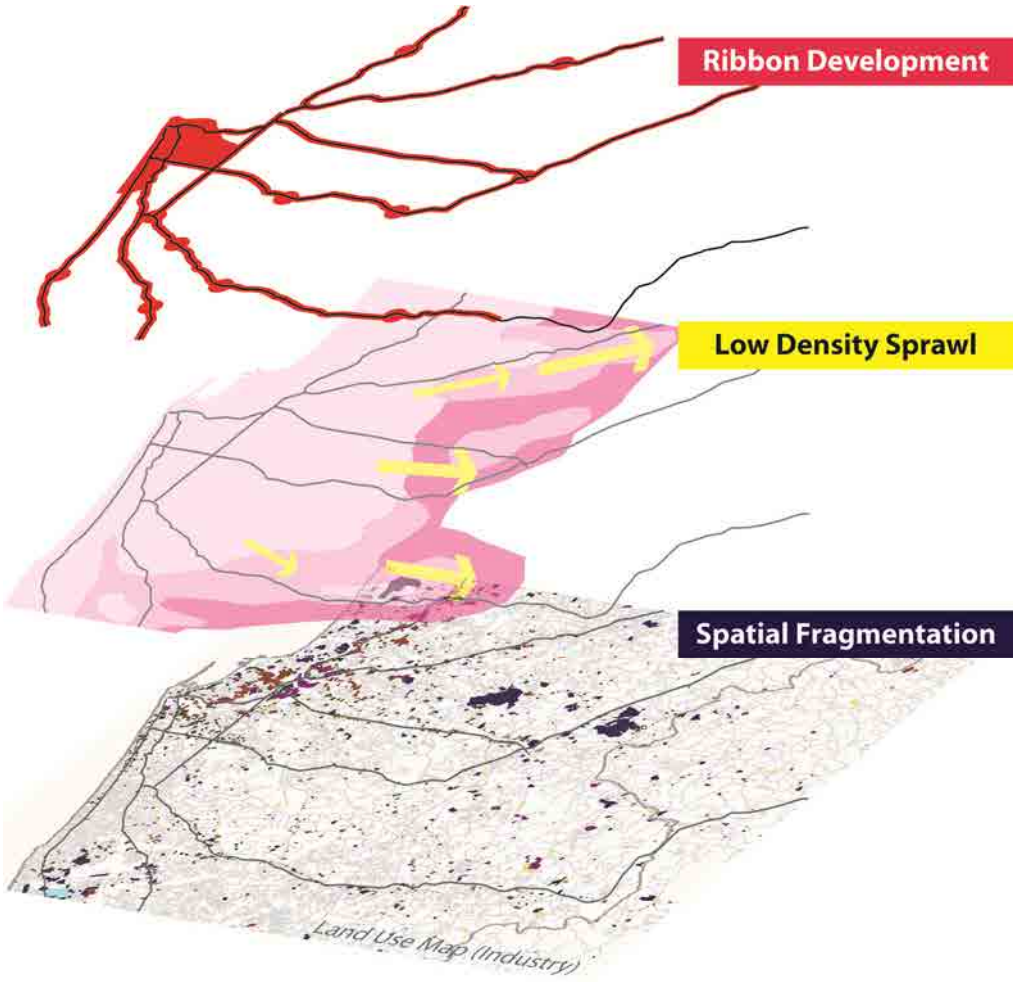
(2) Spatial Fragmentation

Whilst new residents are seeking a better quality of life, bad neighbouring uses such as industrial, logistics and mining uses are also proliferating within the peri-urban residential and agricultural areas. Due to the lack of planning regulations for land use zoning, it is possible that a residential area is located just next to these undesirable land uses. For instance, some active quarries in the suburban area of Colombo District and some industrial uses along Kelani River are scattered and intermixed with residential areas. This results in undesirable road conditions; heavy vehicles drive through residential areas.

(3) Ribbon Development

The current patterns of business and commercial activities are concentrated along the major roads, such as Galle Road, Kandy Road, Negombo Road, and High Level Road and around the railway stations. Most of the major urban centres in the suburbs of Colombo are also located along the roads and around the railway stations. Especially, urbanised areas are being continuously developed from the centre of Colombo towards suburbs along the major radial roads. In rural areas, towns are located at junctions of regional roads in many cases. The bus network is also intensified on these roads to connect these urbanised areas with the towns. As a result, a great deal of traffic is concentrated on specific roads and this causes heavy traffic congestion.

In general, low density sprawl and a dispersed pattern of development have resulted in unorganised land use and inefficient public transport systems. Future growth will need to focus on compact town centres with increased residential density to halt the current inefficient uses of land and enable resources to be used in a more efficient and sustainable manner.



Note: Ribbon Development shows a schematic indication of commercial land use, Low Density Sprawl shows a schematic indication of urbanised area, and Spatial Fragmentation shows industrial land use according to the Land Use Survey.

Figure 5.4.1 Urban Development Characteristics

CHAPTER 6. Identification of Colombo Metropolitan Area

6.1 Definition of Colombo Metropolitan Area

The Colombo Metropolitan Area (CMA) is defined in order to analyse and assess future transport demands and formulate a master plan. For this purpose, Colombo Metropolitan Area is defined by:

A) areas that are already urbanised and those to be urbanised by 2035, and

B) areas that are dependent on Colombo.

In an urbanised area, urban activities, which are mainly commercial and business activities, are active and it is assumed that demand for transport is high. People living in areas dependent on Colombo are assumed to travel to Colombo by some transport measures.

6.2 Factors for Identification of CMA and Formulation of Urban Structure

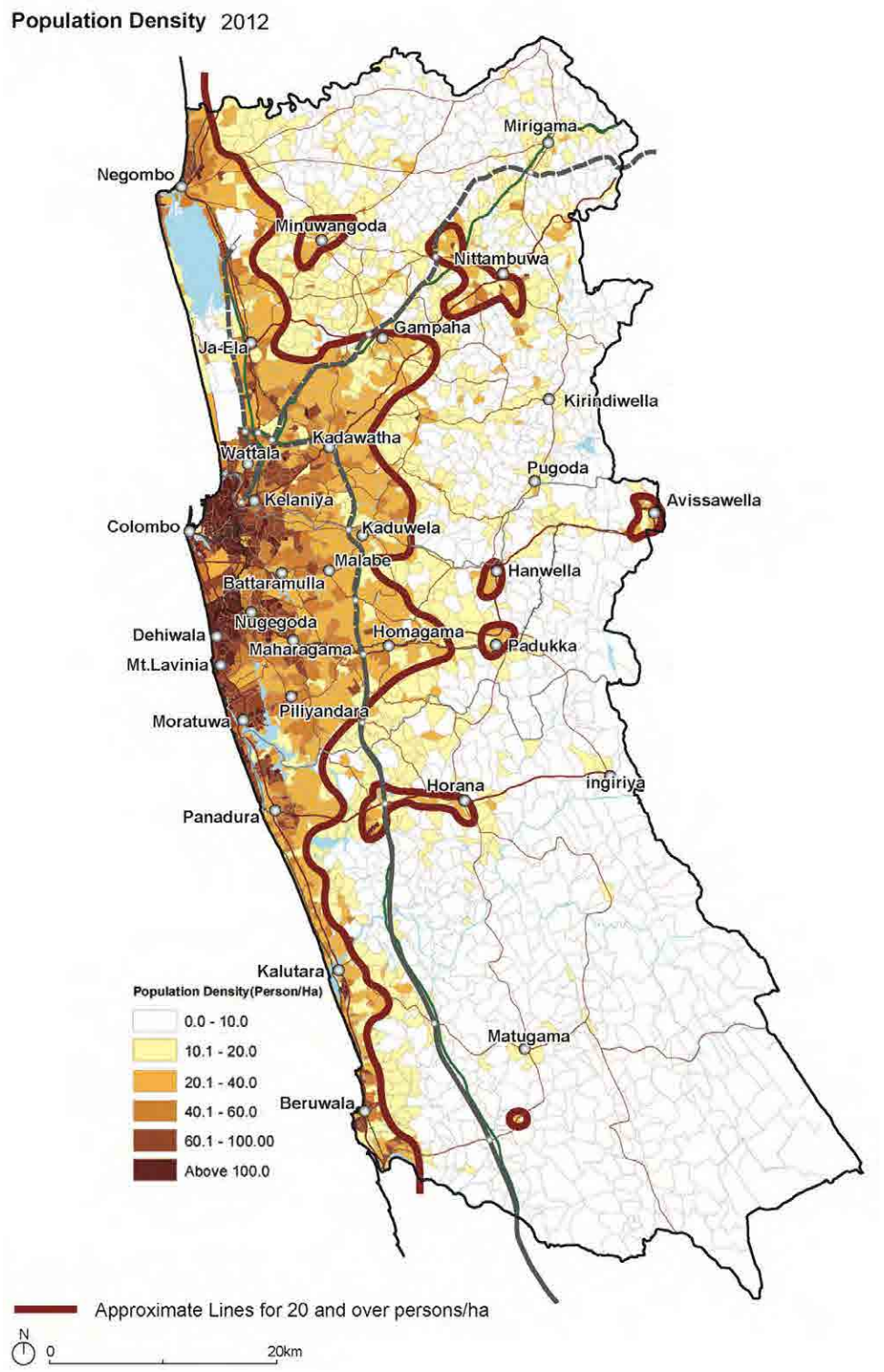
In order to identify the CMA, the following factors are considered. The factors indicate the existing urban situation from many points of view and urbanising areas in the future.

At the same time, these factors are examined to formulate the urban structure. They are the basis to explore urban conditions in the future.

6.2.1 Population Factors

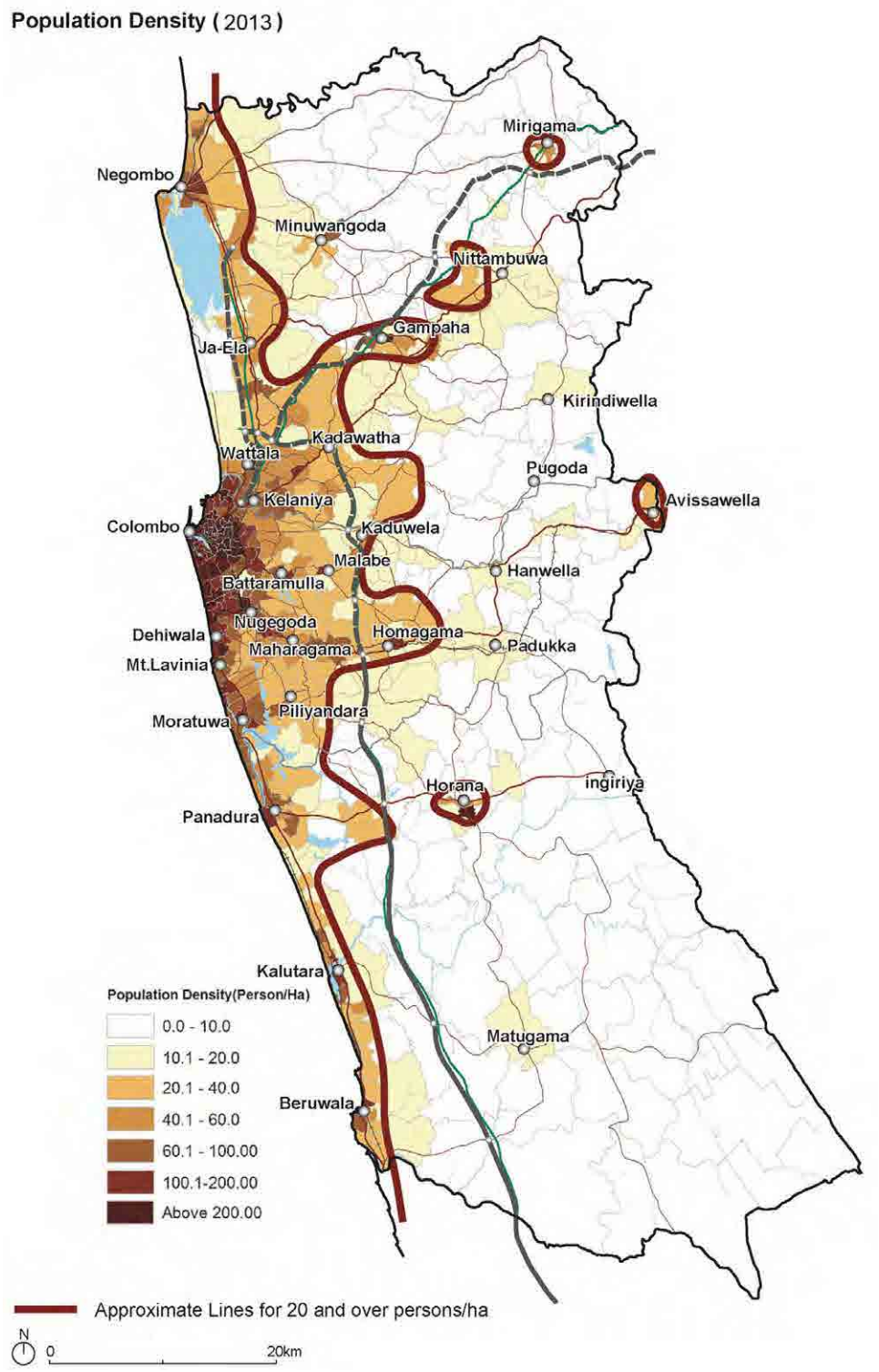
Existing population distribution and growth are mentioned in Chapter 2. They indicate the urbanised areas in Western Province and the trend of urbanisation in the past years.

1) **Population Distribution**: Most of the population is concentrated in CMC and in the coastal areas, and along major roads. The employed population density is more clearly concentrated in CMC. Existing urban centres such as Negombo, Gampaha, Panadura and Kalutara have a higher density as well. Figure 6.2.1 and Figure 6.2.2 show the population density (2012) and the daytime population density (2013). The daytime population is considered to be both the employed population and the student population.
2) **Population Increase:** the average annual growth rates from 2001 to 2012 clearly show that the population in CMC decreased and suburbs located around 15-20km from the centre of Colombo increased. It clearly indicates the movement of residential population from CMC toward the suburbs, especially in the eastern direction. Figure 6.2.3 shows the population increase, or the average annual growth rate from 2001 to 2012.



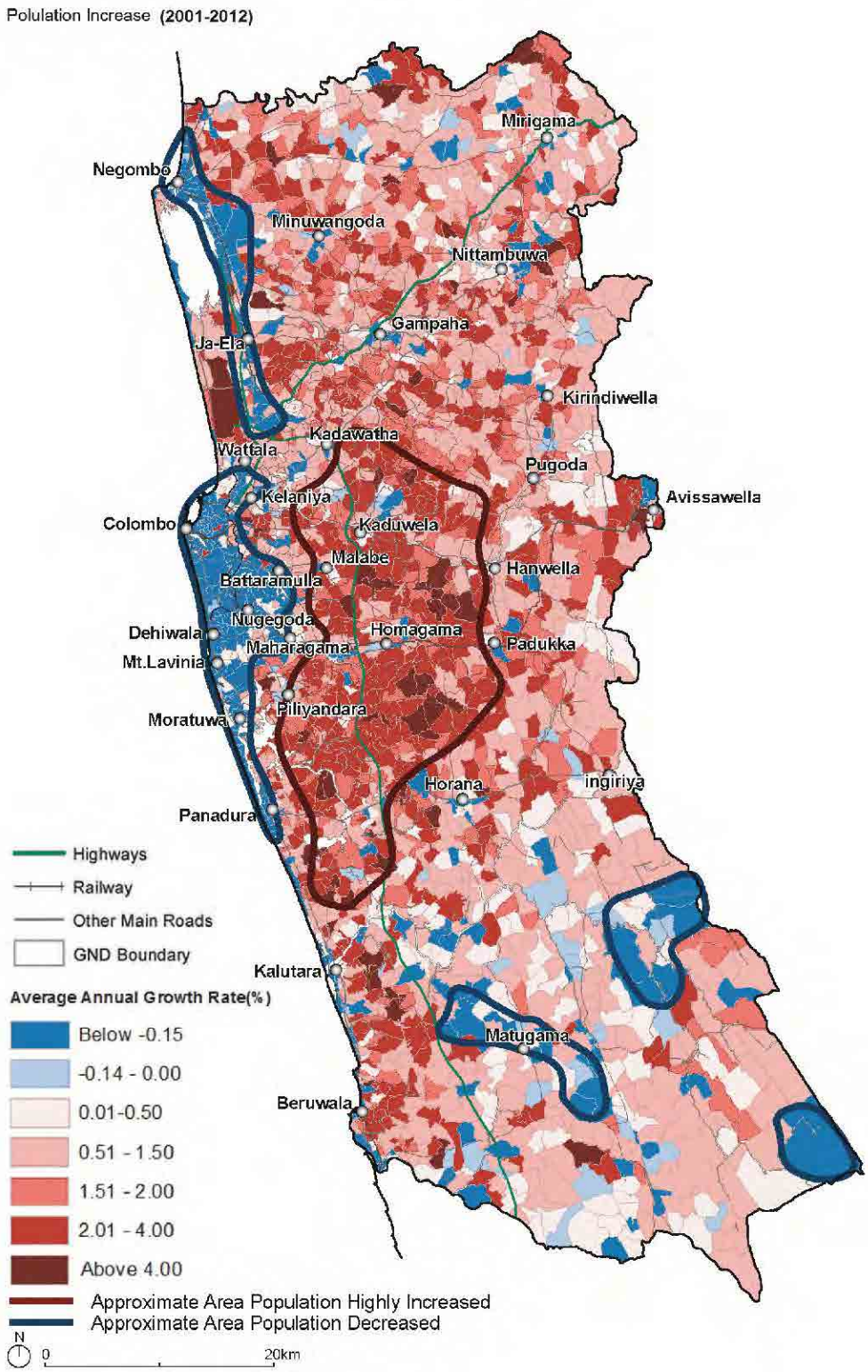
Source: Department of Census and Statistics

Figure 6.2.1 Population Density (2012)



Source: CoMTrans Study Team

Figure 6.2.2 Daytime Population Density (2013)



Source: Department of Census and Statistics

Figure 6.2.3 Population Increase (2001-2012)

6.2.2 Land Use Factors and Urban Structure Factors

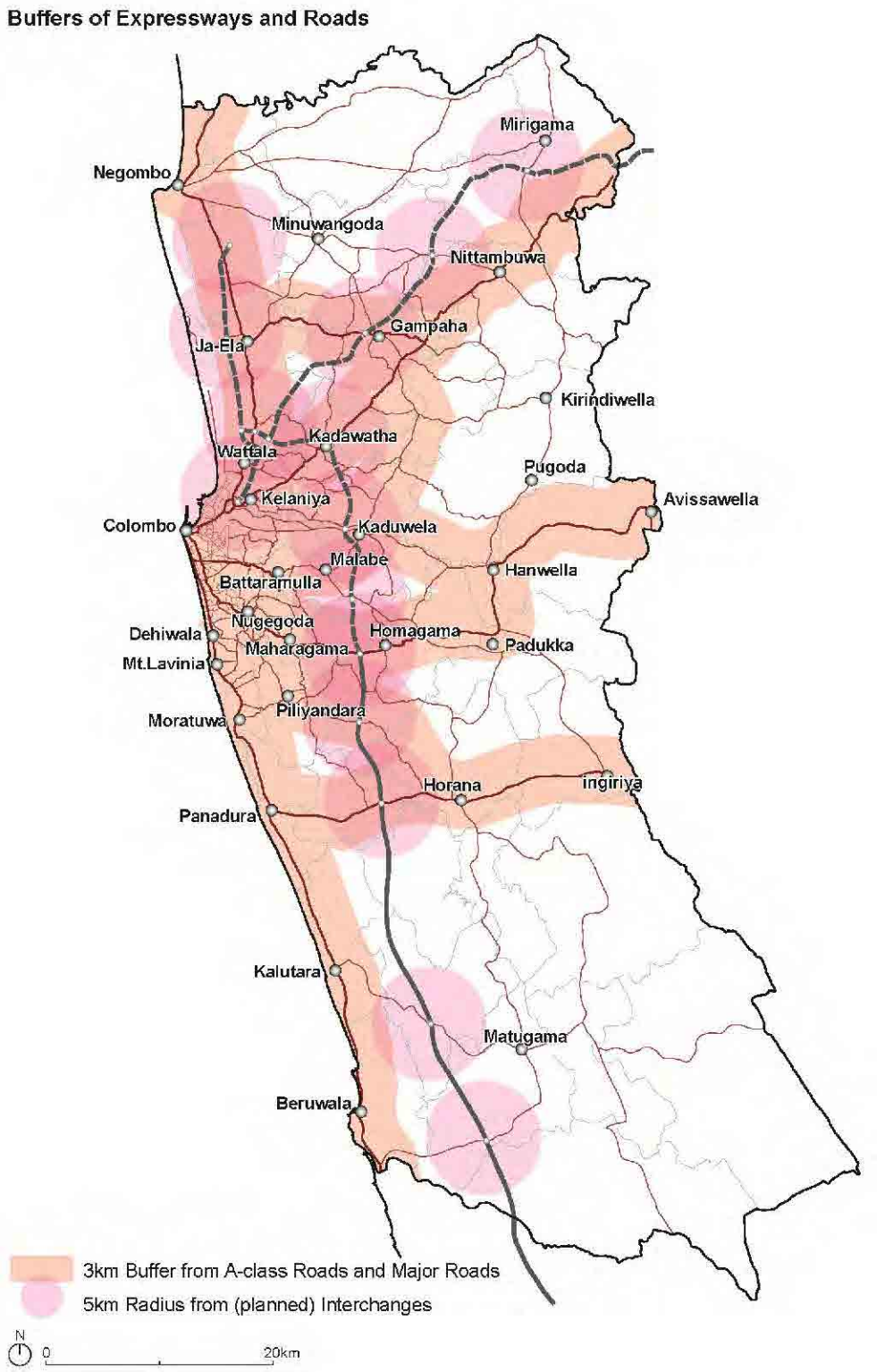
Subsequent to the past trends in population growth, the urbanisation along the major roads, bus routes, railway lines, and around the active urban centres is expected to continue in the future.

1) **Land Use:** Major urban activities are highly concentrated in CMC and along the major corridors as ribbon development. Residential areas are scattered in many parts of the province as the population density map shows. Please see Chapter 5 for more details of the result of the land use survey.
2) **Expressway Network and Interchanges:** Expressways are a new aspect in the Sri Lankan context. Although the expressway network was originally planned as truck roads, the network and the interchanges will affect human settlement and future urbanisation patterns.
3) **Major Roads:** Urbanisation has been concentrated along the major roads. Many of the bus routes are overlapped with the major roads, and they have boosted the urbanisation more. The roads have been upgraded by RDA and other related agencies. Continuing urban growth and urbanisation would continue to concentrate along the roads.

   Figure 6.2.4 shows 3 km buffer areas from the major roads and 5 km buffer areas from the existing and planned interchanges.
4) **Railways and Stations:** Dependence on public transport would become higher, and a TOD is expected to be proposed in transport nodes around the railway stations. More commercial and business activities would gather around the node stations and more commuters would be attracted to those areas. This trend will take place along with improving the transport system.

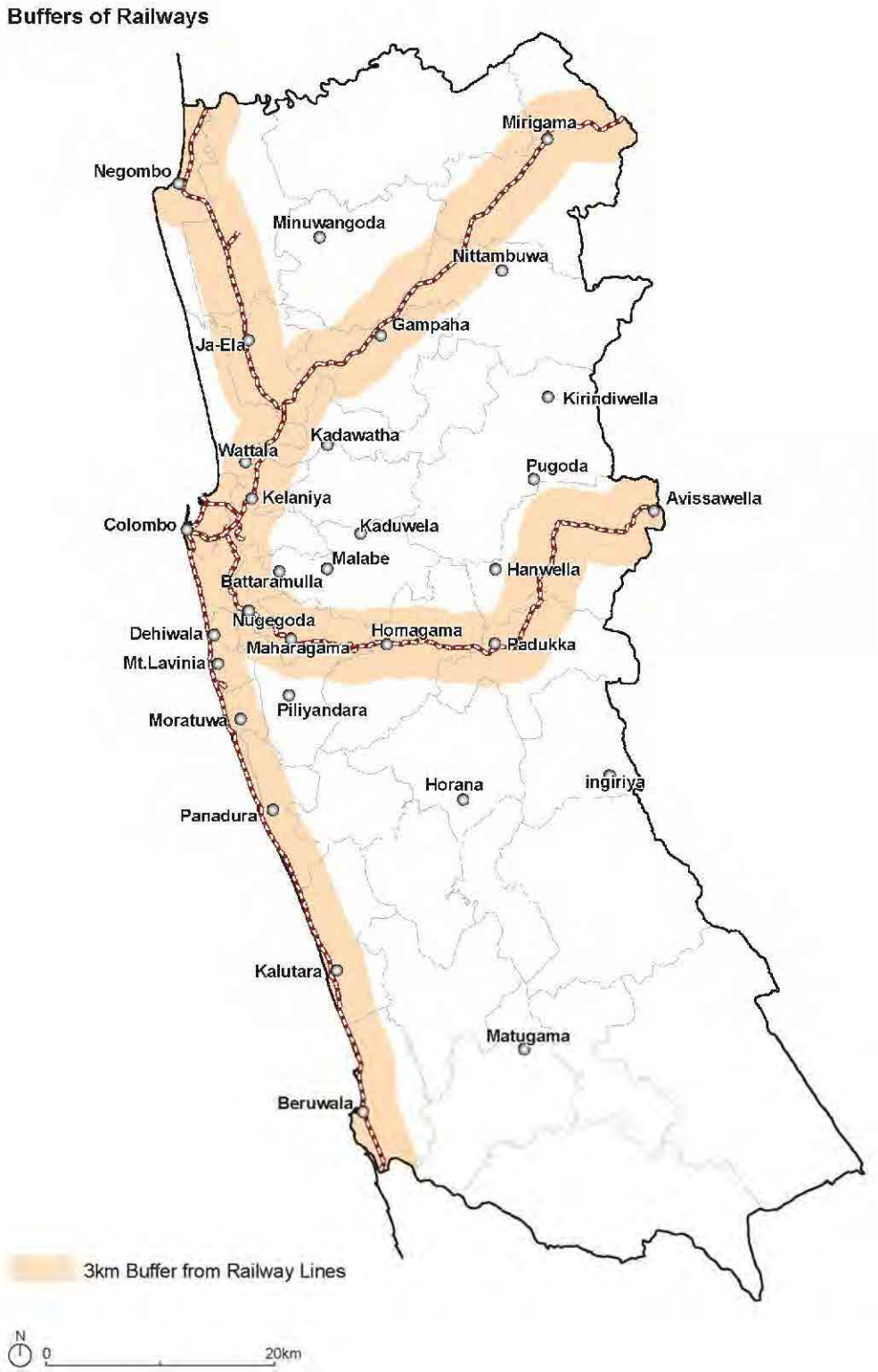
   Figure 6.2.5 shows 3km buffer areas from the railway lines.
5) **Urban Centres:** The existing urban centres are spread around Western Province. Urban structures are expanding greatly around these centres. Effective and well planned concentration of urban areas should be guided.
6) **Industry and Employment Centres:** The existing and proposed export processing zones (EPZ), industrial parks, IT parks, and other industrial estates would continue to affect the population growth. Due to land availability, they are located in suburban areas and would affect land use changes. And new employment centres that are expected to be located around urban centres would also be an attraction for urbanisation.

   Figure 6.2.6 shows the Conglomerate of the existing urban centres and the industrial areas.



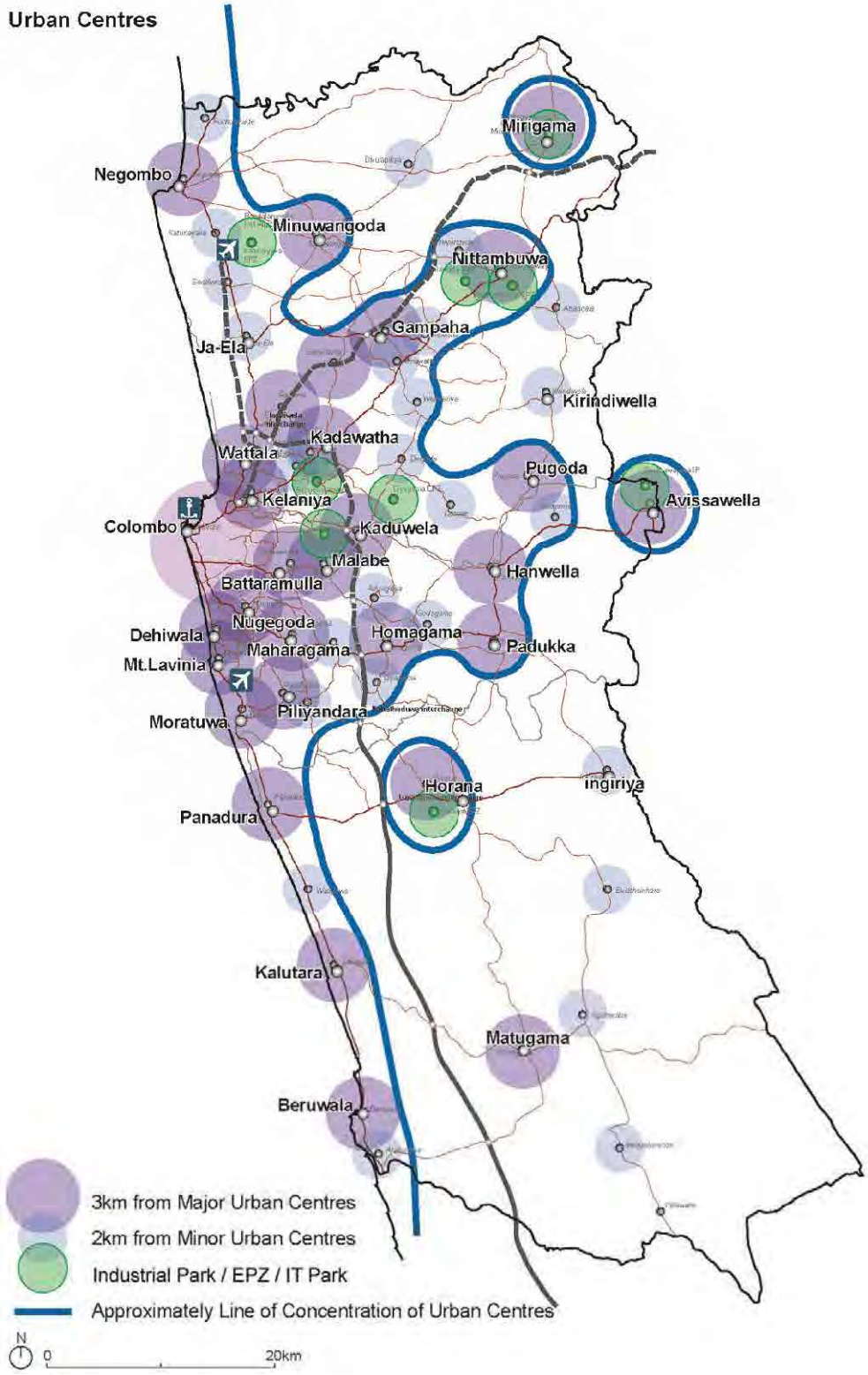
Source: CoMTrans Study Team

Figure 6.2.4 3km Buffers from Major Roads and 5km Buffers from Interchanges



Source: CoMTrans Study Team

Figure 6.2.5 3km Buffers from Railway Lines



Source: CoMTrans Study Team

Figure 6.2.6 Conglomerate of Existing Urban Centres

6.2.3 Urban Development Factors

1) **Urban Development Plan:** Figure 6.2.7 and Figure 6.2.7 show the "Colombo Metropolitan Regional Structure Plan" of 1998 and Figure 6.2.8 shows the "Western Region Megapolis Master Plan" of 2004 by UDA. Although they did not define urbanised areas clearly, they can be references to consider future urbanised areas.

   The Colombo Metropolitan Regional Structure Plan (1998) indicated the several urban centres in the proposed structure plan targeted for the year of 2010. Basically, they are located along the major roads and this growth pattern was very similar to the actual urban development trend, except for the development centre around Horana. This is continuously considered for future urbanised areas and urban centres in the target year of 2035 in this study.

   Western Region Megapolis Master Plan (2004) proposed the new urban centres as Outer Ring Townships in Negombo, Attangalla, Hanwella, Horana, and Kalutara. Although the new centres were proposed dynamically, it is not likely to happen in the future due to their distance from Colombo, and not high population growth is not expected in Western province. On the other hand, Inner Ring Townships around Homagama, Kaduwela, and Kadawatha are considered for future urban centres in the suburbs of Colombo.

2) **UDA Declared Area:** UDA declared areas are the areas that UDA considers as urban. This is also a reference to examine the CMA and future urban structure.

   Figure 6.2.9 shows the UDA declared area.

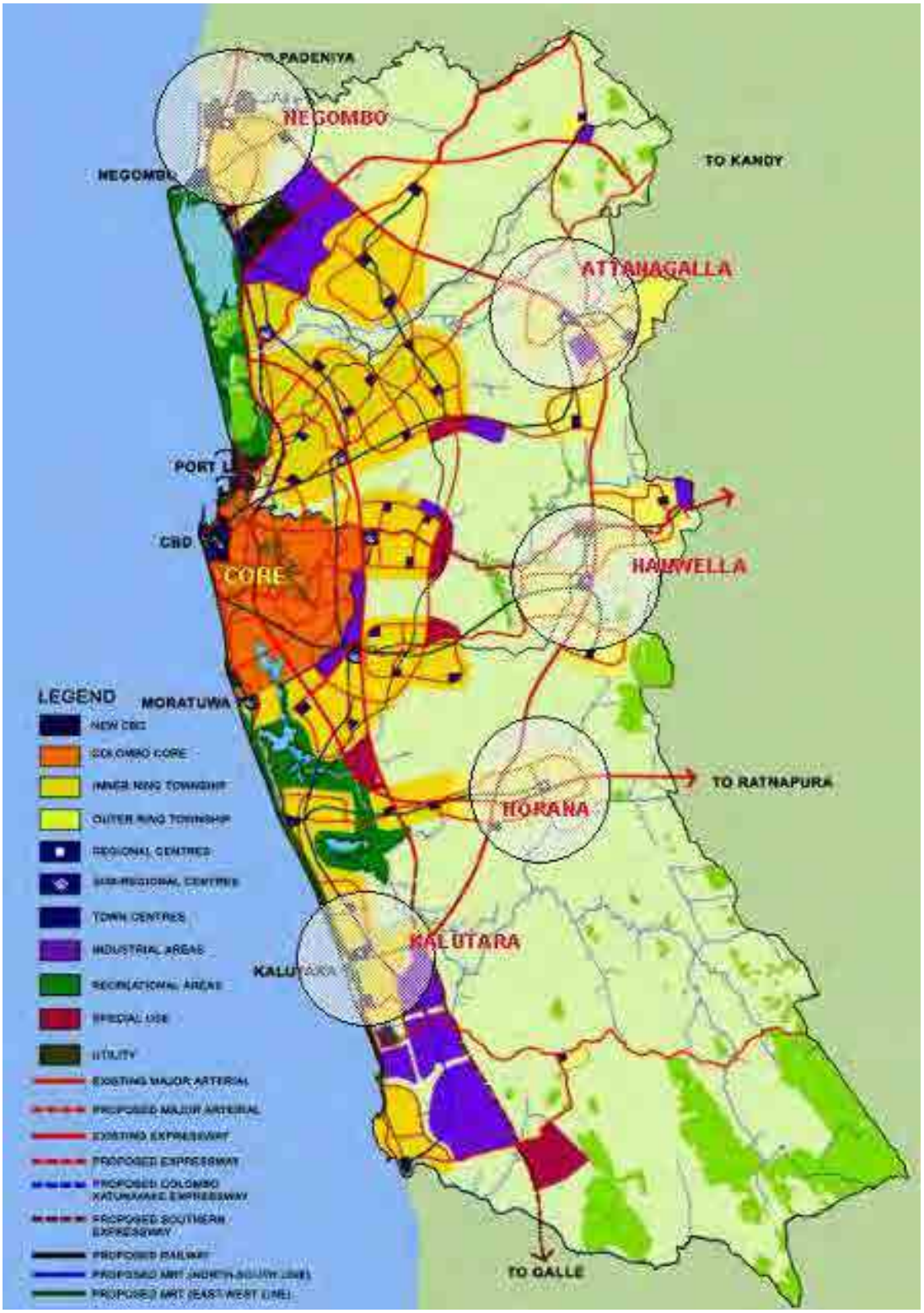
3) **Urban Development Projects:** Approximately 100 projects are proposed and/or on-going in Western Province. They are directly affecting the new urban structure in Western Province, although many of the projects are proposed in the heart of Colombo. Especially, major projects such as Battaramulla administrative centre should be strongly considered.

   Figure 6.2.10 shows urban development projects and their concentrated areas.

4) **Station Development Projects:** "Re-development of Railway Stations" prepared by the Strategic Enterprise Management Agency (SEMA) and UDA suggests developments on/around stations on the Coastal Railway Line. There are high potentials for TOD on/around not only the stations on this particular railway line, but also stations of the other railway lines as well.

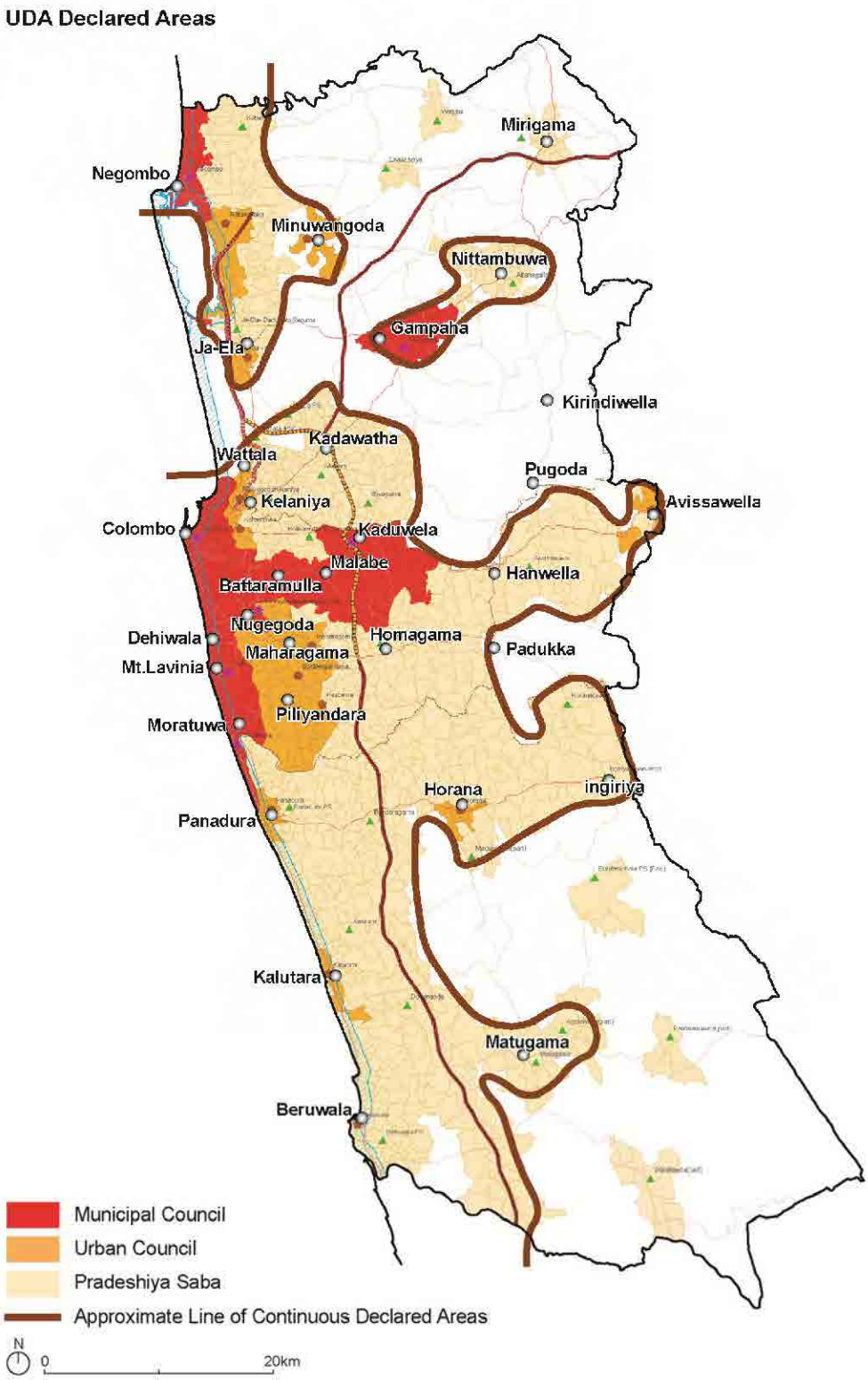
Source: Colombo Metropolitan Regional Structure Plan (1998)

Figure 6.2.7 Proposed Structure Plan of Colombo Metropolitan Regional Structure Plan



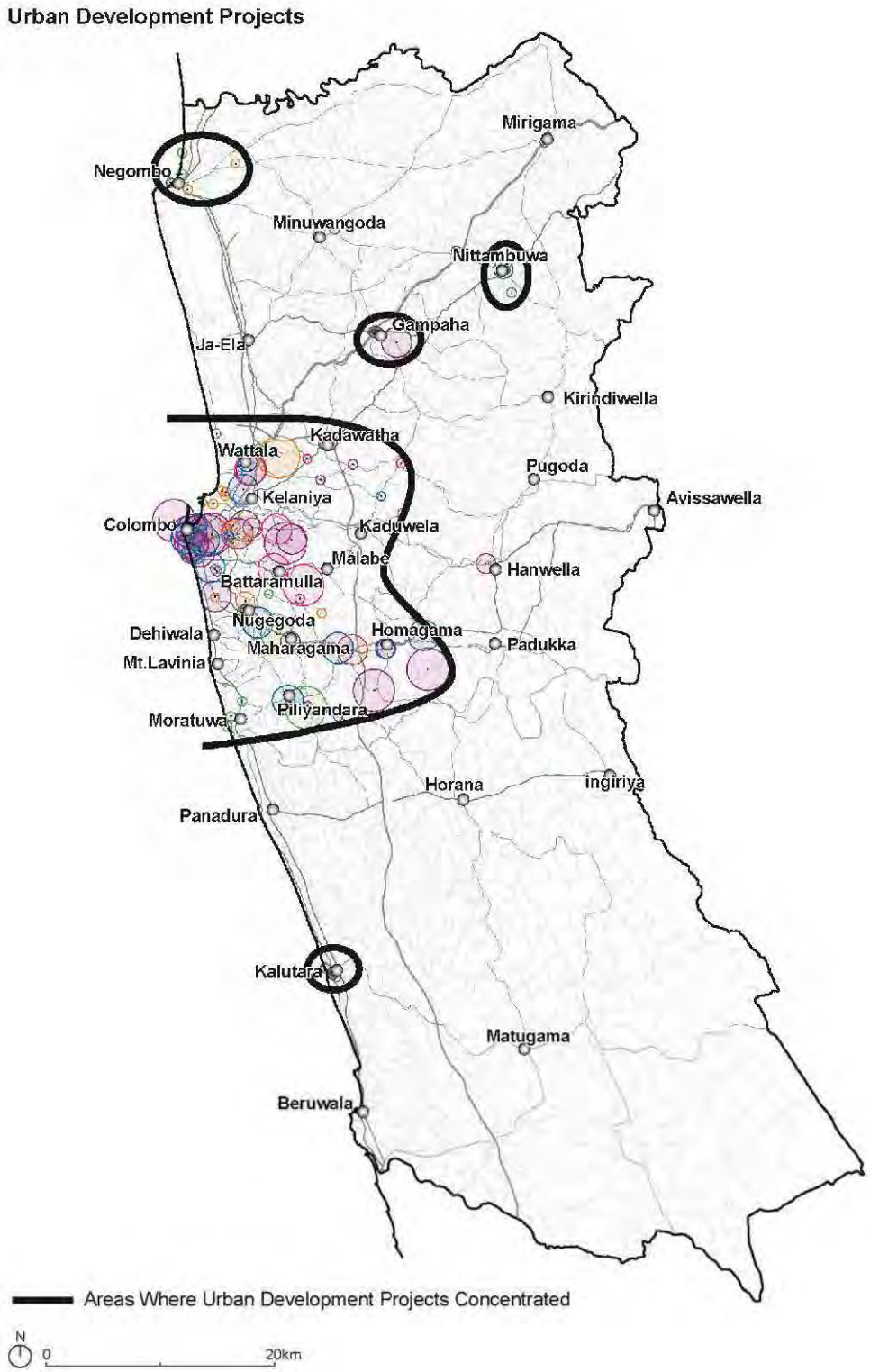
Source: Western Region Megapolis Master Plan (2004)

Figure 6.2.8 Proposed Structure Plan of Western Province Megapolis Plan



Source: UDA

Figure 6.2.9 UDA Declared Area



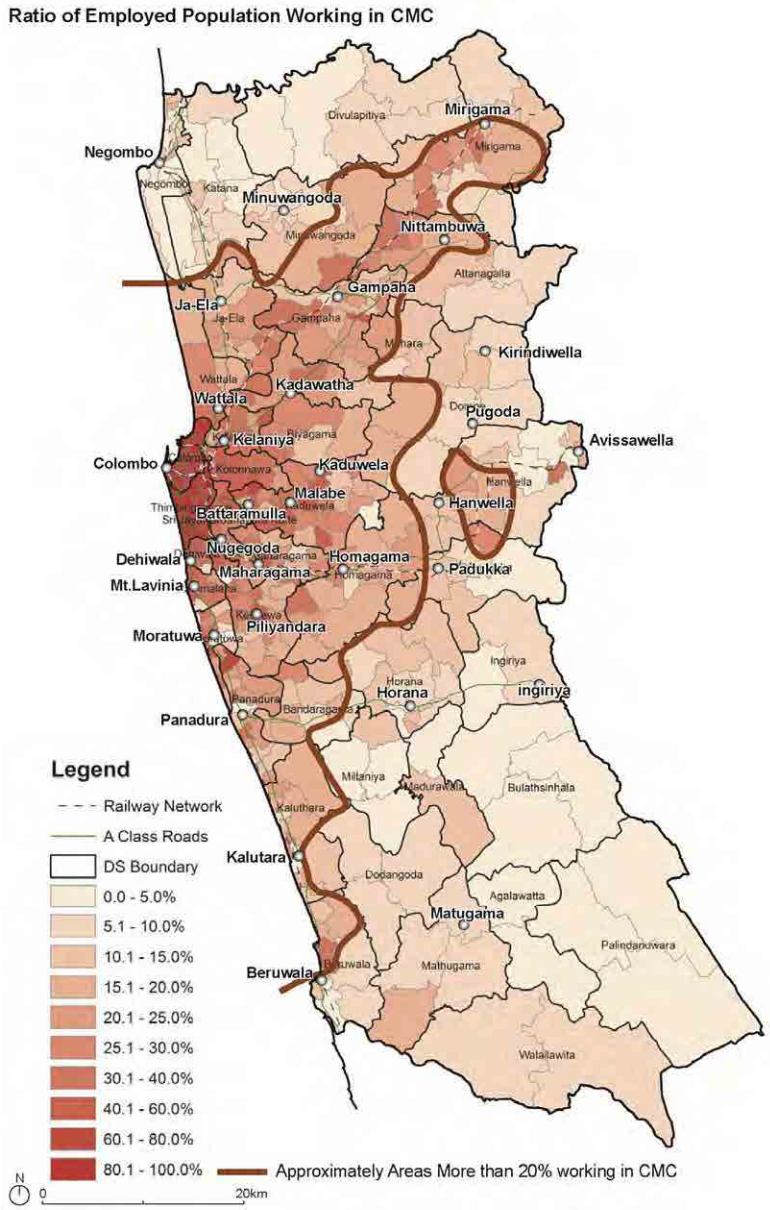
Source: UDA, manipulated by CoMTrans Study Team

Figure 6.2.10 Locations of Urban Development Projects Proposed by UDA

6.2.4 Commuters Trip Factors

Some of the results of the CoMTrans Home Visit Survey 2013 indicate the areas that depend on Colombo and those that are independent urban centres.

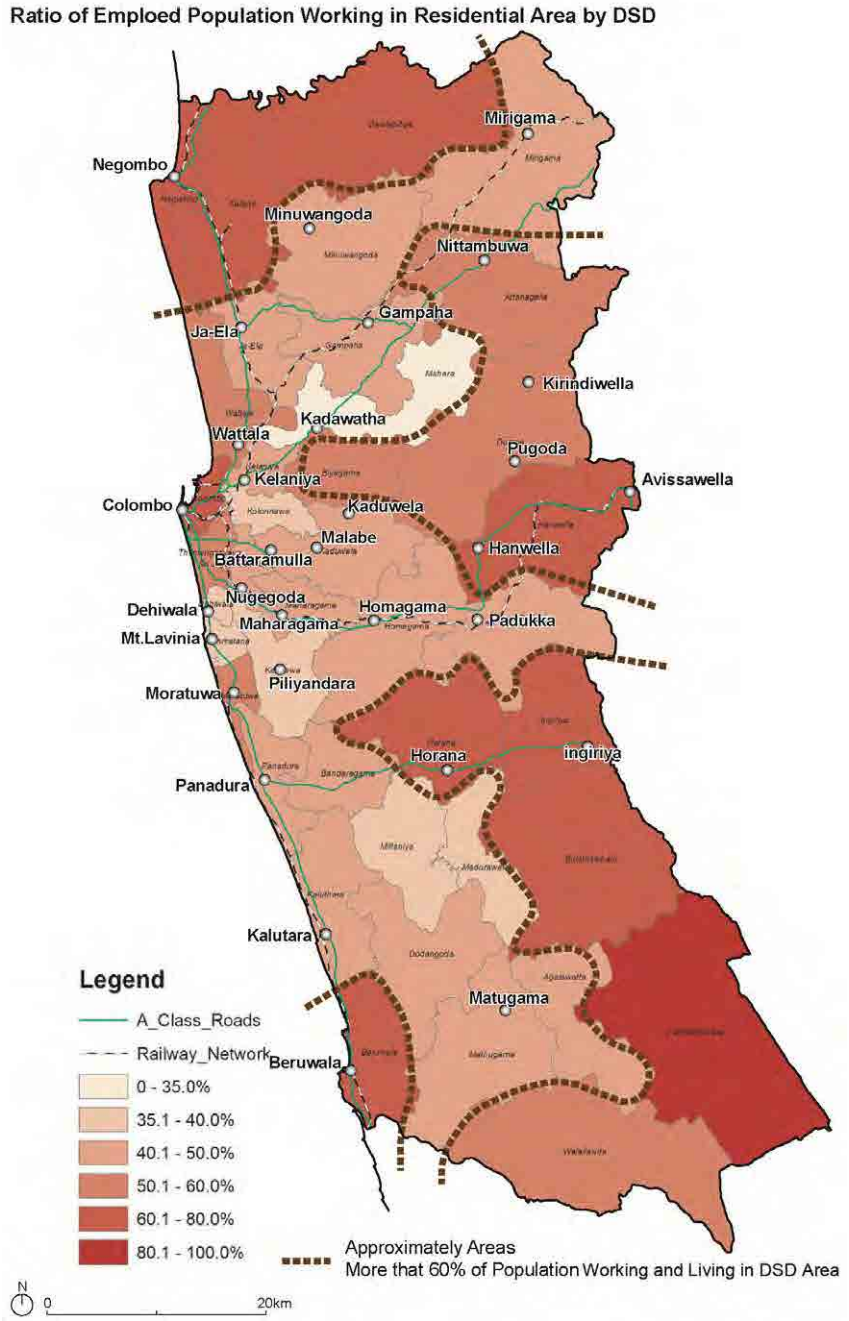
1) **Workers Commuting to CMC:** Figure 6.2.11 shows the ratio of the employed population commuting to CMC, according to Traffic Analysis Zone (TAZ). It is clearly illustrated that many workers that reside in the areas along the Main Line and Coast Line commute to CMC. On the other hand, the South-eastern part of the province and around the Negombo area have considerably fewer workers commuting to CMC.



Source: CoMTrans Home Visit Survey 2013

Figure 6.2.11 Ratio of Workers' Commuting to CMC by TAZ

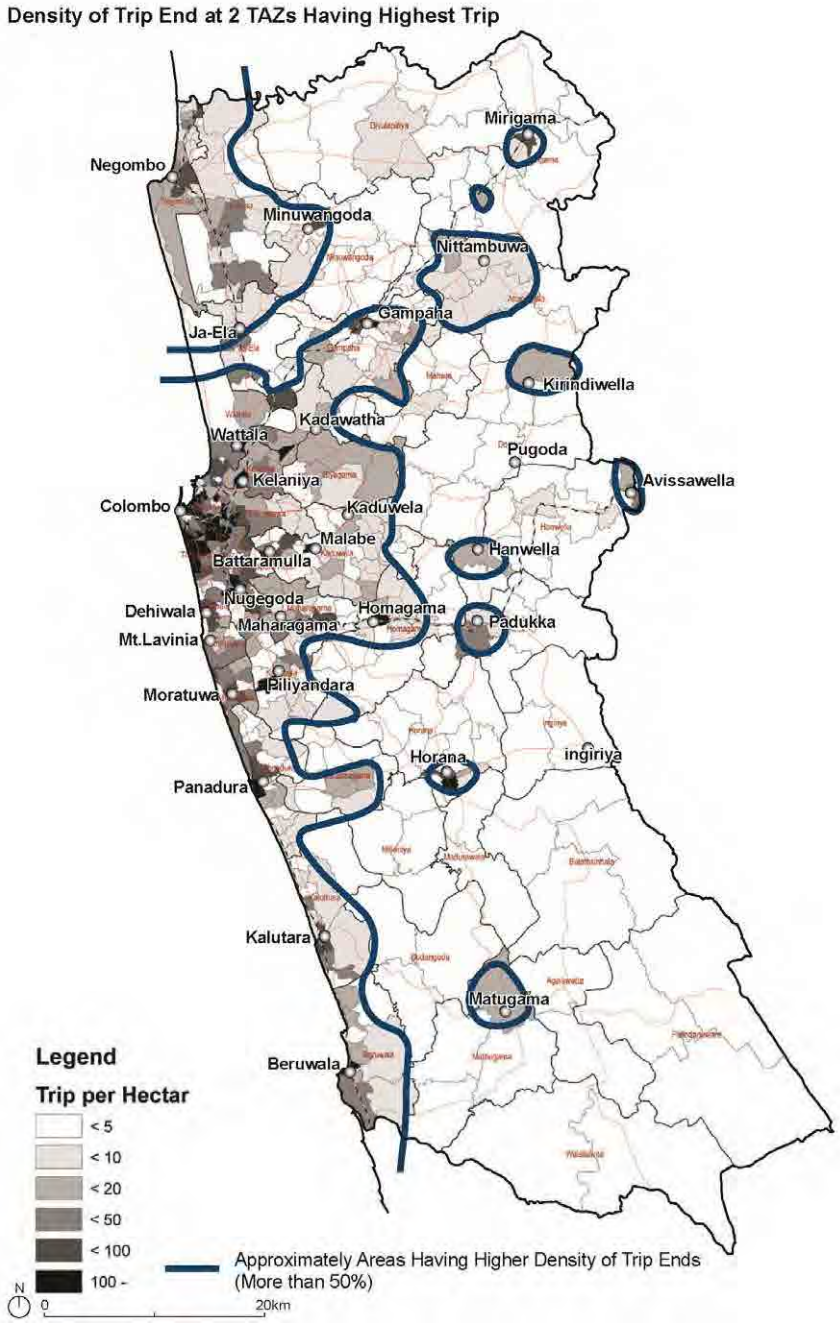
2) **Employed Population Living and Working in their DSD Area:** Figure 6.2.12 shows the ratio of the employed population working in their residential areas, according to the DSDs. In the south-eastern and northern parts of the province, the majority of the employed population are working for agriculture in their residential Area. Negombo DSD, Hanwella DSD, Beruwala DSD, and Horana DSD have high rates of employed population living and working in the same DSD. These areas have their own centrality.



Source: CoMTrans Home Visit Survey 2013

Figure 6.2.12 Ratio of Employed Population Living and Working in their DSD Area

3) **Density of Trip Ends:** Figure shows the density of trip ends at two TAZs having the highest trip rates for all purposes (Home-to-Work, Home-to-School, Home-to-Others, and Non-Home-based). A higher density of trip ends shows a concentration of urban activities. Colombo and areas along the major corridors have a high density of trip ends, namely the areas which have concentrated urban activities such as commercial and business.



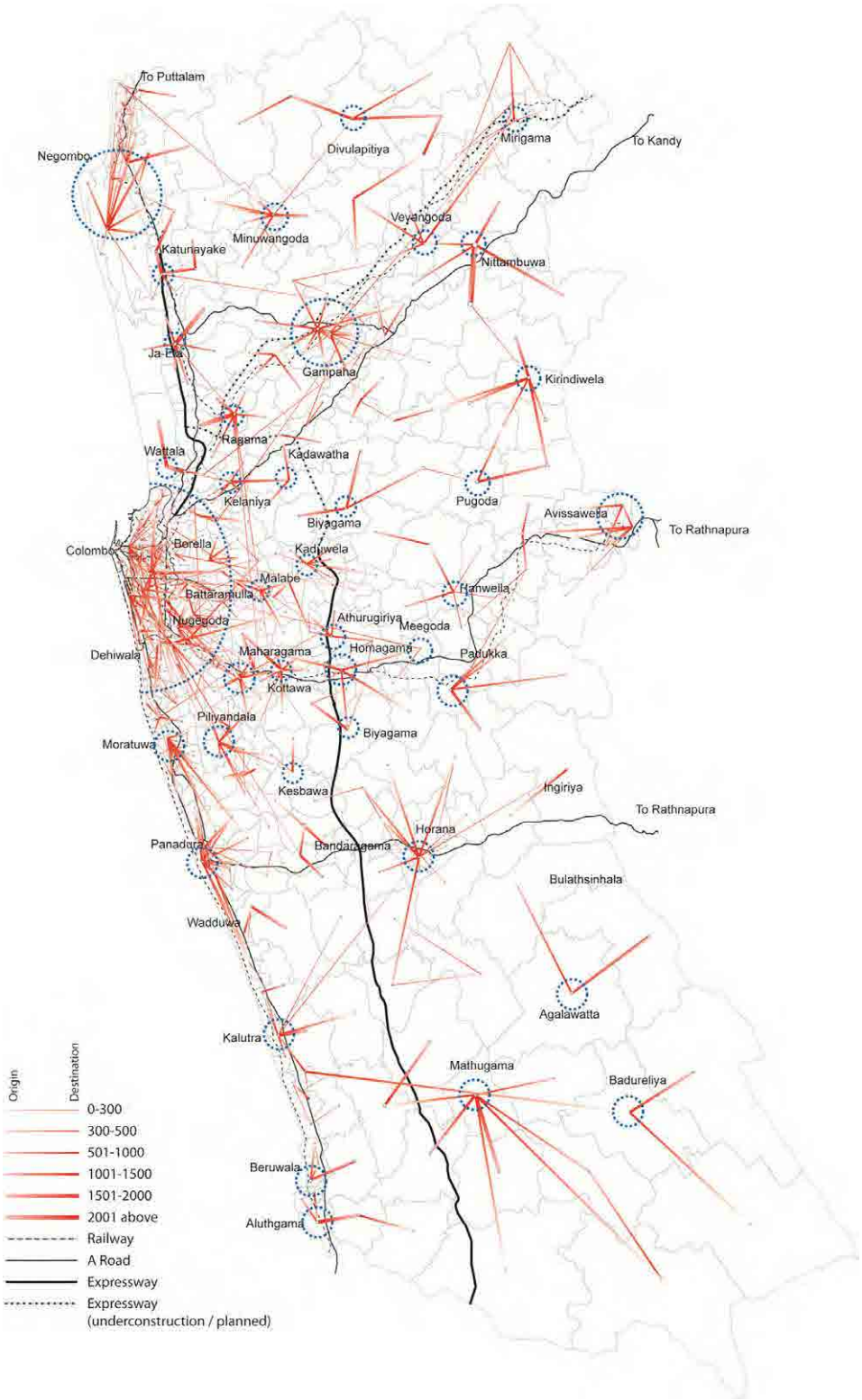
Source: CoMTrans Home Visit Survey 2013

Figure 6.2.13 Density of Trip Ends at 2 TAZs having the Highest Trip Rates

4) **Desire Line for OD Pairs with the 2 Highest Trip Rates:** This is one of the results of HVS, and new findings to confirm where urban centres are located. The destinations indicate commercial or business activities, and the concentration indicates urban centres.

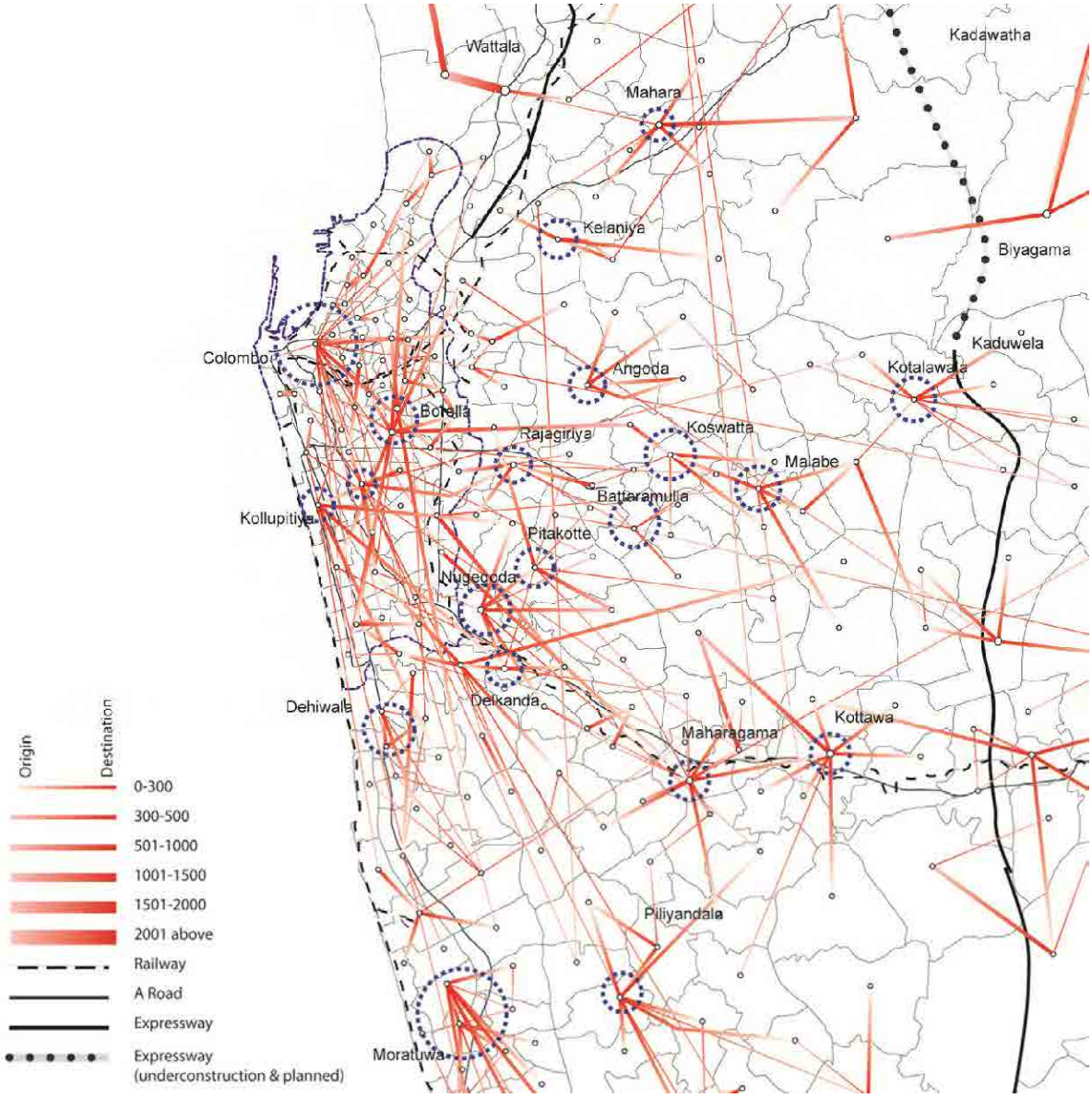
Figure 6.2.14shows the desire lines for OD pairs with the highest trip rates in Western Province. Concentrations of the destinations are found in CMC and urban centres along the major corridors, such as Naharagama, Kottawa, Homagama, Motatuea, Panadura, and Gampaha. Local urban centres are also found at Avissawella, Padukka, Negombo, and Matugama and they are more independently concentrated, and it is assumed that they have their own centrality.

Figure 6.2.15 shows desire lines for OD pairs with the highest trip rates around CMC. Pettah, Borella, and Kollupitiya are the major destinations in CMC. Nugegoda and Dehiwala also have a high concentration. Battaramulla shows a few concentrations in terms of the trip ends.



Source: CoMTrans Home Visit Survey 2013

Figure 6.2.14 Desire Line for OD Pairs with the 2 Highest Trip Rates in Western Province



Source: CoMTrans Home Visit Survey 2013

Figure 6.2.15 Desire Line for OD Pairs with the 2 Highest Trip Rates around CMC

6.3 Identification of Colombo Metropolitan Area (CMA)

According to the factors mentioned above, the urbanised area, namely the Colombo Metropolitan Area (CMA) was identified based on the DSD boundaries. The factors were examined separately and overlaid respectively, and thus determined the best boundaries for the CMA.

The existing population distribution and population growth especially guided the determination of the boundaries of CMA. Both night time and day time population densities having more than 20 people/ha would indicate the boundaries of CMA roughly. High population growth areas also confirmed the boundary. After consideration of the other factors, such as the current land use, urban structure, and urban development projects, the results of the CoMTrans Home Visit Survey were considered more carefully. Accordingly, dependency on the CMC is observed as they showed strong connectivity between the CMC and the other areas of Western Province. These factors would form a suitable basis for defining the CMA.

On Galle Road, continuous urbanised areas reach to Kalutara while Beruwala shows independency from CMC. On High Level Road, the urbanised areas end after Homagama. On Negombo Road, the populated areas are almost continuous up to Negombo, but Negombo shows their own centrality in the northern part of Western Province. On Kandy Road, although a strong dependency on CMC is observed, especially along the railway, separate centralities are observed after Gampaha.

Thus, the CMA was finalised and is shown in Figure 6.3.1. The CMA has a strong influence on the centre of Colombo, and continuous urban growth is anticipated.

Source: CoMTrans Study Team

Figure 6.3.1 Colombo Metropolitan Area

CMA consists of 20 DSDs. The extent is 995.5 km2, which is 27% of Western Province, and the population is 3,682,531, which was 63% of the population in Western Province in 2012. The DSDs constituting CMA are listed in Table 6.3.1 along with the area and census population in 2012.

Table 6.3.1 Area and Census Population 2012 of DSDs constituting CMA

District	DSD	Area (km2)	Population 2012
Colombo	Colombo	17.9	318,397
	Dehiwala	8.4	87,758
	Homagama	119.0	236,270
	Kaduwela	87.8	252,168
	Kesbewa	61.4	243,907
	Kolonnawa	26.0	190,931
	Maharagama	37.4	195,303
	Moratuwa	19.2	167,301
	Rathmalana	13.1	95,037
	Sri Jayawardanapura Kotte	16.5	107,172
	Thimbirigasyaya	22.4	236,903
Gampaha	Biyagama	60.3	186,730
	Gampaha	90.7	196,308
	Ja-Ela	61.4	201,217
	Kelaniya	21.9	135,994
	Mahara	94.3	207,077
	Wattala	57.7	174,281
Kalutara	Bandaragama	57.4	108,877
	Kaluthara	77.7	159,208
	Panadura	45.0	181,692
CMA		995.5	3,682,531

Source: Census of Population and Housing 2012, Department of Census and Statistics

CHAPTER 7. Socio-Economic Framework

7.1 Population Projection

7.1.1 Method

The estimated population in 2012, which is described in Chapter 2.1, is considered as the baseline population for future projections.

The future population is obtained from the baseline population giving consideration to the natural increase and the social increase. The natural increase is obtained from the future crude birth rate and the future crude mortality rate, which can be estimated from the historical data and trends. The social increase is mainly based on the internal migration in the case of Western Province. However, there is not enough reliable data available for the migration. Therefore, anticipated migration trends need to be set up as high, medium, and low scenarios. Thus, the future population projections to 2035 by these scenarios are obtained. Figure 7.1.1 illustrates the steps to obtain the population projections for 2035.

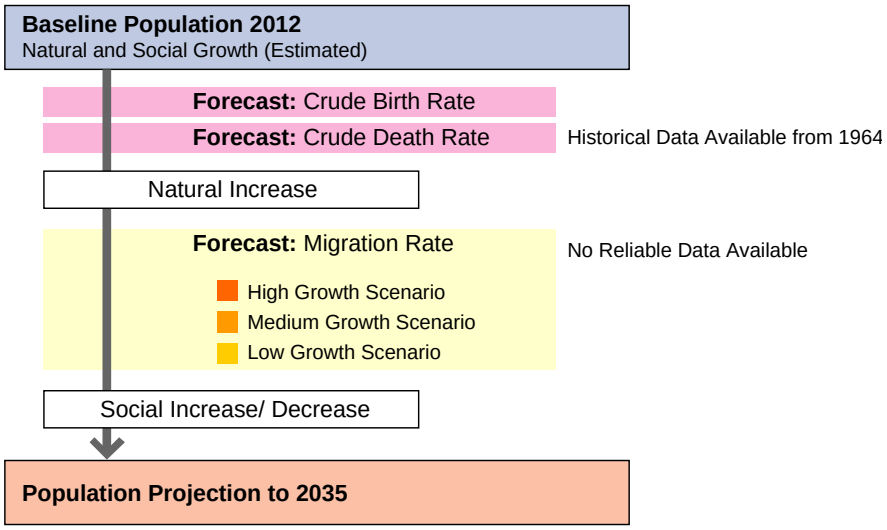


Figure 7.1.1 Steps for the Population Projection 2035

7.1.2 Birth Rate Forecast

The historical data of crude birth rates in Sri Lanka is available from 1964. Around 1970, the crude birth rate of Sri Lanka was approximately 30, however, it is falling gradually, and in recent years, the rate dropped to approximately 18.

As for the district level, the registered numbers of live births from 2000 to 2008 are available in "Statistics on Vital Events" published by the Registrar General's Department in 2011. From this, the actual birth rates of usual residents according to the districts can be obtained. The Crude Birth Rate in Western Province in 2009 was 17.4, which is a little lower than the national level of 18.8.

As many countries have experienced, the crude birth rate of Sri Lanka is decreasing. In the past ten years, the crude birth rate of Sri Lanka has declined by an average of 0.6% annually. This rate will be applied to the crude birth rate for the three districts. Thus, the crude birth rates of the future are forecast as shown in Table 7.1.1.

Table 7.1.1 Estimated Crude Birth Rates (every 5 years to 2035)

	Colombo Dis.	Gampaha Dis.	Kalutara Dis.
2010-2015	17.2	16.1	17.8
2015-2020	16.8	15.7	17.4
2020-2025	16.3	15.3	16.9
2025-2030	15.8	14.8	16.4
2030-2035	15.4	14.4	15.9

Source CoMTrans Study Team

The sex ratio at birth has stayed the same in Sri Lanka as well as in the three districts; about 104.5 males per 100 females (Male 51.1%, Female 48.9%). It is assumed that the average sex ratio would stay the same in the future.

7.1.3 Mortality Rate Forecast

The historical data of crude mortality rates is available from 1959 in Sri Lanka. During the '60s, the crude mortality rate was around 8.5, however, it is improving gradually, and it became around 6.0 in the '90s. In recent years, the rate has been almost stable.

The "Statistics on Vital Events" in 2011 shows the number of deaths of usual residents from 2000 to 2007. From these, the actual mortality rates of usual residents according to the districts can be obtained. In 2008, the crude mortality rate of Sri Lanka was 5.8, and that of Western Province was 6.6. Kalutara District shows a higher mortality rate of 7.1 than the other two districts in the Province.

Crude mortality rates by cohort, or five year age group populations, in 2001 can be calculated by census population and the registered number of deaths of usual residents. And also, it is possible to estimate crude mortality rates in 2007 from the estimated population in 2007 and the registered number of deaths. From these mortality rates in 2001 and 2007, the annual rate of change or improvement rate can be obtained. Most of the age groups show improvement of mortality rates.

For the future, it is anticipated that the mortality rate of each cohort will decrease due to the assumption of the improvement of medical facilities and treatment. For the forecast, there is not enough data available, therefore, the improvement rate of the crude mortality rates from 2001 to 2007 are taken in consideration.

In general, it is assumed that mortality rates of infants and the elderly would decrease due to the improvement of medical conditions. Some cohorts, in which the crude mortality rates are already small, would not be expected to improve drastically. Similarly, some cohorts, which have already shown significant improvement, would not be expected to continue such a high improvement rate. For those cohorts, improvement rates are adjusted. Taking into consideration these factors, future crude mortality rates are forecast according to the districts, as shown in Table 7.1.2.

Table 7.1.2 Crude Mortality Rates by 5-year Age Group and Sex in 2001 and Forecast for 2035 according to Districts

	Colombo District				Gampaha District				Kalutara District			
	2001		2035		2001		2035		2001		2035	
	M	F	M	F	M	F	M	F	M	F	M	F
<4	6.12	4.92	1.13	0.91	1.22	1.13	0.85	0.78	1.43	0.91	0.80	0.67
5-9	0.72	0.84	0.27	0.25	0.28	0.16	0.19	0.12	0.31	0.24	0.17	0.15
10-14	0.76	0.61	0.18	0.12	0.34	0.11	0.14	0.10	0.30	0.18	0.16	0.13
15-19	1.20	0.84	0.64	0.31	0.66	0.25	0.46	0.22	0.91	0.30	0.43	0.29
20-24	1.54	0.98	1.01	0.40	1.03	0.29	0.70	0.31	1.58	0.40	0.97	0.31
25-29	2.36	0.96	0.87	0.52	1.45	0.33	0.71	0.29	1.64	0.28	0.96	0.40
30-34	3.07	1.04	0.94	0.53	2.25	0.57	1.10	0.41	2.08	0.48	1.28	0.43
35-39	4.58	1.45	1.55	0.85	4.20	0.77	1.59	0.56	3.50	0.78	1.79	0.76
40-44	6.59	1.98	2.17	1.04	6.21	1.14	2.94	0.60	5.44	0.94	2.40	0.76
45-49	8.68	3.54	3.97	1.41	8.14	1.85	3.75	1.14	6.50	1.86	4.59	1.57
50-54	14.16	5.38	5.94	3.73	11.92	2.67	6.04	2.87	8.50	2.24	5.51	2.48
55-59	17.21	7.30	7.95	5.22	14.87	4.63	8.06	3.11	12.31	3.55	9.24	3.69
60-64	25.82	11.88	12.03	6.86	20.81	8.08	11.96	5.75	20.91	7.44	14.24	5.01
65-69	34.18	19.60	19.85	11.43	33.03	15.58	18.51	10.26	31.22	13.91	16.95	9.84
70-74	49.67	33.01	28.11	17.35	52.85	28.28	31.82	19.83	47.14	24.68	30.60	19.55
75-79	60.95	47.91	47.00	24.61	73.58	46.19	48.73	31.24	73.89	46.90	50.15	32.61
80-84	93.11	79.71	70.07	57.06	122.73	92.32	88.91	67.40	112.89	98.02	86.73	51.39
85-90	168.30	156.28	148.18	116.32	215.35	184.59	149.83	113.67	252.48	202.11	155.47	110.08
total	8.15	5.50	N/A	N/A	7.51	4.14	N/A	N/A	8.12	4.76	N/A	N/A

Source: CoMTrans Study Team

7.1.4 Population Growth Scenarios

As mentioned in section 3.1.2, migration has moved outward from Western Province in the past. However, the after-conflict situation and anticipated future developments in Western Province could change the migration trend. Development of the country would focus on Western Province, the most developed province. This would cause more population to be attracted to Western Province.

On the other hand, "A Population Projection in Sri Lanka – For the New Millennium 2001-2100" by W, Indralal De Silva, Institute of Health Policy, mentioned that the Sri Lankan population will be decreasing around 2030 to 2035. And, there is a nationwide development policy that will also be implemented, such as development of Hambantota and the northern part of the islands. Therefore, outflow migration from Western Province would continue due to the national population scenario and the development of the other areas.

Taking into consideration the two opposing factors, the following scenarios of migration trends are considered for the population projection.

Scenario 1: High Growth with Rapid Urbanisation

Due to rapid urbanisation and economic growth in Western Province, job opportunities and educational facilities would be expanded. This would attract a large number of people towards Western Province. This trend would be remarkable in the working age population, especially those of a young age. They would live in the suburbs of Colombo and surrounding areas that would become employment centres such as EPZ and Industrial estates. New employment centres would be generated around the suburbs as well. Also, the expressway network would affect this population concentration. In some areas of Kalutara District, rural conditions would transform to urban, especially along major roads and around the interchanges of the Southern Expressway. New development in the other provinces will take place. However, the central role of the Colombo Metropolitan Area as an economic capital would become stronger. As a whole, many migrants would be attracted to Western Province and the recent slow population growth would turn to rapid growth.

Scenario 2 Medium Growth with Moderate Urbanisation

Economic growth and urbanisation would continue moderately. As it has until now, the central area of Colombo would not show more population concentration, but suburbanisation would occur strongly and more people would come to suburban areas. In Gampaha District, the population would grow continuously, but not drastically. The Kalutara District used to be rural, however, the Southern Highway would affect and change the growth scenario towards urban. On the other hand, the expected development in the other provinces would reduce growth and population concentration in Western Province. However, the importance of Colombo Metropolitan Area would remain. As a total, more migrants than now would gradually come to Western Province.

Scenario 3 Low Growth with Minor Social Change in Western Province

Even though the civil conflict ended in 2009, the population growth speed has been slow after 2009 up until now. Following this trend, economic and urban growth would not be expected to attain a high pace in Western Province. Some of the population would be concentrated in Colombo, but more of the population will move outward. At the same time, the development in Hambantota and the northern and eastern part of the island will be promoted in the national policy, and more people would be attracted to these areas. As a result, negative migration of Western Province would continue, and the Colombo Metropolitan Area would not show a high population growth in this case.

7.1.5 Projected Population to 2035

From the above scenarios, the projected populations to 2035 are summarised in the following Table 7.1.3 and Figure 7.1.2.

The population of Western Province is now 5.8 million, and it is estimated to reach 8.7 million in the high growth scenario, 7.9 million in the medium growth scenario, and 7.1 million in the low growth scenario.

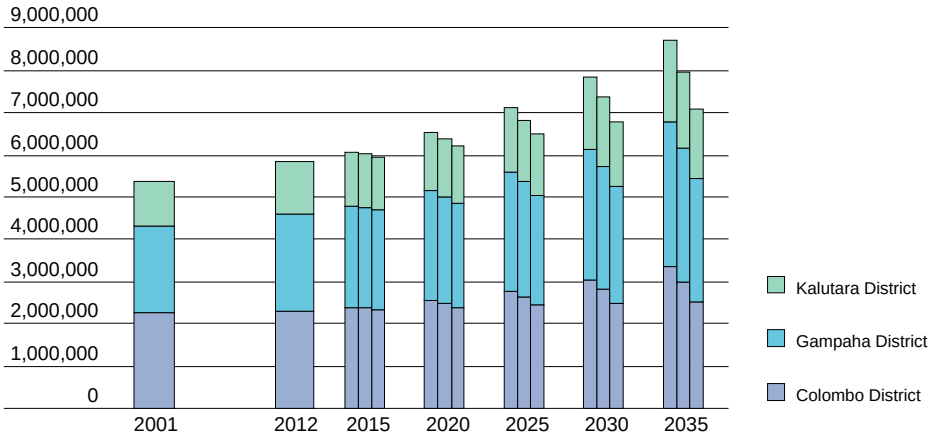
As for AAGR, historically it has been falling from 2.5% in the 1960's to 0.7% in the 2000's. By

2035, it would be raising to 2.0% in the high scenario, raising to 1.5%, which is the same as the AAGR between 1981 and 2001 in the medium growth scenario, and maintaining the same level as the current AAGR in the low growth scenario.

Table 7.1.3 Projected Population to 2035

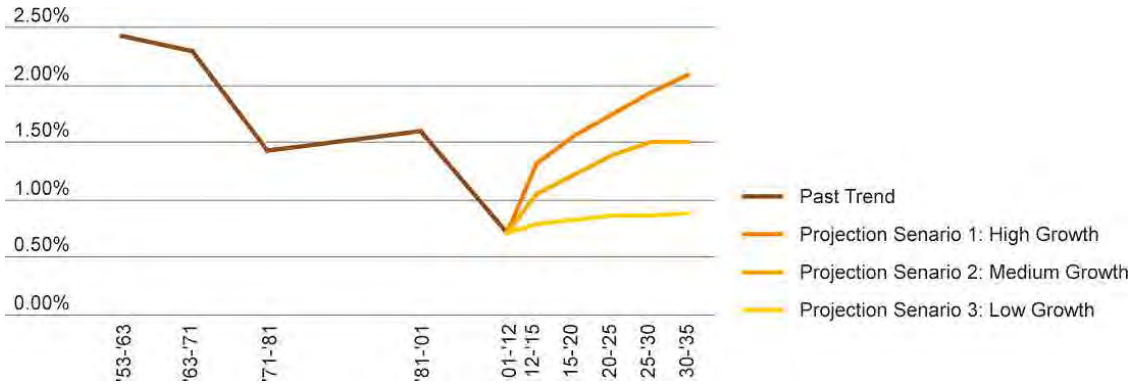
Scenario 1 High	**2001**	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
Colombo District	2,251,274	2,309,809	2,382,600	2,555,700	2,774,400	3,045,800	3,368,800
Gampaha District	2,063,684	2,294,641	2,393,200	2,586,000	2,821,400	3,101,800	3,435,900
Kalutara District	1,066,239	1,217,260	1,277,500	1,396,500	1,537,300	1,704,300	1,903,100
Western Province	5,381,197	5,821,710	6,053,300	6,538,200	7,133,100	7,851,900	8,707,800
AAGR		**'01-'12**	**'12-'15**	**'15-'20**	**'20-'25**	**'25-'30**	**'30-'35**
Colombo District		0.23%	1.04%	1.41%	1.66%	1.88%	2.04%
Gampaha District		0.97%	1.41%	1.56%	1.76%	1.91%	2.07%
Kalutara District		1.21%	1.62%	1.80%	1.94%	2.08%	2.23%
Western Province		0.72%	1.31%	1.55%	1.76%	1.94%	2.09%
Scenario 2 Mid	**2001**	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
Colombo District	2,251,274	2,309,809	2,359,400	2,476,100	2,624,400	2,795,900	2,979,700
Gampaha District	2,063,684	2,294,641	2,377,900	2,536,700	2,725,700	2,943,500	3,178,500
Kalutara District	1,066,239	1,217,260	1,270,200	1,373,200	1,492,100	1,629,700	1,782,000
Western Province	5,381,197	5,821,710	6,007,500	6,386,000	6,842,200	7,369,100	7,940,200
AAGR		**'01-'12**	**'12-'15**	**'15-'20**	**'20-'25**	**'25-'30**	**'30-'35**
Colombo District		0.23%	0.71%	0.97%	1.17%	1.27%	1.28%
Gampaha District		0.97%	1.20%	1.30%	1.45%	1.55%	1.55%
Kalutara District		1.21%	1.43%	1.57%	1.67%	1.78%	1.80%
Western Province		0.72%	1.05%	1.23%	1.39%	1.50%	1.50%
Scenario 3 Low	**2001**	**2012**	**2015**	**2020**	**2025**	**2030**	**2035**
Colombo District	2,251,274	2,309,809	2,332,500	2,379,500	2,428,700	2,480,200	2,534,100
Gampaha District	2,063,684	2,294,641	2,364,200	2,485,300	2,618,000	2,757,200	2,903,000
Kalutara District	1,066,239	1,217,260	1,262,800	1,346,700	1,437,000	1,534,600	1,640,600
Western Province	5,381,197	5,821,710	5,959,500	6,211,500	6,483,700	6,772,000	7,077,700
AAGR		**'01-'12**	**'12-'15**	**'15-'20**	**'20-'25**	**'25-'30**	**'30-'35**
Colombo District		0.23%	0.33%	0.40%	0.41%	0.42%	0.43%
Gampaha District		0.97%	1.00%	1.00%	1.05%	1.04%	1.04%
Kalutara District		1.21%	1.23%	1.29%	1.31%	1.32%	1.34%
Western Province		0.72%	0.78%	0.83%	0.86%	0.87%	0.89%

Source: CoMTrans Study Team



Note: After 2015, the projected populations are shown in the Group A, Group B, and Group C growth scenarios.
Source: CoMTrans Study team

Figure 7.1.2 Population Projections to 2035

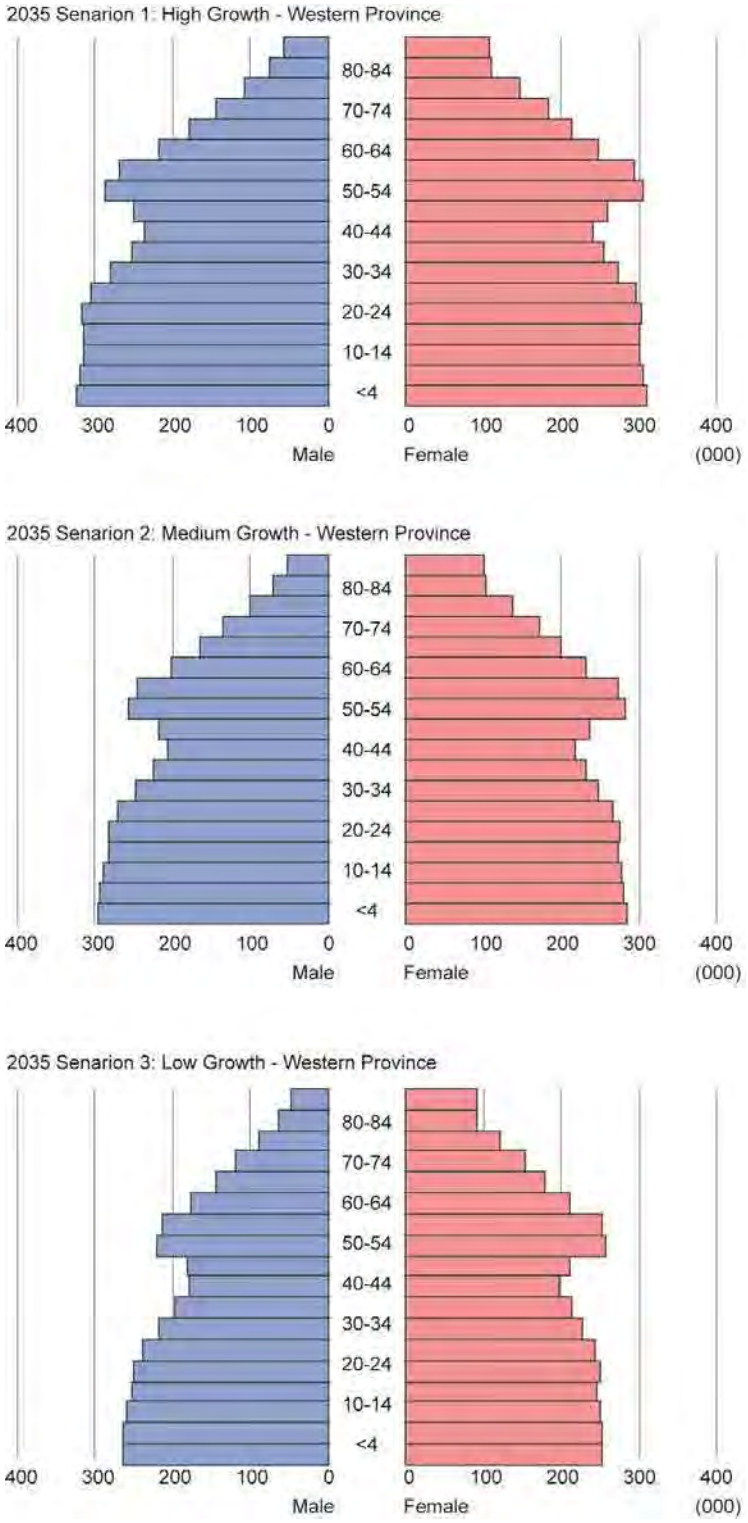


Source: CoMTrans Study team

Figure 7.1.3 Average Annual Growth Rates of Western Province to 2035

The population pyramids of Western Province in 2035 according to these three scenarios are shown in Figure 7.1.4.

In the high scenario, it is obvious that more young people would come to Western Province. On the other hand, in the low scenario, outward migration would reduce the population in all age groups.



Source: CoMTrans Study team

Figure 7.1.4 Population Pyramids in Western Province in 2035

7.1.6 Selected Growth Scenario

From the above mentioned three scenarios, the medium growth scenario is taken.

Five years have passed since the end of the civil conflict and after that, economic growth of Sri Lanka has been recovering favourably. These positive conditions attract more population to Western Province and population growth would be also expected. In such conditions, the same growth rate as that of present in the third scenario – Low Growth - is not suitable for future projection.

On the other hand, there is a population projection report, "A Population Projection in Sri Lanka – For the New Millennium 2001-2100" by W, Indralal De Silva, Institute of Health Policy. This mentioned a decrease in the population of Sri Lanka around 2030. High population growth in the nation would not be expected. There is another negative factor for the population growth of Western Province; the development of the other regions would affect the concentration of population in Western Province. By considering these factors, the rapid population growth mentioned as the first scenario –High Growth is not likely to happen.

Therefore, the second scenario - Medium Growth - is taken for further forecasts of spatial distribution, framework by industry and students, population by income, day-time population and also traffic analyses.

7.2 Forecast of GRDP Growth

In order to project the employed population by sector and population by income in the following sections, GRDP of Western Province is forecast.

7.2.1 GDP Growth

National GDP growth reached over 8% in 2010 and 2011. Now it has slowed down and became 6.4% in 2012. In Western Province, nearly 45% of the National GDP is concentrated. These GDP growths are shown in the table below**.**

Table 7.2.1 GDP growth in Sri Lanka and Western Province

Year	Sri Lanka				Western Province			
	GDP in Sri Lanka (Current Prices) (Mil.Rs.)	GDP in Sri Lanka (Constant Prices) (Mil.Rs.)	GDP Deflator (Base Year 2002)	Annual GDP Growth	GRDP in WP (Current Prices) (Mil.Rs.)	GRDP in WP (Constant Prices) (Mil.Rs.)	Annual GRDP Growth	Share
2007	3,578,688	2,232,656	160		1,663,759	1,037,979		46.5%
2008	4,410,682	2,365,501	187	6.0%	2,003,055	1,074,024	3.5%	45.4%
2009	4,835,293	2,449,214	197	3.5%	2,216,346	1,122,769	4.5%	45.8%
2010	5,604,104	2,645,542	212	8.0%	2,512,908	1,186,453	5.7%	44.8%
2011	6,544,009	2,863,715	229	8.2%	2,905,159	1,271,404	7.2%	44.4%
2012	7,582,376	3,047,277	249	6.4%	* 3,336,245	* 1,340,802	* 5.5%	* 44.0%

Note: * Estimation, CoMTrans Study Team
Source: Central Bank of Sri Lanka

In Mahinda Chintana, which is a development policy framework of Sri Lanka setting out development visions for a ten year period, Sri Lanka is targeting that the annual GDP growth will hold at more than 8% continuously until 2016. On the other hand, IMF published the "World Economic Outlook – April 2013" and projected that GDP growths will be 6.3 % in 2013, 6.7% in 2014, and 6.5 % in 2018.

It is assumed that the high GDP growth targeted by the Sri Lankan government will not continue to 2035. The IMF assumption is taken. After 2018, the growth rate will become lower gradually since it is assumed that the GDP would already be high and it is quite unlikely to maintain the high rate of the growth. It would drop to around 4% in 2035, as shown in the table below.

Table 7.2.2 Assumption of GDP growth

Year	GDP Annual Growth Rate	Note
2013	6.3%	IMF Forecast
2014	6.7%	IMF Forecast
2015-2017	6.7%	Assumption
2018	6.5%	IMF Forecast
2019-2020	6.5%	Assumption
2012-2025	6.0%	Assumption
2026-2030	5.0%	Assumption
2031-2035	4.0%	Assumption

Source: "World Economic Outlook - April 2013 - Hopes, Realities, Risks" by IMF and CoMTrans Study Team

7.2.2 GRDP Growth

It is also assumed that GRDP growth in Western Province would follow the national rate.

As for the GRDP growth by Sector, It is assumed that the share of the primary sector would decrease at the same rate of decrease as that in the employed population of the primary sector, which is described in the following section. The share of the secondary sector increased in the past five years at the annual average rate of 0.5%, and the share of the tertiary sector is slowly decreasing at the annual average rate of -0.3%. It would continue till 2035 on the same trend.

Table 7.2.3 shows GRDP forecast by each industrial sector.

Table 7.2.3 GRDP Forecast

	GRDP (Constant Price) (Mil. Rs.)	GRDP of Primary Industry **(Mil. Rs.)**	GRDP Secondary Industry **(Mil. Rs.)**	GRDP Tertiary Industry **(Mil. Rs.)**	*Share of Primary Industry*	*Share of Secondary Industry*	*Share of Tertiary Industry*
2007*	**1,037,979**	30,101	331,115	675,724	*2.9%*	*31.9%*	*65.1%*
2008*	**1,074,024**	33,295	340,466	700,264	*3.1%*	*31.7%*	*65.2%*
2009*	**1,122,769**	31,438	370,514	720,818	*2.8%*	*33.0%*	*64.2%*
2010*	**1,186,453**	35,594	378,479	771,195	*3.0%*	*31.9%*	*65.0%*
2011*	**1,271,404**	40,685	415,749	814,970	*3.2%*	*32.7%*	*64.1%*
2012**	**1,340,802**	42,906	438,442	859,454	*3.2%*	*32.7%*	*64.1%*
2015***	**1,603,800**	47,900	532,300	1,023,600	*3.0%*	*33.2%*	*63.8%*
2020***	**2,209,700**	58,900	751,800	1,399,000	*2.7%*	*34.0%*	*63.3%*
2025***	**2,971,100**	70,600	1,036,200	1,864,300	*2.4%*	*34.9%*	*62.7%*
2030***	**3,828,000**	81,200	1,368,500	2,378,300	*2.1%*	*35.7%*	*62.1%*
2035***	**4,702,200**	88,900	1,723,200	2,890,100	*1.9%*	*36.6%*	*61.5%*

Note: * Source: Central Bank of Sri Lanka, ** Estimation, CoMTrans Study Team, *** Projection, CoMTrans Study Team

7.3 Forecast of Employed Population

7.3.1 Forecast Method and Home Visit Survey

The employed population is forecast by the following process;

1) Projection of the Working Age population: In the case of Sri Lanka, the Census considers that the Working Age population is that of ten years old and over.
2) Projection of Labour Force (Economically Active Population): It can be forecast considering the trend of the decreasing working age population, increasing student enrolment, and women's social progress.
3) Projection of Unemployed Population/Employed Population: It can be forecast considering the trend of the unemployment rate.
4) Projection of the Employed Population by Sector: It is forecast based on the CoMTrans Home Visit Survey, Census of Population and Housing 2001 and 2012, and the forecast of GRDP by sector. As for the Primary Sector, land converted from agriculture to residences is also considered.

7.3.2 Working Age Population

In the case of Sri Lankan statistics, Working Age Population is defined as the population of those aged ten years old and over. The working age populations by GND are available in the 2001 Census. Although population details of the 2012 Census by age have not been published yet, the CoMTrans Study Team has estimated the population by Cohort. Future population projections are calculated by cohort analysis by the CoMTrans Study Team as well. Thus, the estimated and projected working age populations are shown Table 7.3.2. Labour Force Participation Rate and Economically Active Population

Economically Active Population (or Labour Force) is defined as persons who are employed or who are currently unemployed but looking for work, and Labour Force Participation Rate is given from the Labour Force divided by the Working Age Population. The trend of Labour Force Participation Rates in Sri Lanka from 2006 to 2012 is shown in Table 7.3.1.

Table 7.3.1 Labour Force Participation Rate in Sri Lanka (2004-2012)

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
Labour Force Participate Rate (%)	48.6	48.3	51.0	50.1	49.5	48.8	48.1	47.8	47.2

Source: Central Bank Statistics 2013

The rate shows a decrease in recent years. For the future, it is assumed that the labour force participation rate would decrease due to the following factors, which are assumed to occur in the course of development in Western Province.

a) Decreasing Working Age Population: The population share of 15 years to 60 years old was 67% in 2001 and 64% in 2012 according to the Census of Population and Housing 2001 and

2012, and it would drop to 57% in 2035 according to the estimation by the CoMTrans Study Team. This is considered as a base of the future economically active population.

b) Increasing School Enrolment: The Sri Lankan government has a policy to increase the number of students of secondary and tertiary education. In the course of the policy, it is assumed that the number of students will be increased. This increase in the student population will cause a decrease in the economically active population.

c) Women's Social Progress: More women will find their way into society, and they will have jobs. This will increase the Labour Force Participation Rate. According to the Sri Lanka Labour Force Survey Annual Report 2011 by the Department of Census and Statistics, the female employed population in Sri Lanka in 2002 was 2.1 million, which was 22.3% of the total employed population. It increased to 2.6 million, which was 24.9% of the total employed population in 2011. In Western Province, the rate of the female employed population is assumed to increase continuously at the same level as the national trend. Thus, the economically active populations are forecast as shown in Table 7.3.2.

7.3.3 Employment / Unemployment Rates and Employed Population

The unemployment rate improved from 2001 to 2011, from 7.7% to 3.5% in Western Province. The unemployment rate in 2012 would hold at the same level since the unemployment rates are already low in comparison with other countries. According to the estimated and forecast unemployment rates, employed populations are projected in the following Table.

Table 7.3.2 Employed Population Forecast

		2001	2012	2015	2020	2025	2030	2035
Total Population	Colombo Dis.	2,251,274	2,309,809	2,359,400	2,476,100	2,624,400	2,795,900	2,979,700
	Gampaha Dis.	2,063,684	2,294,641	2,377,900	2,536,700	2,725,700	2,943,500	3,178,500
	Kalutara Dis.	1,066,239	1,217,260	1,270,200	1,373,200	1,492,100	1,629,700	1,782,000
	Western Prov.	**5,381,197**	**5,821,710**	**6,007,500**	**6,386,000**	**6,842,200**	**7,369,100**	**7,940,200**
10 years and over Population	Colombo Dis.	1,924,867	1,949,970	1,986,800	2,086,300	2,220,200	2,374,800	2,540,900
	Gampaha Dis.	1,739,940	1,928,702	2,004,600	2,157,500	2,330,600	2,521,700	2,732,600
	Kalutara Dis.	892,511	1,006,632	1,051,600	1,145,200	1,253,600	1,376,300	1,511,900
	Western Prov.	**4,557,318**	**4,885,304**	**5,043,000**	**5,389,000**	**5,804,400**	**6,272,800**	**6,785,400**
Economically Active population	Colombo Dis.	912,231	906,811	915,000	950,900	1,009,900	1,078,800	1,152,900
	Gampaha Dis.	824,425	827,438	857,600	919,700	992,000	1,071,800	1,159,600
	Kalutara Dis.	395,777	464,605	483,600	522,300	568,300	621,800	682,200
	Western Prov.	**2,132,433**	**2,198,854**	**2,256,200**	**2,392,900**	**2,570,200**	**2,772,400**	**2,994,700**
Labour Force participation Rate	Colombo Dis.	47.4%	46.5%	46.1%	45.6%	45.5%	45.4%	45.4%
	Gampaha Dis.	47.4%	42.9%	42.8%	42.6%	42.6%	42.5%	42.4%
	Kalutara Dis.	44.3%	46.2%	46.0%	45.6%	45.3%	45.2%	45.1%
	Western Prov.	**46.8%**	**45.0%**	**44.7%**	**44.4%**	**44.3%**	**44.2%**	**44.1%**
Employed Population	Colombo Dis.	855,142	880,303	888,100	923,100	980,300	1,047,100	1,119,000
	Gampaha Dis.	756,186	794,738	823,600	883,200	952,500	1,029,300	1,113,700
	Kalutara Dis.	356,837	444,964	463,200	500,200	544,300	595,600	653,600
	Western Prov.	**1,968,165**	**2,120,005**	**2,174,900**	**2,306,500**	**2,477,100**	**2,672,000**	**2,886,300**
Unemployment Rate	Colombo Dis.	6.3%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
	Gampaha Dis.	8.3%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
	Kalutara Dis.	9.8%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%
	Western Prov.	**7.7%**	**3.6%**	**3.6%**	**3.6%**	**3.6%**	**3.6%**	**3.6%**

Note: 2001: Census of Population and Housing 2001, Department of Census and Statistics
2012: Estimation by CoMTrans Study Team based on the preliminary result of Census of Population and Housing 2012 and Sri Lanka Labour Force Survey Annual Report 2011, the Department of Census and Statistics
2015-2035: Estimation based on the population projection (medium growth scenario), CoMTrans Study Team

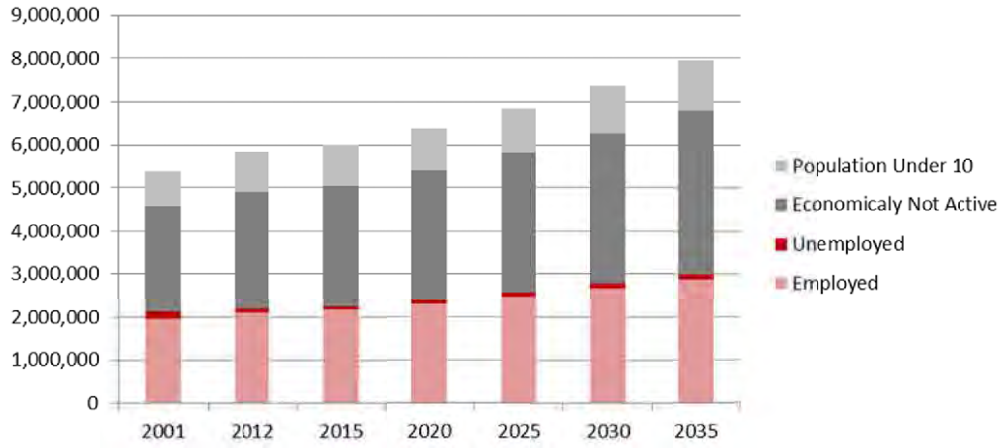


Figure 7.3.1 Proportion of Forecast Employed Population in Western Province

7.3.4 Forecast of Employed Population by Industrial Sector

In the past ten years in Sri Lanka, the employed population share of the primary sector was slowly decreasing, the secondary sector was increasing, and the tertiary sector was almost stable. These are shown in Table 7.3.3**.**

Table 7.3.3 Population Share by Industrial Sector in Sri Lanka (2003-2012)

Employed Population Share by Industrial Sector (%)	2003 (a)	2004 (b)	2005 (c)	2006 (d)	2007 (d)	2008 (a)	2009 (a)	2010 (a)	2011 (c)	2012 (c)
Primary Sector	34.0	33.5	30.7	32.2	31.3	32.6	32.6	32.7	33.0	31.0
Secondary Sector	21.8	22.9	25.6	26.6	26.6	26.2	25.2	24.2	24.1	26.1
Tertiary Sector	44.2	43.6	43.7	41.3	42.1	41.3	42.4	43.1	42.8	43.0

Note: (a) Data excludes the Northern Province, (b) Data excludes both Mullaitivu and Kilinochchi districts, (c) Data covers the entire island, (d) Data excludes both Northern and Eastern Provinces, (e) Data includes Mining & Quarrying, Electricity, Gas & Water sub sectors also.

Source: Economic and Social Statistics of Sri Lanka 2013, Central Bank, Department of Census and Statistics

In the trend of Sri Lanka, the population share of the primary sector has been decreasing slowly. On the other hand, the secondary sector has been increasing. The tertiary sector was decreasing until 2006, however, recently it is increasing. The share of employed population in Western Province is as follows: Primary Sector 6%, Secondary Sector 33% and Tertiary Sector 61%. Obviously, the share of the service sector in Western Province is much higher than that of the national level.

For the future, it is assumed that the primary sector will be decreasing, and the tertiary sectors will be growing more, in general. In the Gampaha district, there is an international airport and a proposed junction of the expressway network (CKE, OCH, and Northern Expressway). It may affect the concentration of the secondary sector. In Kalutara District, the Southern Expressway has been opened and land availability will attract industrial activities as well.

The projections for the industrial sector were given based on the following assumptions.

a) Primary Sector

The employed population of the primary sector would decrease following urbanisation in Western Province. The area of agricultural lands is assumed to decrease due to population growth. It is forecast that the population would increase by 2.1 million up to 2035 in Western Province. As the number of persons per household is approximately 4.2, according to the Census of Population and Housing 2001, there would be approximately 500,000 more households.

In highly urbanised areas such as CMC, it is expected that many people will live in an apartment and little land will be required for the increase in households. However, in the suburban areas, people tend to live in a detached house and more lands are required. A plot size per house is assumed to be 150 m2, which is the minimum plot size according to the UDA's regulation, in DSDs where urbanisation is expected, and in the other DSDs where there are still rural areas the minimum is 200 m2. As a result, 8,200 ha from agricultural land are required for residences. From the land use survey, there are 88,000 ha in agricultural use, therefore 9% of the agricultural land would be diverted to residential areas.

At the same time, lands used for manufacturing, commercial, and infrastructure should be considered. It is assumed that those lands would increase at the same rate as the increasing population. As a result, 2% of the agricultural land is required for those land uses. In total, 11% of the agricultural land would be converted to residential and other built-up land.

The employed population of the primary sector would decrease at the same rate as the decreasing agricultural land. The actual calculation was done by DSD, and resulted in the employed population of the primary sector decreasing from 117,400 in 2012 to 97,400 in 2035.

b) Secondary and Tertiary Sectors

From the forecast of GRDP and population, GRDP per capita can be calculated as 632,500 Rs in 2012 and 1,635,500 Rd in 2035. It is increasing annually by 4.2%. Productivity of the secondary sector would increase more due to industrial mechanisation, therefore it is assumed that GRDP per capita of the secondary sector is increasing annually by 5.0% and the tertiary sector is increasing by 3.7%. This means that the GRDP per capita in the industrial sector in 2035 would be 1,931,000 and the tertiary sector would be 1,527,000.

From the forecast of GRDP by industrial sector, the employed populations by sectors can be projected. The employed population of the secondary sector in 2035 would be 897,000, which is 200,000 more than 2012, and the employed population of the tertiary Sector in 2035 would be 1,891,000, which is 600,000 more than 2012. This is deemed reasonable when new developments, new urban centres, and the possibilities of expansion of the industrial activities are considered.

Accordingly, the projected employed populations by industrial sector are shown in Table 7.3.4.

Table 7.3.4 Projected Employed Populations by Industry Sector

		2001	2012	2015	2020	2025	2030	2035
Colombo District	Primary Sector	20,392	20,052	18,700	17,000	15,700	14,500	13,300
	Secondary Sector	245,492	251,083	249,300	251,600	258,400	266,400	273,800
	Tertiary Sector	589,258	609,169	620,000	654,500	706,100	766,200	831,900
	Share of Primary Sec.	*2.4%*	*2.3%*	*2.1%*	*1.8%*	*1.6%*	*1.4%*	*1.2%*
	Share of Secondary Sec.	*28.7%*	*28.5%*	*28.1%*	*27.3%*	*26.4%*	*25.4%*	*24.5%*
	Share of Secondary Sec.	*68.9%*	*69.2%*	*69.8%*	*70.9%*	*72.0%*	*73.2%*	*74.3%*
Gampaha District	Primary Sector	40,055	38,853	38,200	36,600	34,900	33,100	31,100
	Secondary Sector	305,194	319,025	328,300	347,900	376,700	408,200	435,100
	Tertiary Sector	410,937	436,860	457,100	498,800	541,000	588,000	647,400
	Share of Primary Sec.	*5.3%*	*4.9%*	*4.6%*	*4.1%*	*3.7%*	*3.2%*	*2.8%*
	Share of Secondary Sec.	*40.4%*	*40.1%*	*39.9%*	*39.4%*	*39.5%*	*39.7%*	*39.1%*
	Share of Secondary Sec.	*54.3%*	*55.0%*	*55.5%*	*56.5%*	*56.8%*	*57.1%*	*58.1%*
Kalutara District	Primary Sector	57,668	58,574	58,400	57,500	55,400	54,200	52,900
	Secondary Sector	99,675	129,343	134,500	145,100	158,100	172,400	188,300
	Tertiary Sector	199,494	257,048	270,300	297,600	330,900	368,900	412,300
	Share of Primary Sec.	*16.2%*	*13.2%*	*12.6%*	*11.5%*	*10.2%*	*9.1%*	*8.1%*
	Share of Secondary Sec.	*27.9%*	*29.1%*	*29.0%*	*29.0%*	*29.0%*	*29.0%*	*28.8%*
	Share of Secondary Sec.	*55.9%*	*57.8%*	*58.4%*	*59.5%*	*60.8%*	*61.9%*	*63.1%*
Western Province	Primary Sector	118,115	117,478	115,300	111,100	106,000	101,800	97,300
	Secondary Sector	650,361	699,451	712,100	744,600	793,200	847,000	897,200
	Tertiary Sector	1,199,689	1,303,076	1,347,400	1,450,900	1,578,000	1,723,100	1,891,600
	Share of Primary Sec.	*6.0%*	*5.5%*	*5.3%*	*4.8%*	*4.3%*	*3.8%*	*3.4%*
	Share of Secondary Sec.	*33.0%*	*33.0%*	*32.7%*	*32.3%*	*32.0%*	*31.7%*	*31.1%*
	Share of Secondary Sec.	*61.0%*	*61.5%*	*62.0%*	*62.9%*	*63.7%*	*64.5%*	*65.5%*

Note: 2001: Census of Population and Housing 2001, Department of Census and Statistics
2012: Estimation by CoMTrans Study Team based on the preliminary result of Census of Population and Housing 2012 and Sri Lanka Labour Force Survey Annual report 2011, Department of Census and Statistics
2015-2035: Projection, CoMTrans Study Team

7.4 Forecast of Student Population

Since the result of Census 2012 is not published yet, the latest information for students is taken from the CoMTrans Home Visit Survey 2013. Based on that survey and government policies on education, the future student populations are forecast.

a) School Students of Grade 1-10

This is the compulsory education period. It is assumed that the enrolment rate would not change drastically, since the primary education system in Sri Lanka has already been established and the enrolment rate is fairly high, approximately 95%. Only the proportion of school-age population would affect the school enrolment rate.

b) School Students of G.C.E. (Ordinary Level)

The forecast is based on the national policy to widen the opportunity for education for all children. The policy was mentioned in the 2012 Annual Performance Report, Ministry of Education as the "National Development Targets in Education and Strategic Plan for the period of 2012 – 2016". In the report, a target was set as increasing the survival rate from 85% to 90% up to G.C.E. (O/L).

According to the CoMTrans Home Visit Survey, the school enrolment rate of G.C.E. (O/L) is 85% in Colombo District, 76% in Gampaha District, and 67% in Kalutara District.

Colombo District already has a high rate, and the target of 90% can be achieved by 2016. For Gampaha and Kalutara Districts, the target is too high to be achieved by 2016. It is assumed that the target would be achieved by 2020 in Gampaha District and by 2025 in Kalutara District. After that, the enrolment rate would be static till 2035.

c) School Students of G.C.E. Advanced Level

This forecast is also based on the national policy mentioned in the 2012 Annual Performance Report, Ministry of Education. It mentioned increasing the percentage of students passing the G.C.E (O/L) examination from 61% to 75%.

According to the CoMTrans Home Visit Survey, the rate is 62% in Colombo District, 57% in Gampaha District, and 55% in Kalutara District.

It is assumed that the target of 75% by 2016 is too high. The target would be achieved by 2020 in Colombo District, and by 2025 in Gampaha and Kalutara Districts. After that, the rate would be static until 2035.

d) University Students

The forecast is based on the national policy to widen the opportunity for higher education. The Ministry of Education set a goal of "Increased opportunities and access to Higher Education" as the first priority in the National Higher Education Strategic Management Plan of the Sri Lanka 2012-2015 Mid Term Plan. More specifically, the target is that the gross enrolment ratio in higher education will rise from 15% in 2011 to 20% in 2035, and students of state universities will increases from 22,000 in 2011 to 25,500 in 2015.

According to the CoMTrans Home Visit Survey, the enrolment ratio of higher education is 19% in Colombo District, 12% in Gampaha District, and 7% in Kalutara District.

Colombo District already has a high rate, and the target of 20% can be achieved by 2015. For Gampaha and Kalutara Districts, the target is too high to be achieved by 2015. It is assumed that the target would be achieved by 2020 in Gampaha District and by 2025 in Kalutara District. After the achievement, it is assumed that the rate will increase to 25% by 2035. Since the number of students of G.C.E. (A/L) will increase, the rate of 25% is required in order to secure the rate of successful applicants for university on the same level.

e) Students of Other Types of Schools

It is assumed that the other types of school students will increase as well, due to increasing the employed population of the tertiary sector. There are not enough data available, but students who passed G.C.E (A/L) examinations would pursue the other types of schools such as vocational schools. Therefore, it is assumed that the increase of the other types of school students will follow the same rate as the G.C.E. (A/L) student.

f) Kindergarten

Due to women's social progress, it is assumed that the number of young children participating in Kindergarten will increase at the same rate as the female employment.

Accordingly, the following Table 7.4.1 shows the existing and projected student populations.

Table 7.4.1 Projected Student Populations in Western Province and CMA

Western Province	2012	2015	2020	2025	2030	2035
Total Population	**5,821,710**	**6,007,500**	**6,386,000**	**6,842,200**	**7,369,200**	**7,940,200**
Kindergarten	**15,982**	**17,100**	**18,200**	**19,400**	**20,800**	**22,200**
School Students (Grade1-G.C.E.(A/L)	**1,131,382**	**1,197,000**	**1,318,400**	**1,419,200**	**1,501,800**	**1,587,300**
Students (grade1 - grade5)	422,049	438,100	461,600	474,300	504,500	532,800
Students (grade 6 - grade8)	276,612	290,400	315,900	336,900	349,800	373,300
Students (grade 9 - grade10)	170,290	178,800	194,500	207,500	215,500	229,900
Students (G.C.E. (O/L))	123,303	135,500	157,800	178,000	192,000	200,600
Students (G.C.E. (A/L))	139,128	154,200	188,600	222,500	240,000	250,700
University Students	**42,398**	**48,200**	**65,800**	**83,000**	**99,500**	**116,400**
Other Students	**27,681**	**32,000**	**39,100**	**46,200**	**49,800**	**52,000**
Total Students	**1,217,442**	**1,294,300**	**1,441,500**	**1,567,800**	**1,671,900**	**1,777,900**
% of Student Population to Total	*20.9%*	*21.5%*	*22.6%*	*22.9%*	*22.7%*	*22.4%*

Source: CoMTrans Study Team

7.5 Forecast of Population by Income Group

Considering the economic growth mentioned above, it is assumed that income for households would simply grow at the same rate as the GRDP growth projection. The following Table 7.5.1 and Figure 7.5.1 show the projected population by income level. In 2012, 68% of the total population was Group C and only 8% was Group A. Following the growth of GRDP, in 2035 the Group C population will be less than 1 million, which is 13% of the total projected population, and over 4.5 million will be in the Group A population, which is 57% of the total.

Table 7.5.1 Projected Population by Income Level in Western Province

Year	Group C Less than Rs. 40,000		Group B Rs. 40,000 - 79,999		Group A Rs. 80,000 and Above	
	Population	***%***	**Population**	***%***	**Population**	***%***
2012	3,947,663	*67.8%*	1,419,174	*24.4%*	443,912	*7.6%*
2015	3,226,500	*53.7%*	2,016,500	*33.6%*	764,500	*12.7%*
2020	2,143,600	*33.6%*	2,623,500	*41.1%*	1,618,900	*25.4%*
2025	1,520,500	*22.2%*	2,636,900	*38.5%*	2,684,800	*39.2%*
2030	1,181,400	*16.0%*	2,503,200	*34.0%*	3,684,600	*50.0%*
2035	994,500	*12.5%*	2,386,800	*30.1%*	4,558,900	*57.4%*

Note: 2012 Estimation from CoMTrans Home Visit Survey. Income Unknown: 10,961 (0.2%)
2015-2035 projection, CoMTrans Study Team

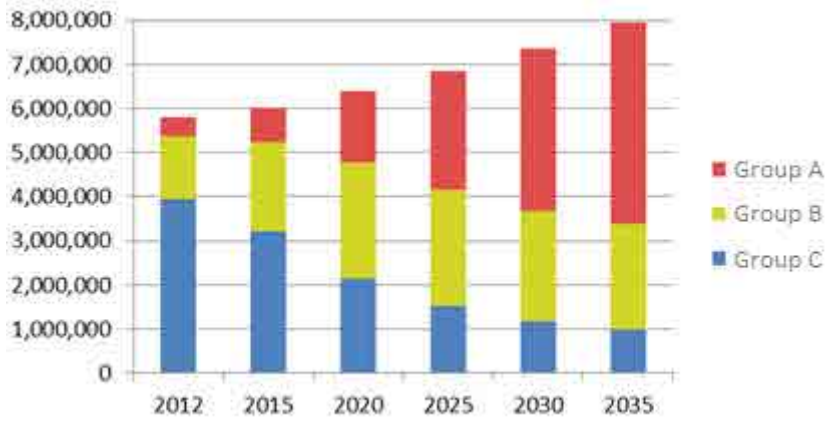


Figure 7.5.1 Proportion of Projected Population by Income Level in Western province

CHAPTER 8. Proposed Urban Structure of Western Province

8.1 Envisioned Urban Centres and Urbanised Area

In the same way that urban structures were considered based on the same factors mentioned in the above section, to identify urban centres is an essential step to formulate the urban structure.

Some of the results of the CoMTrans Home Visit Survey 2013 indicate the areas that depend on Colombo and those that are independent urban centres, and the factors mentioned in section 4.2.2 (4) show where the active commercial and business areas are in the present condition, namely, urban centres. In the future, a strategic scenario is to be adapted and major urban centres identified, as shown in Figure 8.1.1.

Based on the envisioned urban centres, the population forecast, and past trend of the expansion of urbanised area, the future urbanised area for 2035 is presumed as shown Figure 8.1.2

Both the envisioned urban centres and urbanised areas would be the basis of formulating the urban structure.

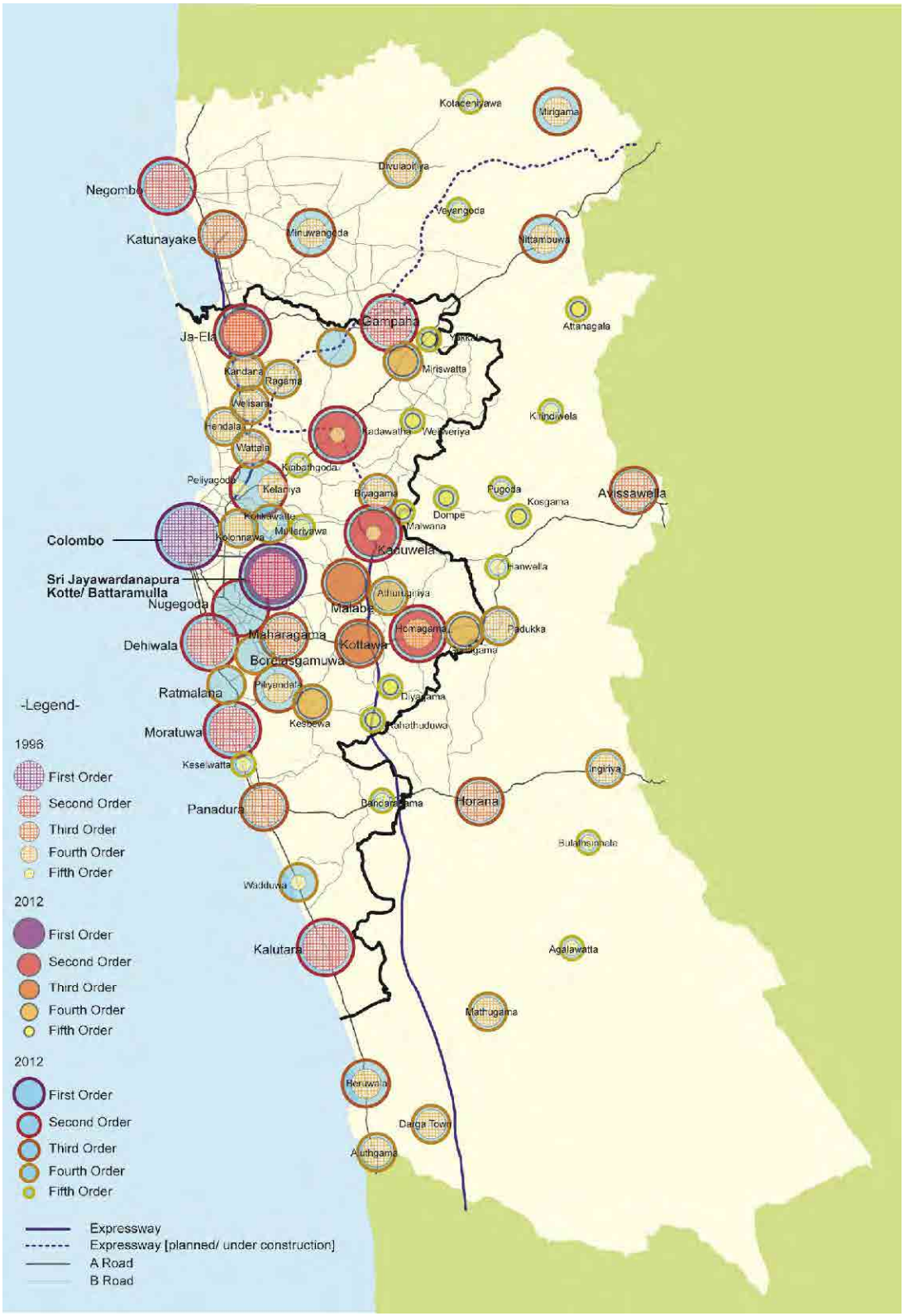


Figure 8.1.1 Envisioned Urban Centres for 2035

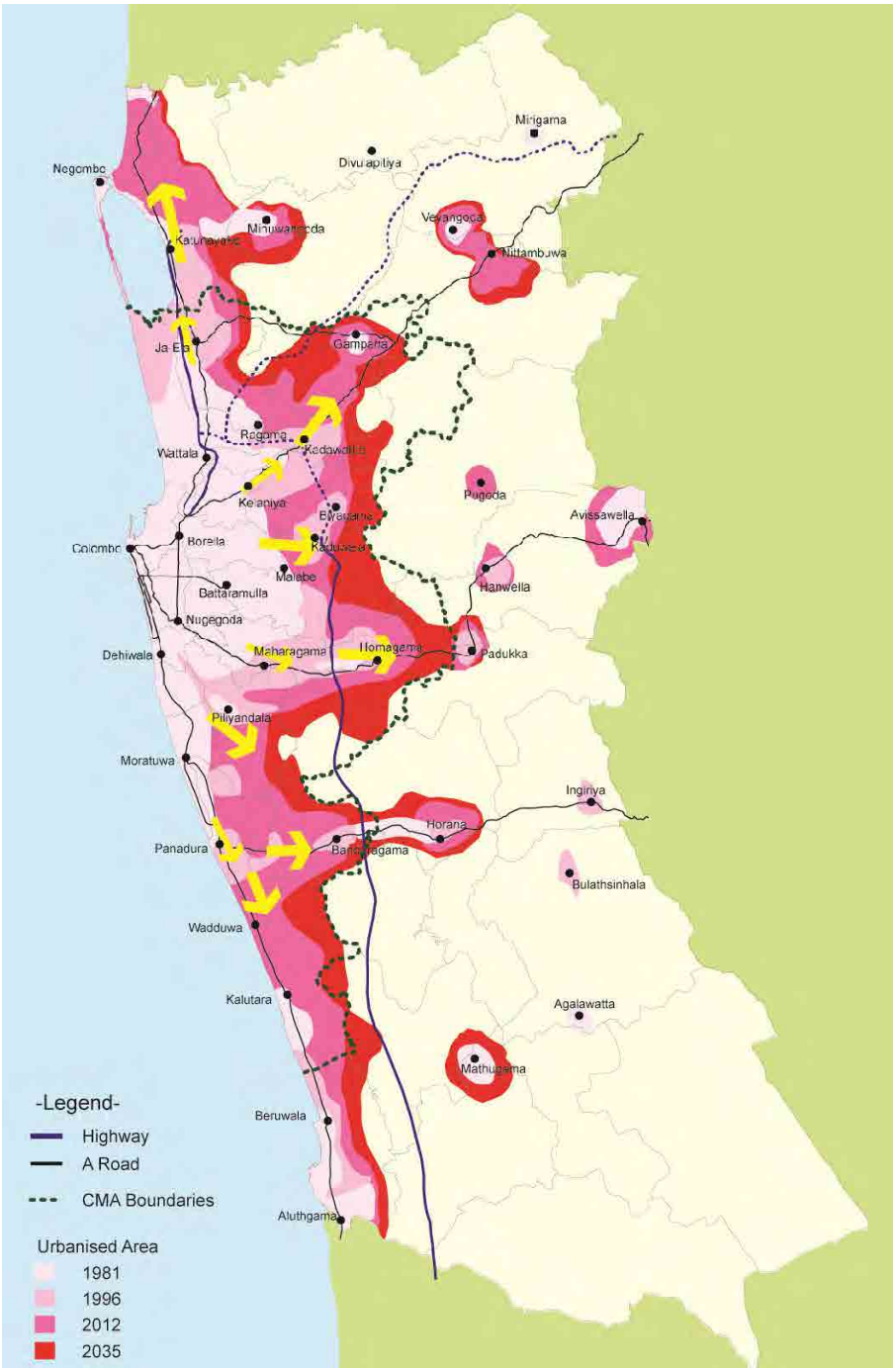


Figure 8.1.2 Envisioned Urbanised Area for 2035

8.2 Proposed Urban Structure

Agglomerations of urbanised areas are characterised by the corridors or other special functions, and are clustered. Thus, the urban structure of Western Province is formulated as shown in Figure 8.2.1, and CMA is enlarged in Figure 8.2.2.

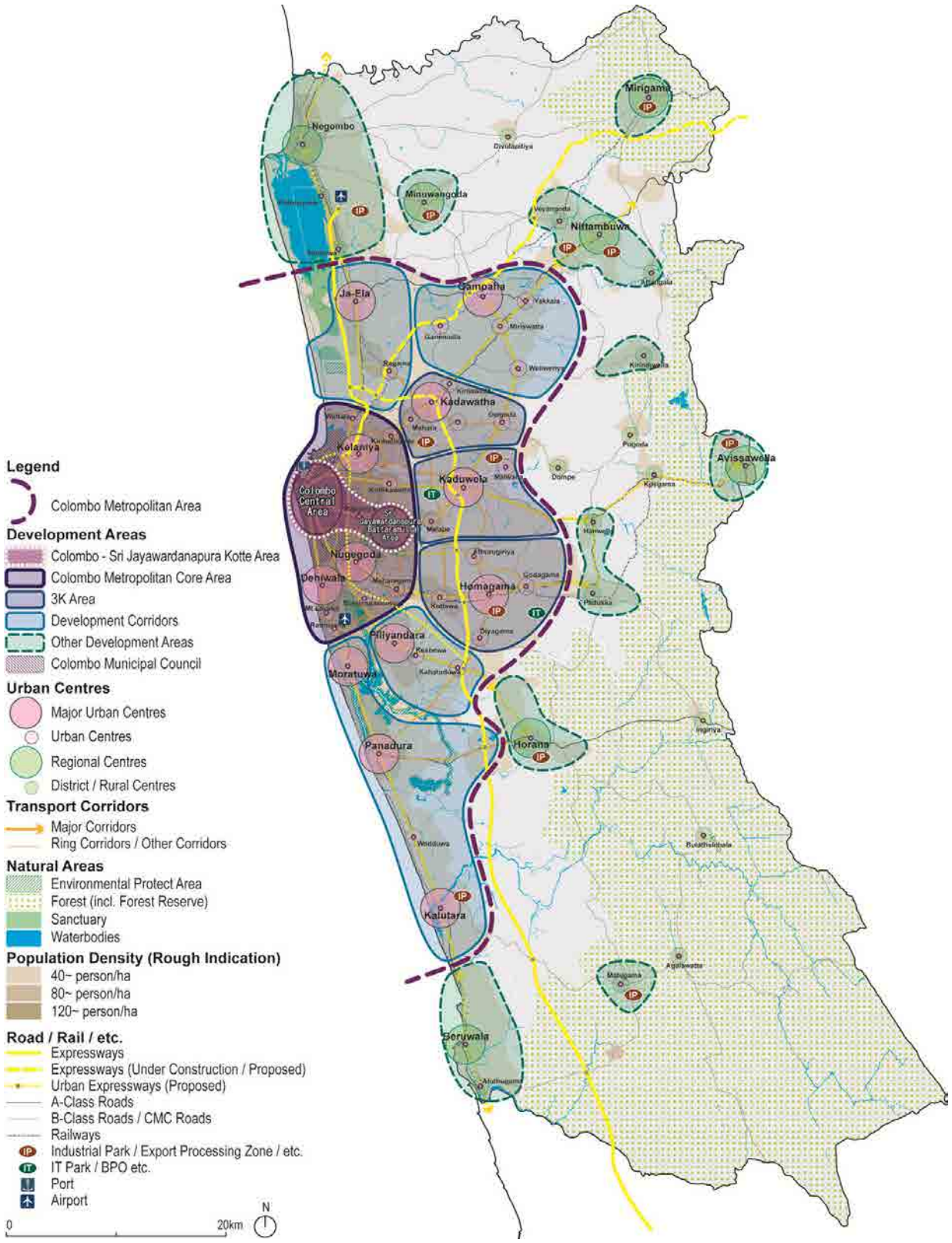


Figure 8.2.1 Envisioned Urban Structure of Western Province

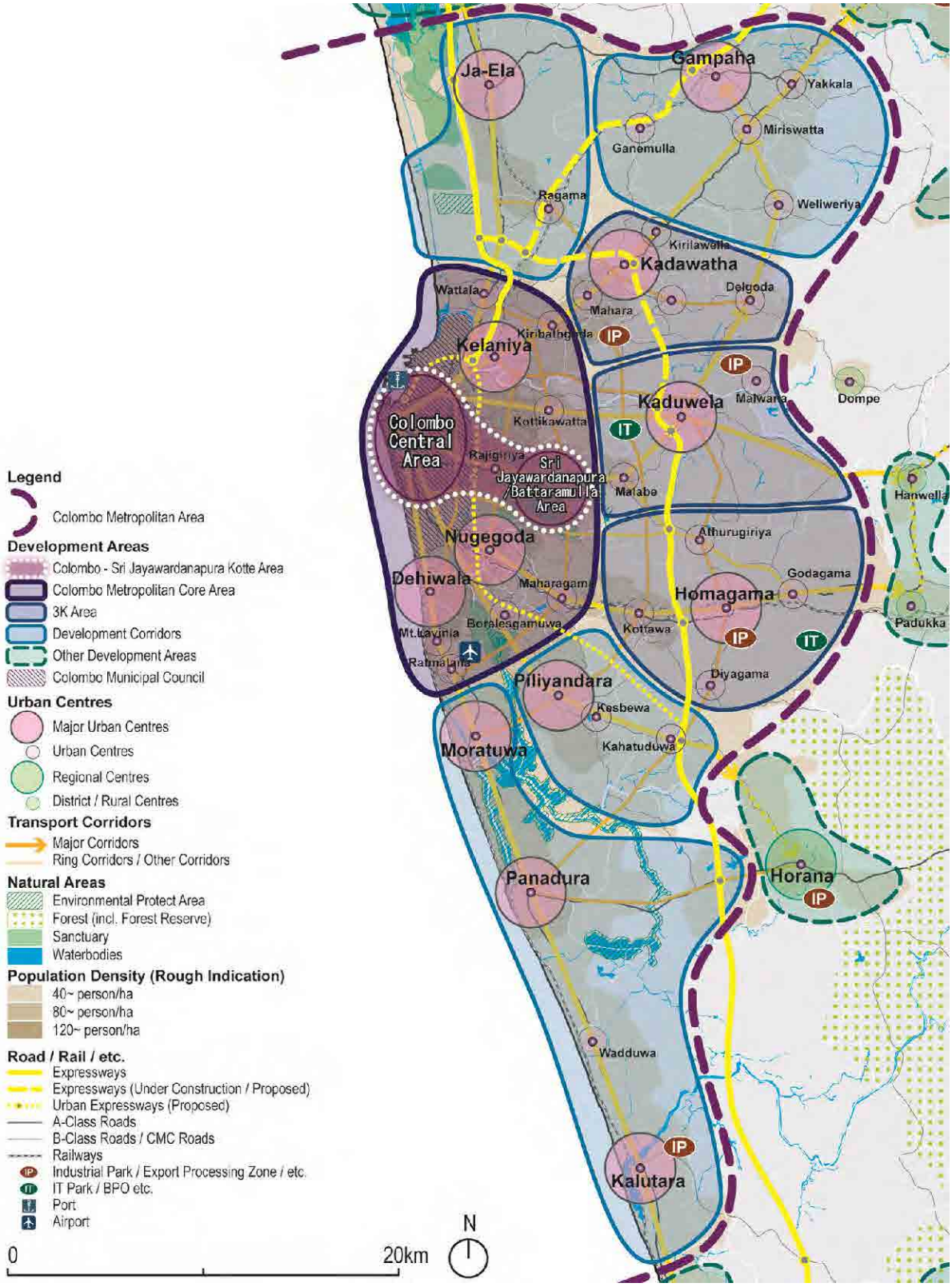


Figure 8.2.2 Envisioned Urban Structure of CMA

CMA consists of the Colombo Metropolitan Core including the administrative and economic capital area, and other development areas. Urban Centres are scattered around CMA, and they are centres of urban services and activities. The importance of the centres can be defined depending on the characteristics of each urban area.

Population density is one of the indicators to explain the urban structure functioned efficiently. At the present, the population density is 20 persons/ha, which is low for an urbanised area. Following the urbanisation projected in the CMA, the population density would increase to approximately 40 persons/ha, and the main land use would be residential. Within the area, some urban centres would be located, and they have more dense residential areas and commercial and business activities. The population density of these urban centres would be approximately 80 persons/ha. At the same time, some natural elements such as wetlands should be retained in the CMA. Urban activities and environmental areas would be able to coexist and would provide a sustainable environment.

Outside of CMA, there are some urban centres which are relatively independent from the Centre of Colombo where most economic activities are concentrated. They are the centres of rural regions.

A Transport Network plan as well as a Land Use plan should be established effectively in order to achieve sustainable development in CMA.

Each area in the urban structure is described as follows:

(1) Colombo Metropolitan Core

The area is identified as having an agglomeration of continuous urban conditions from the centre of Colombo, where most economic activities are concentrated. The political capital, Sri Jayawardenapura Kotte is in the Colombo Metropolitan Core as well. This area is the centre of Sri Lanka, economically and administratively.

In the Colombo Metropolitan Core, population density will rise to 80 people/ha. The area targets more active urban activities. Especially, in the Colombo Central Area, the resident population is decreasing, but more commercial and business enterprises will concentrate there. This area has had a high residential population density with as many as 160 people/ha. Some residential areas would be replaced with commercial/business areas. Therefore the population density of residents will decrease from 120 people/ha.

1) **Colombo Central Area:** Mainly made up of the Colombo Municipal Council area. This is the economic centre and most commercial and business activities are concentrated here. Although the residential population is decreasing, the day-time population will grow and the importance of Colombo will increase.
2) **Sri Jayawardanapura / Battaramulla Area:** Sri Jayawardanapura Kotte is the political capital, and most administrative functions have been relocating to Battaramulla area. This area will be the administrative capital and will grow with a concentration of more services and commercial activities. The area is also considered a part of **Malabe Corridor** connecting to the Kaduwela (Interchange) Township Area.

3) **Urban Centres:** There are urban centres within the Area. They were originally independent centres, however, land use shows continuing urban conditions. They are becoming a part of Colombo Metropolitan Core. The major urban centres are:

   - Dehiwala, Nugegoda, Kelaniya, Ratmalana, Boralesgamuwa, Maharagama, Kotikawatta, Kiribathgoda, and Wattala

(2) Development Areas in the Suburbs

Urbanised areas have developed along the major roads, especially the radial corridors from Colombo towards the suburbs and this trend will continue. However, this ribbon development is not suitable, and an effective and sustainable growth scenario is required to support rapid urbanisation. Since natural conditions and environmental values still remain, the areas should be developed maintaining these natural conditions. Therefore, the urban centres are to be strategically located in each corridor, and major developments should be guided around the centres. The UDA has proposed some projects in the centres, and similarly TOD or other mixed developments, including commercial and residential development are expected in and around the centres.

At the same time, the "3K area" located in the eastern suburb of Colombo where the Outer Circular Highway is being built is specially identified since the area will have a direct impact on the highway. The highway is perpendicular to the radial roads, therefore the 3K area has different characteristics than the other development corridors. The area is rapidly growing in terms of population in recent years, and rapid growth is expected even well beyond the highway. Many lands are being converting to residential use from the natural condition. New employment centres would be developed around the town centres, and TOD is also expected to be developed around the transport nodes such as stations.

The following Development Areas are identified in the suburbs of CMA.

1) **3K Area - Kottawa (Interchange) Township Area:** This is located around the Kottawa Interchange. It is also considered as part of the **High level Road Corridor** and the Kelani Valley Railway Line. There is Homagama as the main urban centre, and Kottawa, Godgama, Athurugiriya, Diyagama as the other urban centres. New projects are on-going, such as Diyagama development with a sports complex and Mahenawatta Nanotechnology Park. They are the catalysts for further development.
2) **3K Area - Kaduwela (Interchange) Township Area:** This is located around the proposed Kaduwela interchange. It is also considered as part of the **Malabe Corridor** continuing from Aattaramulla Area and the **Low Level Road Corridor**. There is the Kelani River and this has negative impacts such as flood risk but also positive potential as the waterfront is attractive in terms of urban design. The area also has Biyagama EPZ, or one of the biggest industrial estates which attracts population. Kaduwela is the main urban centre, and Malabe and Malwana are the other centres.
3) **3K Area - Kadawatha (Interchange) Township Area:** This is located around the proposed Kadawatha Interchanges. The Western part of the area is also considered as a part of **Kandy Road Corridor**. The Eastern part is relatively rural. Kadawatha is the main urban centre, and Mahara, Kirilawella and Delgoda are the other urban centres.

4) **Negombo Road Corridor:** Main urbanised areas are developed along Negombo Road and around Ragama where a station is located. There are the main urban centres, namely Ja-ela on Negombo Road and Ragama. Recently, Colombo –Katunayake Expressway opened, and it will affect urbanisation in this corridor.

5) **Kandy Road Corridor:** The corridor is developed on Kandy Road as well as the main railway line. Gampaha is the main urban centre of the area, and other urban centres, such as Ganemulla, Miriswatta, Yakkala, and Weliweriya, are supporting the area.

6) **Horana Road Corridor:** There are urbanised areas on Horana Road. There are the main urban centres of Piliyandara and Kesbewa. The corridor continues to the Kahatuduwa Interchange on the Southern Expressway.

7) **Galle Road Corridor:** Urbanised areas have been developed on Galle Road in ribbons. There is a series of urban centres such as Moratuwa, Panadura, and Kalutara. Parallel to Galle Road, there is the Southern Expressway. Although the expressway is approximately 10km from Galle Road, it will affect the development in this corridor.

(3) Outside of CMA: Local Development Area

Outside of CMA is mainly considered as rural area. However, there are some characteristic regional and rural centres located there. They are independent of Colombo and create their own urban areas:

Negombo is located north of CMA. Together with the area around Katunayake International Airport, it creates its own urban area with employment centres, rather than depending on Colombo.

Avissawella is located on the eastern edge of Western Province. The area does not have many influences from Colombo. It is considered as a regional centre.

Padukka and Hanwella are located on High Level Road just outside of CMA. Now, the two towns are separated, but they are expected to merge as an urban group.

Horana is located just outside of CMA on Horana Road. The town is considered as a regional centre since the town plays a major role in the area.

Nittambuwa, Mirigama, **Beruwala, and Matugama** are also considered as important urban centres of the surrounding region.

8.3 Land Use Structure Model

8.3.1 Development of Sub-Centres

In the above mentioned proposed urban structure, the urban centres are emphasised. The urban centres are strategically situated within all of the development areas and around the junctions of the major roads such as major radial corridors and the proposed ring roads. While the Colombo Central Area is the main centre of the CMA, these urban centres are sub-centres as their locations are in the suburban areas.

It is anticipated that more residential as well as work places will be located around the sub-centres. It is also proposed that some of the sub-centres should be developed as Transit Oriented Development (TOD). This means that the sub-centres should be supported by the improved public transport network.

Structural changes will be required since the major business and commercial activities are concentrated in CMC at the present. Therefore, it is recommended that the following urban structure model in smaller scales should be proposed at the same time. One is a conceptual land use model around the sub-centres, and the other is an area development structure model. The proposed urban structure would be realised together with the following smaller scale models.

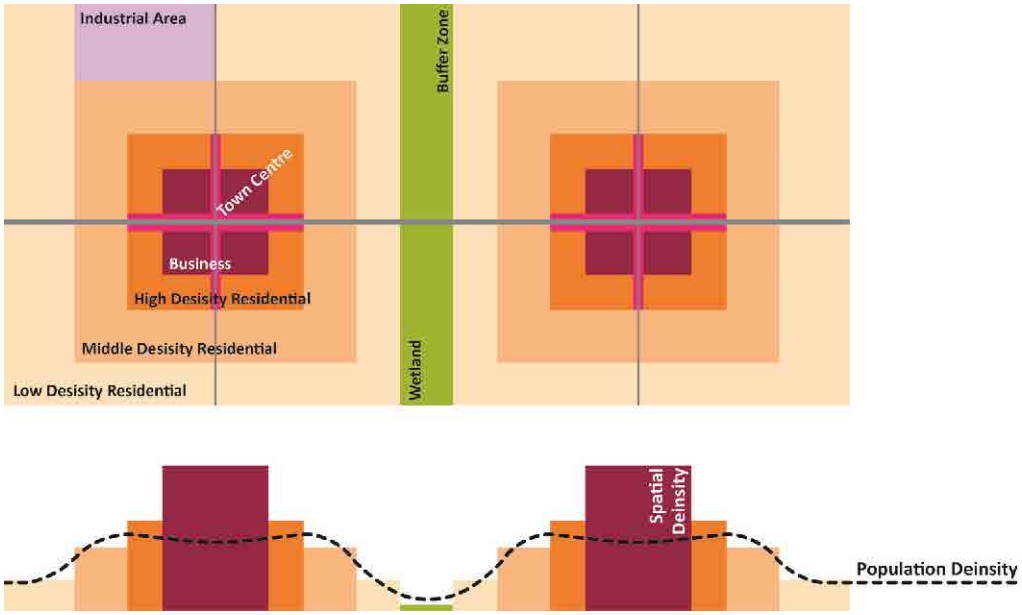
8.3.2 Conceptual Model of Land Use Zoning

Land use is one of the most important elements of an urban structure. For the urban structure in the future, land use planning should directly guide the development. In the planning system in Sri Lanka, Development Plans of Local Authorities include land use zoning plans and building regulations. Therefore, the Development Plans are the statutory documents to lead the future. However, there are no integrated models of land use zoning at the regional level. In order to establish effective transport systems, such land use models for the regional level, which will work with the new transport network, are necessary and should be recommended.

The land use zoning should seek to promote compact urban centres and not encourage ribbon development or sprawl. The model below, Figure 8.3.1, demonstrates the idealised pattern of land use zoning sought within centres where more intense use takes place. Commercial activities are located in the centre, mixed use areas surround those, and outside of the centre are low-density residential areas. Employment Centres are also to be located close to the centre with good transport connections. In addition, between the urban centres, buffer zones such as conserved natural area or wetlands are retained.

In terms of spatial density, the heights of the buildings and floor area ratios should be higher in the centre and gradually reducing in the surroundings. This assures higher commercial and business activities in the centre, high-density apartment type residences located around the centre, and calm low-density residential areas in the surroundings. Population density will also follow this spatial density.

In order to develop ideas for the Transport Master Plan, an efficient transport network should be proposed together with the appropriate land use models. The transport network should mutually support this land use model, then the sustainable model of future development will be realised.



Source: Township Development Component- Local Area Development Plans, modified by CoMTrans Study Team

Figure 8.3.1 Conceptual Model of Land Use Zoning

8.3.3 Area Development Structure Model

The area inside of the CMA is supposed to be increasing in density in terms of population as well as urban activities. To support this increase with the land use model mentioned above, the road structure is one of the essential elements. In urban planning history, simple grid systems with urban facilities have been proposed such as the "Neighbourhood Unit" by Clarence Perry. In this idea, the road structure is composed of major arterial roads, minor arterial roads and collectors, and this provides area development structure on a neighbourhood scale.

This area development structure can be applied to the urbanised area in CMA with some adjustments. At present, there are not enough road networks in the Suburban Area of Colombo. CMA is expected to be more urbanised. In order to support the urbanisation, an effective transportation system is required. Then, the traditional urban planning idea can be adjusted to the conceptual model for CMA. This is shown in Figure 8.3.2

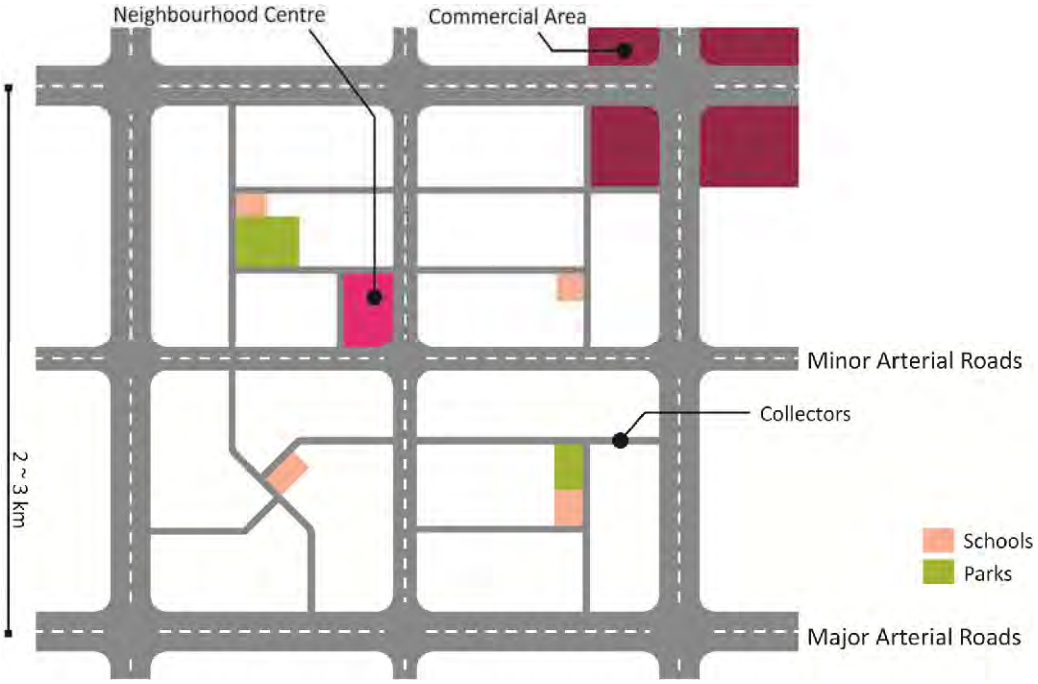


Figure 8.3.2 Conceptual Area Development Structure Model

Major arterial roads are composed of a grid system. In this case, a 2 to 3 km grid is applied for typical suburban areas. The major arterial roads are the main links between urban centres, and serve inter-regional traffic. The areas around junctions will be the hearts of urban centres with commercial and business functions. At the same time, the roads can be public transport corridors with a BRT system or major bus routes.

Minor arterial roads are set between the major arterial roads, and compose a 1 to 1.5 km grid. This grid creates urban blocks of 1 to 2 km^2, which embraces a population of 6,000 to 8,000. Theoretically, the urban block is considered as a community unit. And junctions of the minor arterial roads have neighbourhood centres providing local commercial functions within a walkable distance from anywhere in the block. The minor arterial roads link between the service centres and urban centres or major arterial roads.

Collectors serve local traffic to connect to the arterial roads inside a community.

Inside the block, community facilities, such as schools, parks, and commercial facilities are placed to provide community services.

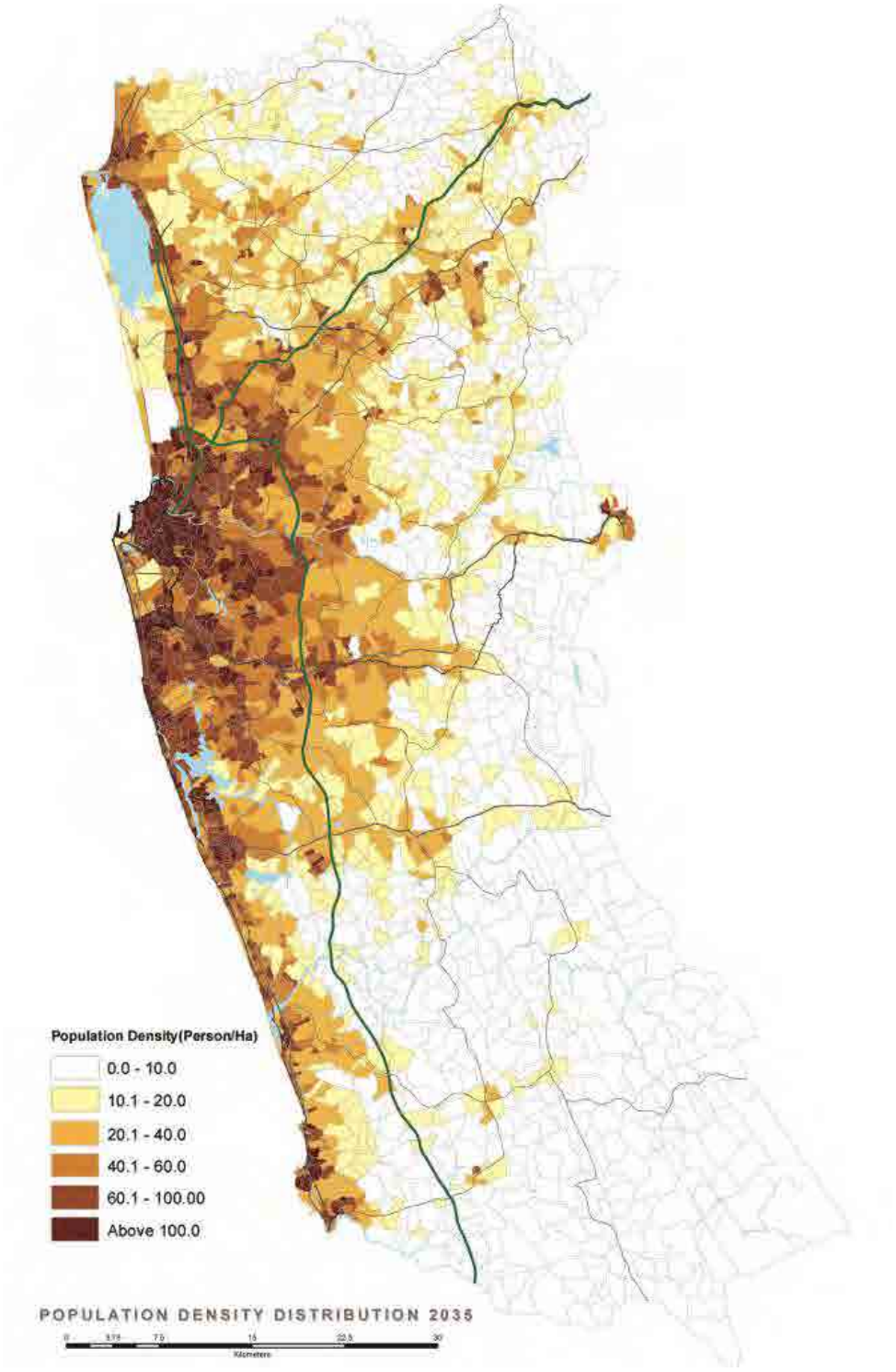
Although this area development structure model is a theoretical idea in order to separate through traffic and community lives, it can direct urban planning concepts in CMA. At present, Western Province has only major radial corridors and minor roads in low density suburbs. However, traffic problems are becoming serious issues. Therefore, an effective road network has to be adapted to CMA enforcing the rapid urban growth. The area development structure model can be a sustainable framework for this master plan.

CHAPTER 9. Population Distribution and Zonal Parameters

9.1 Future Population Distribution by GND

The population is distributed by considering the factors described in Chapter 4.1 and the future urban structure described in Chapter 4.3. The typical factors are the road and public transport networks, the interchanges of Expressways, the urban centres, the employment centres or industrial estates, the proposed and on-going projects, and a sustainable land use pattern. In the case of the medium population growth scenario, the population density map for 2035 is shown in Figure 9.1.1.

According to the density maps, the Combo Metropolitan Area will have a higher population density. The suburbs of Colombo would be the more populated areas, especially Battaramulla area will attract more people. In Gampaha District, the population would concentrate along the Kandy Road, the Main Railway Line, and Negombo Road. In Kalutara District, the populated area will be along the coast. While rural conditions will remain in the south-eastern part, small rural centres will be populated such as Matugama.



Note: Calculated by CoMTrans Study Team
Expressways/Highways are shown on the map as reference.

Figure 9.1.1 Projected Population Densities 2035

9.2 Zonal Parameters

As mentioned above, the projected population is distributed to the GNDs. For further analysis and projections, the detailed results of the CoMTrans Home Visit Survey by TAZ are used for the zonal parameters.

9.2.1 Population by Income according to TAZ

The population by income according to TAZ is estimated from the result of the CoMTrans Home Visit Survey. And also the projected population by income level are divided into TAZ by considering the proportion of income levels and GRDP growth. Table 9.2.1 shows the population in the CMA by income in 2013 according to the DSD.

Table 9.2.1 Population by Income in CMA and Western Province (2035)

			Population			*Share*		
	District	**DSD**	**Group C**	**Group B**	**Group A**	***Group C***	***Group B***	***Group A***
CMA	**Colombo**	Colombo	33,000	76,700	128,400	*13.9%*	*32.2%*	*53.9%*
		Dehiwala-Mt.Lavinia	6,700	18,700	50,200	*8.9%*	*24.7%*	*66.4%*
		Homagama	52,800	126,900	236,900	*12.7%*	*30.5%*	*56.9%*
		Kaduwela	53,200	130,600	321,700	*10.5%*	*25.8%*	*63.6%*
		Kesbewa	38,100	95,800	201,400	*11.4%*	*28.6%*	*60.1%*
		Kolonnawa	34,200	86,400	181,300	*11.3%*	*28.6%*	*60.1%*
		Maharagama	27,900	70,700	166,700	*10.5%*	*26.6%*	*62.8%*
		Moratuwa	18,800	47,500	102,400	*11.1%*	*28.2%*	*60.7%*
		Rathmalana	11,100	28,600	66,800	*10.4%*	*26.8%*	*62.7%*
		Kotte *	12,200	31,800	87,400	*9.3%*	*24.2%*	*66.5%*
		Thimbirigasyaya	20,700	53,700	122,000	*10.5%*	*27.3%*	*62.1%*
	Gampaha	Biyagama	38,300	94,700	190,800	*11.8%*	*29.2%*	*58.9%*
		Gampaha	35,000	86,700	175,000	*11.8%*	*29.2%*	*59.0%*
		Ja-Ela	38,900	93,000	179,800	*12.5%*	*29.8%*	*57.7%*
		Kelaniya	21,800	53,800	104,200	*12.1%*	*29.9%*	*58.0%*
		Mahara	38,500	93,400	184,100	*12.2%*	*29.6%*	*58.3%*
		Wattala	30,200	71,200	134,800	*12.8%*	*30.1%*	*57.1%*
	Kalutara	Bandaragama	26,000	59,000	95,400	*14.4%*	*32.7%*	*52.9%*
		Kalutara	35,000	80,500	136,800	*13.9%*	*31.9%*	*54.2%*
		Panadura	38,000	90,800	162,200	*13.1%*	*31.2%*	*55.7%*
	Total		**610,300**	**1,490,800**	**3,028,400**	***11.9%***	***29.1%***	***59.0%***
Outside of CMA			**384,900**	**895,000**	**1,530,700**	***13.7%***	***31.8%***	***54.5%***
Western Province			**995,200**	**2,385,800**	**4,559,200**	***12.5%***	***30.0%***	***57.4%***

Note: * Sri Jayawardanapura Kotte
Source: CoMTrans Study Team

9.2.2 Employed Population by Industrial Sector and Income according to TAZ

The estimated employed population in residential areas, or the night time employed population, in 2013 are distributed to each TAZ using the result of the CoMTrans Home Visit Survey. In the same way, the projected population is also distributed following the ratio of the industrial sector.

The employed population in working places, or the day time population, in 2013 is estimated from the CoMTrans Home Visit Survey by TAZ. For future distribution, the following factors also need to be considered:

1) **Population Employed in the Primary Sector:** It is assumed that the population employed in the primary sector within CMA will decrease at a rate greater than that outside of CMA. Annually there is a 1.6% decrease in CMA, and a 0.4% decrease outside of CMA.
2) **Population Employed in the Tertiary Sector (CMA)**: It is assumed that the population employed in the tertiary sector within CMA will increase at a rate greater than that outside of CMA. Annually there is a 1.7 % increase in CMA, and 1.5% increase outside of CMA.
3) **Compact City Model of Urban Structure (Sub Centre Model):** By considering placing residences and work places closer together as a target of the urban structure, more employment centres will be located around the urban centres, not only in Colombo. As a result, the commuting demand would be minimised.

   TOD Model: More developments, such as "TOD" should be encouraged in the urban centres in the suburbs, and more job opportunities will be created around these urban centres. The TODs should be developed gradually in step with the improved transport system. Generally, twice the number of those employed in the tertiary sector should be concentrated around the TOD by 2035.

   3K Area: OCH will be opened up to Kadawatha in 2014. The areas will become sub centres earlier than the other centres. Concentration of the employed population will be seen from 2015. The employed population in the tertiary sector in 2035 will increase to be 2.5 times larger than in 2012.

   Administrative Centre: Sri Jayawardanapura Kotte and Battaramulla area will be the administrative centre of Sri Lanka due to the relocation of government institutions. Urban development would be accelerated and the area would have a role as the capital. Thrice the number of the employed population will be attracted to this area.

   Since the sub centre structure is proposed and employed population would follow the structure, concentration in the CMC would be slowed.
4) **Urban Development Projects:** There are almost 100 on-going and proposed projects by the Public and Private Sectors in Western Province. They include many mixed development projects which will provide offices or other employment opportunities.

Zonal parameters of the employed populations for both night time and day time by the industrial sector and income level are estimated for each TAZ. The employed populations of CMA and Western Province by the industry sector in 2035 are shown in the following tables. Table 9.2.2 shows the night time employed population, or the employed population at their place of residence, and Table 9.2.3 shows the day time employed population, or the employed population at their working places.

Table 9.2.2 Night Time Employed Population by Industrial Sector in CMA and Western Province (2035)

			Night Time Employed Population				*Share*		
	District	**DSD**	**Primary Industry**	**Secondary Industry**	**Tertiary Industry**	**Total**	***Primary Industry***	***Secondary Industry***	***Tertiary Industry***
CMA	**Colombo**	Colombo	500	13,200	56,700	70,500	*0.7%*	*18.7%*	*80.4%*
		Dehiwala-Mt.Lavinia	100	5,200	20,300	25,600	*0.4%*	*20.3%*	*79.3%*
		Homagama	2,600	44,600	118,100	165,300	*1.6%*	*27.0%*	*71.4%*
		Kaduwela	2,200	54,400	146,700	203,300	*1.1%*	*26.8%*	*72.2%*
		Kesbewa	1,300	31,400	95,100	127,800	*1.0%*	*24.6%*	*74.4%*
		Kolonnawa	600	20,200	90,700	111,500	*0.5%*	*18.1%*	*81.3%*
		Maharagama	700	26,200	78,000	105,000	*0.7%*	*25.0%*	*74.3%*
		Moratuwa	500	21,600	38,500	60,600	*0.8%*	*35.6%*	*63.5%*
		Rathmalana	600	10,100	31,600	42,300	*1.4%*	*23.9%*	*74.7%*
		Kotte*	300	9,300	37,800	47,400	*0.6%*	*19.6%*	*79.7%*
		Thimbirigasyaya	300	12,300	56,900	69,500	*0.4%*	*17.7%*	*81.9%*
	Gampaha	Biyagama	1,600	51,200	70,000	122,800	*1.3%*	*41.7%*	*57.0%*
		Gampaha	2,400	31,900	68,000	102,300	*2.3%*	*31.2%*	*66.5%*
		Ja-Ela	1,900	41,700	67,100	110,800	*1.7%*	*37.6%*	*60.6%*
		Kelaniya	900	23,000	40,500	64,400	*1.4%*	*35.7%*	*62.9%*
		Mahara	2,800	40,100	65,600	108,400	*2.6%*	*37.0%*	*60.5%*
		Wattala	1,900	30,600	47,900	80,300	*2.4%*	*38.1%*	*59.7%*
	Kalutara	Bandaragama	5,500	21,300	39,800	66,700	*8.2%*	*31.9%*	*59.7%*
		Kalutara	3,900	20,800	64,500	89,200	*4.4%*	*23.3%*	*72.3%*
		Panadura	3,800	41,900	61,500	107,200	*3.5%*	*39.1%*	*57.4%*
	Total		**34,300**	**551,100**	**1,295,200**	**1,880,700**	***1.8%***	***29.3%***	***68.9%***
Outside of CMA			**63,100**	**346,000**	**596,400**	**1,005,600**	***6.3%***	***34.4%***	***59.3%***
Western Province			**97,400**	**897,200**	**1,891,700**	**2,886,300**	***3.4%***	***31.1%***	***65.5%***

Note: * Sri Jayawardanapura Kotte
Source: CoMTrans Study Team

Table 9.2.3 Day Time Employed Population by industrial Sector in CMA and Western Province (2035)

2035			Employed Population (Day Time)				*Share*		
	District	**DSD**	**Primary Industry**	**Secondary Industry**	**Tertiary Industry**	**Total**	***Primary Industry***	***Secondary Industry***	***Tertiary Industry***
CMA	**Colombo**	Colombo	1,400	68,300	288,600	358,400	*0.4%*	*19.1%*	*80.5%*
		Dehiwala-Mt.Lavinia	100	12,400	28,600	41,100	*0.2%*	*30.2%*	*69.6%*
		Homagama	1,400	37,300	69,000	107,700	*1.3%*	*34.6%*	*64.1%*
		Kaduwela	1,200	32,800	143,100	177,200	*0.7%*	*18.5%*	*80.8%*
		Kesbewa	1,100	33,000	48,600	82,700	*1.3%*	*39.9%*	*58.8%*
		Kolonnawa	400	15,700	48,900	65,000	*0.6%*	*24.2%*	*75.2%*
		Maharagama	600	29,600	101,400	131,700	*0.5%*	*22.5%*	*77.0%*
		Moratuwa	500	37,200	54,000	91,700	*0.5%*	*40.6%*	*58.9%*
		Rathmalana	400	23,800	58,600	82,800	*0.5%*	*28.7%*	*70.8%*
		Kotte*	300	17,700	79,500	97,400	*0.3%*	*18.2%*	*81.6%*
		Thimbirigasyaya	600	52,500	220,900	274,000	*0.2%*	*19.2%*	*80.6%*
	Gampaha	Biyagama	700	52,800	39,500	92,900	*0.8%*	*56.8%*	*42.5%*
		Gampaha	1,900	20,600	64,000	86,500	*2.2%*	*23.8%*	*74.0%*
		Ja-Ela	800	33,400	56,600	90,700	*0.9%*	*36.8%*	*62.4%*
		Kelaniya	1,900	28,700	67,600	98,200	*1.9%*	*29.2%*	*68.8%*
		Mahara	1,900	16,200	32,100	50,200	*3.8%*	*32.3%*	*63.9%*
		Wattala	1,700	26,900	60,000	88,500	*1.9%*	*30.4%*	*67.8%*
	Kalutara	Bandaragama	2,000	12,400	14,400	28,800	*6.9%*	*43.1%*	*50.0%*
		Kalutara	3,600	9,100	57,200	69,900	*5.2%*	*13.0%*	*81.8%*
		Panadura	3,600	30,600	36,900	71,000	*5.1%*	*43.1%*	*52.0%*
	Total		**26,000**	**591,000**	**1,569,600**	**2,186,600**	***1.2%***	***27.0%***	***71.8%***
Outside of CMA			**70,100**	**298,300**	**304,900**	**673,200**	***10.4%***	***44.3%***	***45.3%***
Western Province			**96,100**	**889,300**	**1,874,500**	**2,859,800**	***3.4%***	***31.1%***	***65.5%***

Note: * Sri Jayawardanapura Kotte
Source: CoMTrans Study Team

9.2.3 Student Population by Income according to TAZ

Similarly, by using the result of the CoMTrans Home Visit Survey, the estimated night time student populations in 2012 and projected populations are also subdivided into income level and distributed to the TAZ.

The day time student populations are also distributed to TAZ by using the results of the CoMTrans Home Visit Survey. Public schools on the elementary level are equally distributed. Only some private schools will be built in Colombo and some urban centres. Basically, future daytime student populations are simply distributed into the TAZ, with little change in the location of schools and universities or their number of students.

Thus the zonal parameters of student populations of both night time and day time by income level are obtained for each TAZ.

The following table shows the student population of CMA and Western Province by the school type in 2035. Table 9.2.4 shows the student population at their residential places (night time student population) and Table 9.2.5 shows the student population at their school places (day time student populations).

Table 9.2.4 Night Time Student Population in CMA and Western Province (2035)

2035			Night Time Student Population				Share		
	District	DSD	Kindergarten & Student (Grade 1-5)	Student (Grade 6-10, G.C.E.(O/L) & (A/L))	University and Others	Total	Kindergarten & Student (Grade 1-5)	Student (Grade 6-10, G.C.E.(O/L) & (A/L))	University and Others
CMA	Colombo	Colombo	34,600	54,000	4,400	93,000	37.2%	58.1%	4.7%
		Dehiwala-Mt.Lavinia	6,700	16,500	4,100	27,300	24.5%	60.4%	15.0%
		Homagama	19,600	43,400	6,000	69,000	28.4%	62.9%	8.7%
		Kaduwela	24,300	51,800	8,000	84,100	28.9%	61.6%	9.5%
		Kesbewa	17,300	45,400	7,300	70,000	24.7%	64.9%	10.4%
		Kolonnawa	17,600	37,900	5,300	60,800	28.9%	62.3%	8.7%
		Maharagama	16,100	35,200	8,400	59,700	27.0%	59.0%	14.1%
		Moratuwa	17,600	27,700	3,600	48,900	36.0%	56.6%	7.4%
		Rathmalana	8,700	15,400	2,800	26,900	32.3%	57.2%	10.4%
		Kotte*	9,900	18,600	4,600	33,100	29.9%	56.2%	13.9%
		Thimbirigasyaya	19,200	33,900	4,400	57,500	33.4%	59.0%	7.7%
	Gampaha	Biyagama	16,400	38,700	4,700	59,800	27.4%	64.7%	7.9%
		Gampaha	17,600	36,200	6,900	60,700	29.0%	59.6%	11.4%
		Ja-Ela	20,000	33,200	6,100	59,300	33.7%	56.0%	10.3%
		Kelaniya	11,300	24,000	6,600	41,900	27.0%	57.3%	15.8%
		Mahara	20,000	35,200	6,600	61,800	32.4%	57.0%	10.7%
		Wattala	16,400	34,400	3,000	53,800	30.5%	63.9%	5.6%
	Kalutara	Bandaragama	10,500	22,800	4,600	37,900	27.7%	60.2%	12.1%
		Kalutara	17,800	32,000	5,000	54,800	32.5%	58.4%	9.1%
		Panadura	16,300	42,800	8,800	67,900	24.0%	63.0%	13.0%
	Total		337,700	679,200	111,100	1,128,000	29.9%	60.2%	9.8%
Outside of CMA			217,300	375,300	57,300	649,900	33.4%	57.7%	8.8%
Western Province			555,000	1,054,500	168,300	1,777,800	31.2%	59.3%	9.5%

Note: * Sri Jayawardanapura Kotte
Source: CoMTrans Study Team

Table 9.2.5 Day Time Student Population in CMA and Western Province (2035)

2035			Day Time Student Population				Share		
	District	DSD	Kindergarten & Student (Grade 1-5)	Student (Grade 6-10, G.C.E.(O/L) & (A/L))	University and Others	Total	Kindergarten & Student (Grade 1-5)	Student (Grade 6-10, G.C.E.(O/L) & (A/L))	University and Others
CMA	Colombo	Colombo	33,600	60,400	11,000	105,000	32.0%	57.5%	10.5%
		Dehiwala-Mt.Lavinia	8,700	20,700	3,700	33,100	26.3%	62.5%	11.2%
		Homagama	14,600	22,800	1,500	38,900	37.5%	58.6%	3.9%
		Kaduwela	15,200	31,400	7,800	54,400	27.9%	57.7%	14.3%
		Kesbewa	15,500	29,500	2,400	47,400	32.7%	62.2%	5.1%
		Kolonnawa	8,900	18,100	1,500	28,500	31.2%	63.5%	5.3%
		Maharagama	12,600	29,000	19,000	60,600	20.8%	47.9%	31.4%
		Moratuwa	13,900	25,800	9,900	49,600	28.0%	52.0%	20.0%
		Rathmalana	6,200	17,000	5,100	28,300	21.9%	60.1%	18.0%
		Kotte*	16,100	34,600	9,900	60,600	26.6%	57.1%	16.3%
		Thimbirigasyaya	57,000	157,800	50,500	265,300	21.5%	59.5%	19.0%
	Gampaha	Biyagama	12,300	23,300	700	36,300	33.9%	64.2%	1.9%
		Gampaha	23,000	56,500	3,300	82,800	27.8%	68.2%	4.0%
		Ja-Ela	17,300	27,700	2,800	47,800	36.2%	57.9%	5.9%
		Kelaniya	14,300	32,600	22,200	69,100	20.7%	47.2%	32.1%
		Mahara	14,900	24,700	300	39,900	37.3%	61.9%	0.8%
		Wattala	17,100	32,600	1,100	50,800	33.7%	64.2%	2.2%
	Kalutara	Bandaragama	7,500	12,400	0	19,900	37.7%	62.3%	0.0%
		Kalutara	16,200	29,600	1,400	47,200	34.3%	62.7%	3.0%
		Panadura	21,200	40,100	700	62,000	34.2%	64.7%	1.1%
	Total		346,200	726,800	154,900	1,227,900	28.2%	59.2%	12.6%
Outside of CMA			208,800	327,700	13,400	549,900	38.0%	59.6%	2.4%
Western Province			555,000	1,054,500	168,300	1,777,800	31.2%	59.3%	9.5%

Note: * Sri Jayawardanapura Kotte
Source: CoMTrans Study Team

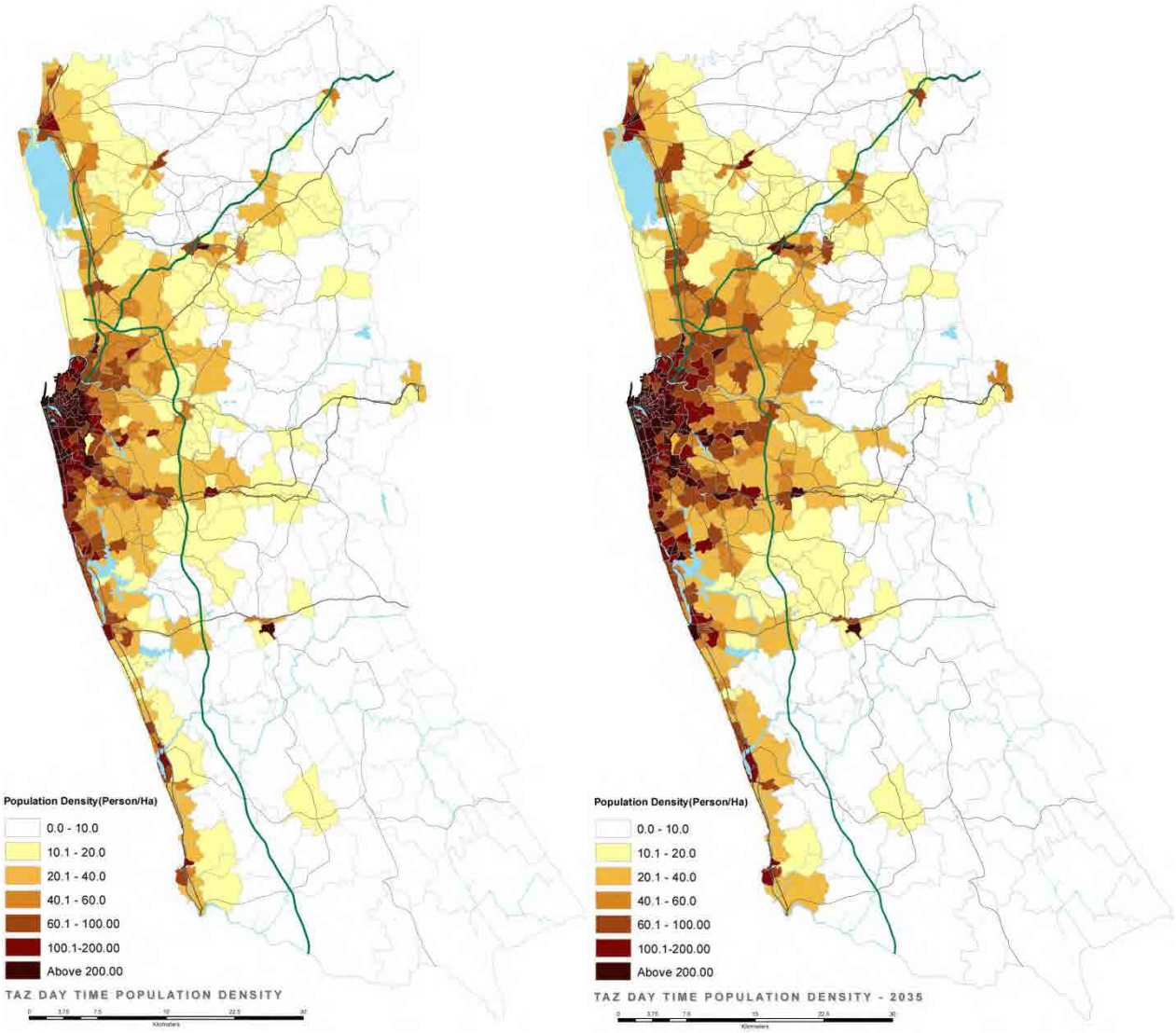
9.2.4 Daytime Population

From the information mentioned above regarding the day time and night time populations of employed workers and students, the total daytime populations are calculated by TAZ. This is shown by the DSDs in CMA in Table 9.2.6, and the densities of the daytime populations in 2013 and 2035 are shown in Figure 9.2.1.

Table 9.2.6 Estimated and Projected Daytime and Night time population by DSD

	District	DSD	2013			2035		
			Night Time Population	Day Time Population	*Day / Night*	Night Time Population	Day Time Population	*Day / Night*
CMA	Colombo	Colombo	318,400	532,700	*1.67*	238,200	538,300	*2.26*
		Dehiwala-Mt.Lavinia	87,800	91,500	*1.04*	75,600	96,900	*1.28*
		Homagama	236,300	192,800	*0.82*	416,700	329,000	*0.79*
		Kaduwela	252,200	213,100	*0.84*	505,500	449,800	*0.89*
		Kesbewa	243,900	191,500	*0.79*	335,300	267,600	*0.80*
		Kolonnawa	190,900	143,800	*0.75*	301,900	223,200	*0.74*
		Maharagama	195,300	182,600	*0.93*	265,400	293,000	*1.10*
		Moratuwa	167,300	162,400	*0.97*	168,700	200,500	*1.19*
		Rathmalana	95,000	104,200	*1.10*	106,500	148,400	*1.39*
		Kotte*	107,200	148,800	*1.39*	131,500	208,900	*1.59*
		Thimbirigasyaya	236,900	515,300	*2.18*	196,400	608,800	*3.10*
	Gampaha	Biyagama	186,700	169,100	*0.91*	323,800	270,400	*0.84*
		Gampaha	196,300	200,100	*1.02*	296,700	303,000	*1.02*
		Ja-Ela	201,200	184,900	*0.92*	311,700	280,200	*0.90*
		Kelaniya	136,000	158,700	*1.17*	179,800	240,800	*1.34*
		Mahara	207,100	156,200	*0.75*	316,000	236,000	*0.75*
		Wattala	174,300	165,100	*0.95*	236,200	241,400	*1.02*
	Kalutara	Bandaragama	108,900	82,100	*0.75*	180,400	124,600	*0.69*
		Kalutara	159,200	145,400	*0.91*	252,400	225,500	*0.89*
		Panadura	181,700	168,400	*0.93*	291,000	249,100	*0.86*
	Total		**3,682,500**	**3,908,700**	***1.06***	**5,129,600**	**5,535,400**	***1.08***
Outside of CMA			**2,139,200**	**1,913,000**	***0.89***	**2,810,600**	**2,404,900**	***0.86***
Western Province			**5,821,700**	**5,821,700**	***1.00***	**7,940,200**	**7,940,200**	***1.00***

Note: * Sri Jayawardanapura Kotte
Source: CoMTrans Study Team



Note: Calculated by the Traffic Analysis Zone (TAZ), CoMTrans Study Team.

Figure 9.2.1 Daytime Population Densities 2013 and 2035

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF TRANSPORT

URBAN TRANSPORT SYSTEM DEVELOPMENT PROJECT FOR COLOMBO METROPOLITAN REGION AND SUBURBS

Technical Report No. 5

Transport Demand Forecast

AUGUST 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ORIENTAL CONSULTANTS CO., LTD.

URBAN TRANSPORT SYSTEM DEVELOPMENT PROJECT FOR COLOMBO METROPOLITAN REGION AND SUBURBS

Technical Report 5
Transport Demand Forecast

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CHAPTER 1 Introduction

1.1 Background

Transport demand forecast is fundamental information for developing an urban transport master plan. Based on the estimated demand and other performance indicators, scenarios and alternatives of the master plan are evaluated.

This technical report aims to describe details regarding the transport demand forecast of the CoMTrans project including basic assumptions, inputs, demand forecast model development, future demand forecast results and estimated performance indicators.

This Chapter 1 describes the background and overall methodology of the transport demand forecast including a flow chart of the analysis flow.

Basic assumptions and inputs on current transport condition of the Western Province are mentioned in Chapter 2.

Based on transport survey data and secondary statistics, transport demand forecast models are developed in Chapter 3.

Chapter 4 summarises the results of the future demand forecast based on the assumptions and inputs in Chapter 2 and models described in Chapter 3.

Finally, Chapter 5 includes estimated results of key performance indicators as well as assumptions made.

1.2 Methodology of Transport Demand Forecast

1.2.1 Overall Methodology

The CoMTrans master plan employed a four-step method which is empirically proven methodology with a number of applications in many countries. The flow of the analysis is shown in Figure 1.2.1.

The initial data input into the demand forecast model include the population projection of the Western Province mentioned in Chapter 4 of the CoMTrans urban transport master plan, the urban development projects and urban planning policies including transit-oriented development. Residential population, employed population and student population by income level are estimated by zone. These data are input into the trip generation model. Origin-destination (OD) tables by trip purpose and income level are estimated by the trip generation and distribution models developed for the Western Province.

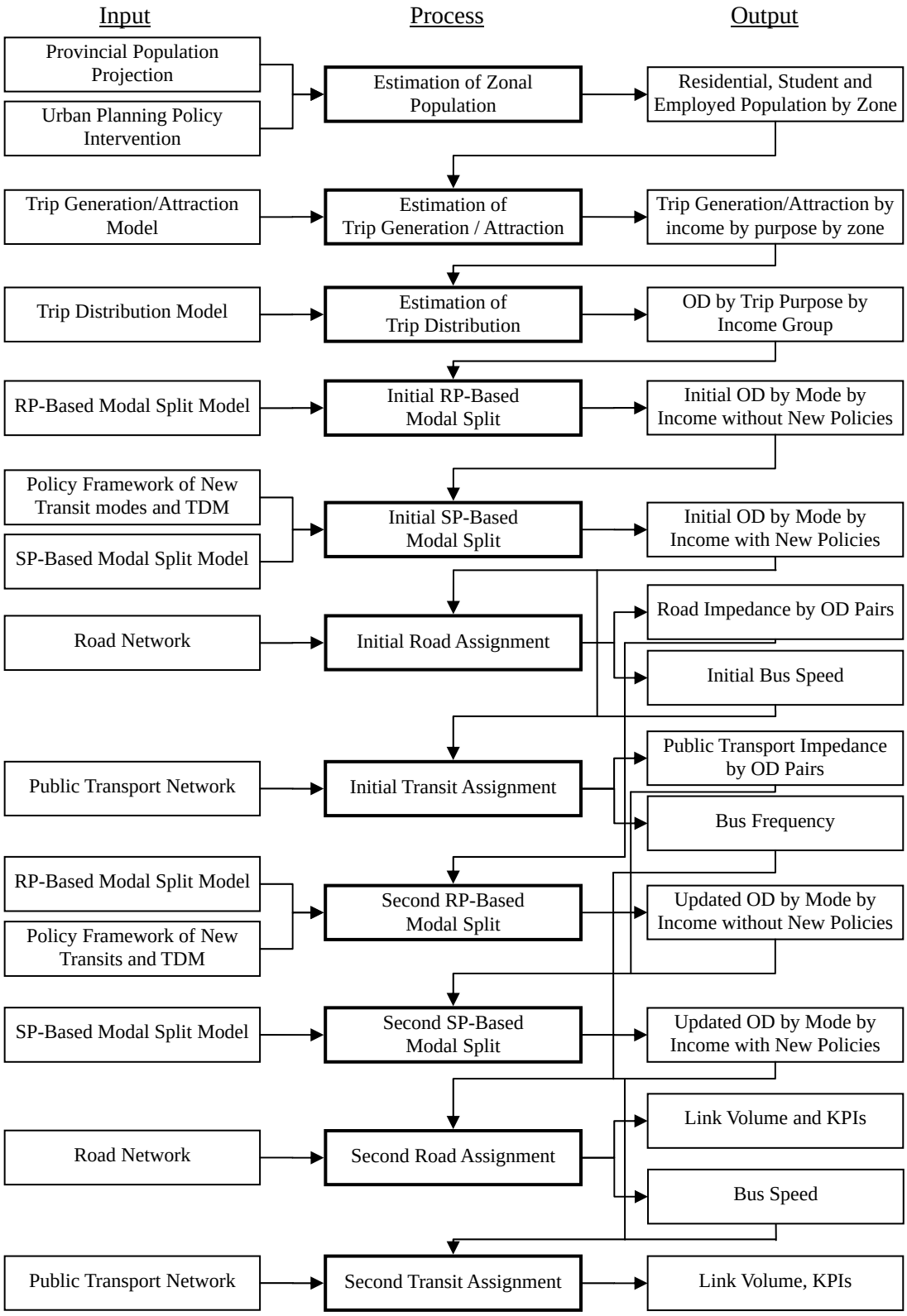
As road traffic and public transport are closely related, these cross-relationships are taken into account in the demand forecast in addition to the conventional four-step modelling. For instance,

bus travel speeds are dependent on the congestion level of roads. Slow travel speed of private motorised mode of transport can contribute to the modal shift to rail-based transport. Therefore, 2 stages of road assignment and 2 stages of transit (public transport) assignment are conducted to consider these relationships.

As some proposed transport systems in the master plan are a new transport mode for Sri Lanka, a Stated Preference (SP) survey was conducted. A stated preference survey is a survey method which requires respondents to indicate their preference in a certain fictive condition such as transport mode choice with a monorail system in the future. In contrast, a revealed preference (RP) survey collects actual choice results such as current mode of transportation.

RP-based modal choice models were developed to estimate the modal share without new policy interventions such as a modernised railway, BRT, monorail and electronic road pricing. The SP-based modal shift model was developed to estimate modal shift due to new policy interventions.

After the initial road and transit assignment; impedance tables, initial link travel speed and initial bus volume on the roads are estimated. These will be input into the second modal split and second road and transit assignment. Finally, link volumes and performance indicators are the final outputs of the assignment.



Source: CoMTrans Study Team

Figure 1.2.1 Flow of Transport Demand Forecast

1.2.2 Software for Transport Demand Forecast

While a variety of software was used for the CoMTrans project as shown in Table 1.2.1, STRADA (The System for Traffic Demand Analysis) developed by the Japan International Cooperation Agency (JICA) is the core software for demand projections, especially for traffic assignment.

The System for Traffic Demand Analysis (STRADA) is a window based package; development was started in 1993 by Japan International Cooperation Agency (JICA) under the leadership of Prof. Hideo Nakamura at Tokyo University with participation of some experts in the relevant fields.

In this traffic demand analysis, JICA STRADA version 3 is used for trip assignment of present transport demand and for future forecast. STARDA is comprehensive, simple and cost effective software, which is also used in the Road Development Authority (RDA) in Sri Lanka.

The software consists of 17 individual modules. 8 modules were used to build private and public transport networks, trip assignment, view assignment outputs and manipulate data through GIS and STARADA.

The summary of the software used for the transport demand forecast and to view the assignment outputs is shown in the table below.

Table 1.2.1 Software Used for Transport Demand Forecast

Software	Manufacture	Purpose	Characteristics
JICA STRADA version 3	IT Urban Planning Inc.	Trip assignment of present transport demand, future forecast, view assignment outputs	Comprehensive software with graphic user interface consisting 17 individual modules
CUBE	Citilabs	Editing origin destination tables	One of the most popular packages of transportation planning software in the world with a variety of functions
ArcGIS version 10.1	ESRI (Environmental Systems Research Institute)	Edit JICA STRADA network and parameter set in the network, inputs and assignment outputs	Location based mapping easy to convert GIS to STRADA and vice versa
Microsoft Excel	Microsoft	Handle transit lines for JICA STRADA in CSV format Convert text formatted JICA STRADA outputs to ArcGIS format	Compatible with JICA STARDA and ArcGIS
Biogeme	Developed by Prof. Michel Bierlaire of Ecolepolytechnique fédérale de Lausanne (EPFL)	Development of mode choice model	Open source free software for discrete choice modelling especially for transport demand forecast

Source: Web site of each software companies and CoMTrans Study Team

The System for Traffic Demand Analysis (STRADA) is a Windows based package; development was begun in 1993 by Japan International Cooperation Agency (JICA) under the leadership of Prof. Hideo Nakamura at Tokyo University with participation of some experts in the relevant fields.

In this traffic demand analysis, JICA STRADA version 3 is used for trip assignment of present transport demand and for future forecast. STARDA is comprehensive, simple and cost effective software, which is also used in the Road Development Authority (RDA) in Sri Lanka.

The software consists of 17 individual modules. 8 modules were used to build private and public transport networks, trip assignment, view assignment outputs and manipulate data through GIS and STARADA.

As several formats of JICA STRADA files are mentioned in the report, major file types of the JICA STRADA are explained below.

File Type of JICA STRADA

A. INT (Network Data)

The network data file contains various attributes of network links that are necessary to run the assignment programs.

B. TNT (Transit Line Data)

The file records transit line descriptions necessary for transit assignment. The line descriptions are read from the nodes in the network data.

The line properties consist of transit mode, direction of service, service frequency and scheduled speed.

C. PAR (Assignment Parameters)

This file contains the parameters for incremental assignments and three types of user equilibrium assignments. Users can specify various options for assignment.

D. TPA (Transit Assignment Parameters)

This file describes the parameters for transit assignment. Users can specify various options for assignments.

E. TRE (Transit Assignment Results)

TRE file describes the result of transit assignment. The transit assignment program can output eleven different reports on the assignment results. Users need to specify the types of reports in the parameter file to have them output in the file.

F. IRE (Assignment Results)

This file type records various link results of road traffic assignment including traffic volume, peak and average velocity and traffic flow for both directions.

CHAPTER 2 Basic Assumptions and Inputs

2.1 Summaries of Transport Surveys for Demand Forecasting

The Study team initiated the works in Sri Lanka on 27th August 2012. The Study team has conducted a variety of transport surveys as briefly summarised in the Table 2.1.1;

Table 2.1.1 Summary of Transport Surveys

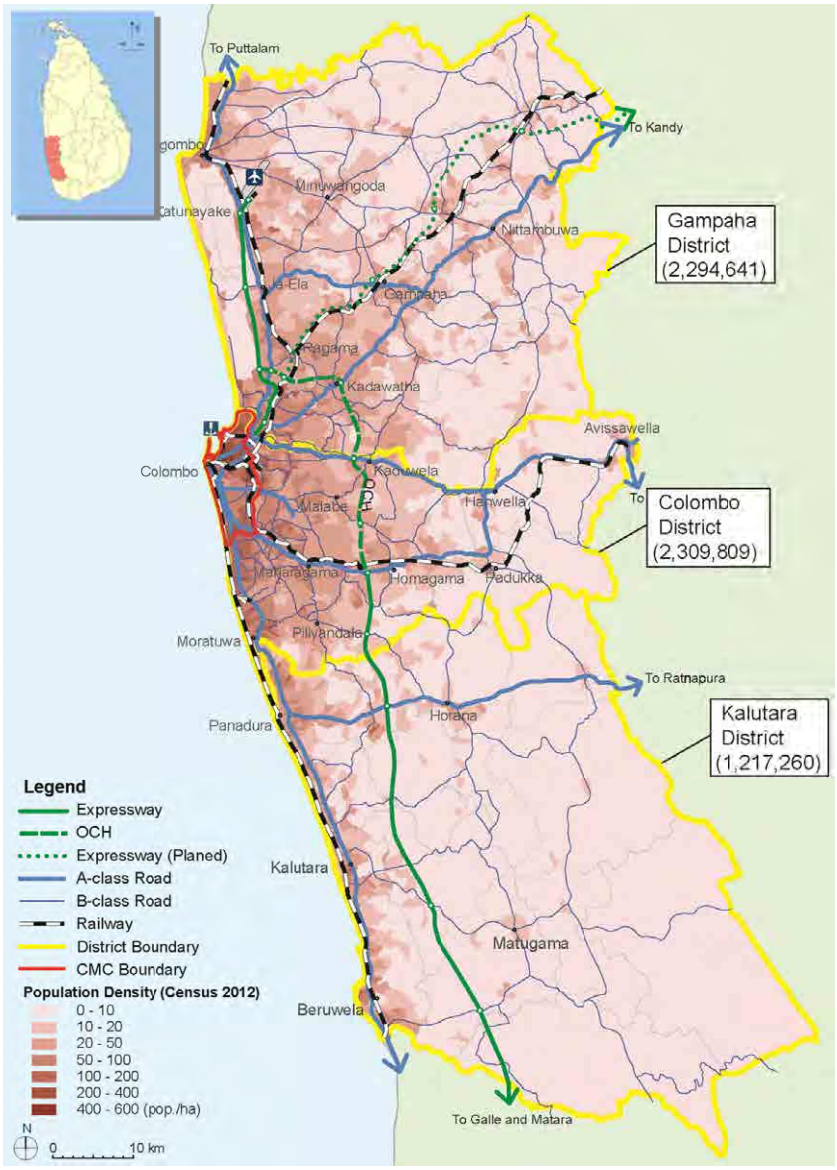
No.	Types of Survey	Survey Coverage		
		Location	Survey Day/Period	Sampling Rate
1	Home Visit Survey	Western Province	Weekday (Tuesday - Thursday) (November, 2012 – August, 2013)	2% of population (or approx. 31,000 HHs)
2	Cordon Line Survey			
	(1) Roadside OD Interview	27 locations along Western Province boundary	24h, 16h or 12h on weekday depending on location (January – February, 2013)	5% for motorcycles and 3-wheelers; and 20% for other vehicles
	(2) Bus Passenger OD Interview	14 of the 27 locations above	16 h on weekday (February – March, 2013)	5% of crossing passengers
	(3) Railway Pax. OD Interview	3 railway lines (Puttalam, Main & Coast lines) at boundary of Western Province	During service hours on weekday (February – March, 2013)	20% of crossing passengers
	(4) Air Passenger OD Interview	Bandaranaike International Airport waiting room	24h on weekday (March, 2013)	20% of departing passengers
3	Screen Line Survey			
	(1) Classified Vehicle Count	67 locations along CMC boundary	24h or 16h on weekday depending on location (February – March, 2013)	100% of passing vehicles
	(2) Bus Passenger Loading Survey	67 locations along CMC boundary	16h on weekday (February – March, 2013)	
4	Trip Generation Survey	10 government office buildings, 10 private office buildings and a total of 10 shopping malls, supermarkets and traditional markets which are major trip generation points in Western Province	During service hours on weekday (April – May, 2013)	10% of facility users
5	Truck OD Interview Survey	8 EPZs, 7 IEs, 1 port, and 4 container terminals in Western Province	24h on weekday (April – May, 2013)	20%
6	Travel Speed Survey	Within 10Km from CMC boundary	Anytime of the day (December, 2012 – July, 2013)	- -

Source: CoMTrans Study Team

2.2 Zone System and Target Area

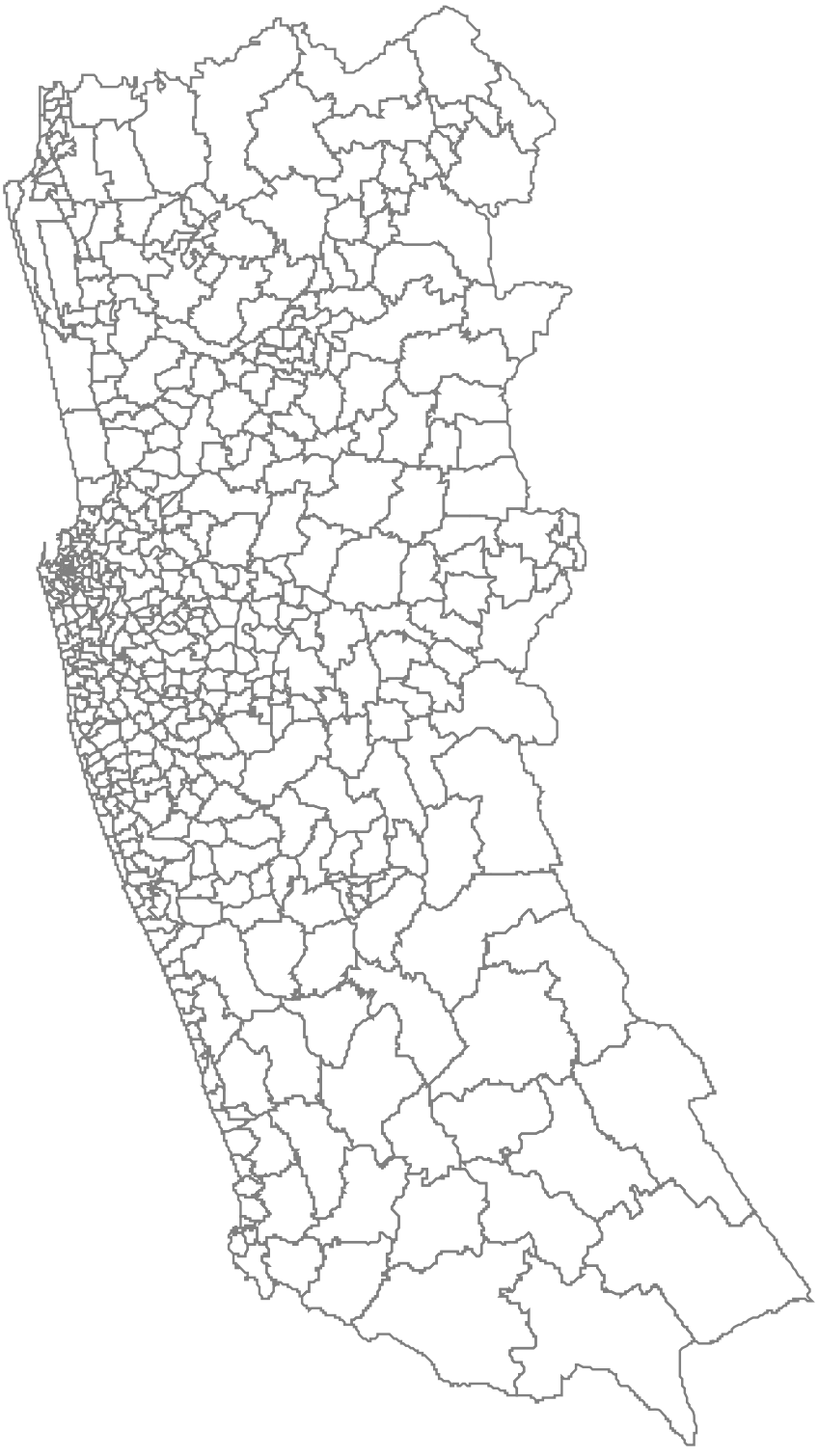
The target area for this study covers the whole Western Province. For analysis purposes, the target area is sub-divided into analysis zones.

In transport planning, the analysis zone is created in order that the area shares homogeneous characteristics in terms of land use, population, accessibility, etc. Taking this practice into consideration, 462 traffic analysis zones (TAZs) were created in the study area. Start points and end points of all movements inside the study area are transferred to these zones which are precisely represented by points called centroids.



Source: CoMTrans Study Team

Figure 2.2.1 Study Area



Source: CoMTrans Study Team

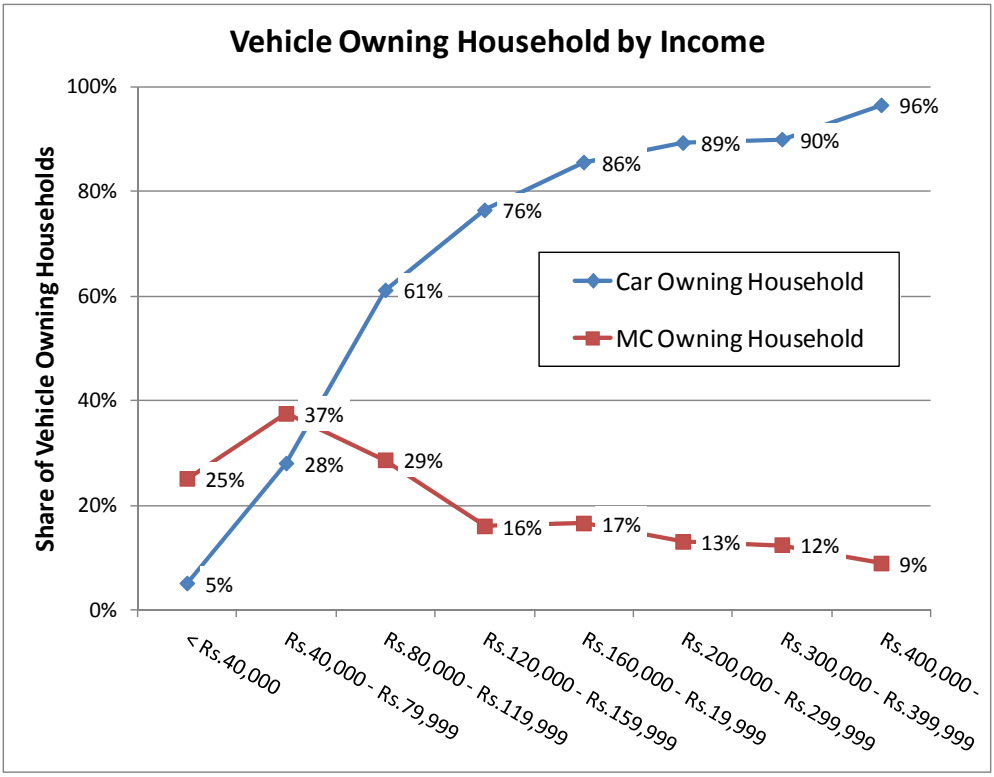
Figure 2.2.2 Traffic Analysis Zones in Western Province

2.3 Income Classification

In subsequent analysis, household income is classified into 3 major groups: Group C, Group B, and Group A.

In general, vehicle ownership of the household is closely correlated with household income. It is observed that the percentage of car-owning households increases proportionately with income. In contrast, the percentage of motorcycle-owning households shows a gradual decrease when income is Rs. 80,000 and beyond. Based on this analysis, the three income groups are classified as follows:

- Group C: Less than Rs. 40,000 per month;
- Group B: Rs. 40,000 –Rs. 79,000 per month;
- Group A: Rs. 80,000 per month or more.



Source: CoMTrans Home Visit Survey, 2013

Figure 2.3.1 Distribution of Vehicle Owning Households by Income

2.4 Vehicle Classification and Average Occupancy

2.4.1 Vehicle Classification

The types of vehicles for the traffic count survey are classified into the following categories as shown in Table 2.4.1.

Table 2.4.1 Survey Vehicle Classification

Types	Classification on Survey
Type 1	Motorbike
Type 2	Three Wheeler
Type 3	Car, Jeep
Type 4	Van
Type 5	Pick-up (Single/ Double Cab)
Type 6	Medium Truck (2 axles)
Type 7	Large Truck (3 axles and more)
Type 8	Container Trailer
Type 9	Minibus (29 seats and below)
Type 10	Bus
Type 11	Others Motorised vehicles

Source: CoMTrans Study Team

Assignment mode specifications are categorised into 5 groups. All modes are represented in Passenger Car Units (PCU). The PCU values for the above modes are shown in the table below.

Table 2.4.2 Assignment Vehicle Classification and PCU Values

Types	Classification in Survey	Passenger Car Unit (PCU)
Type 1	Car (Van. Jeep, Car, pick up and other motorised vehicles)	1.0
Type 2	Motorcycle	0.4
Type 3	Three wheeler	0.8
Type 4	Bus (Minibus, AC bus and Normal bus)	1.8
Type 5	Trucks (Medium/ Large trucks and container)	1.0

Source: Road Development Authority

2.5 Time Value

Value of time is specified by income group as shown in Table 2.5.1. Mean household income was estimated by the Home Visit Survey Results and adjusted by the Household Income and Expenditure Survey 2012/2013. The values were converted to the worker's time value. Although average time value by purpose is used for economic analysis, worker's time value was used for the transport demand forecast. According to experience in other countries, time value of transport mode and route choice is higher than their salary per unit of time.

Table 2.5.1 Value of Time for Traffic Assignment

Income Level	Mean Household Income (Rs.)	Avg. No. of Workers in Household	Monthly Working Hours	Social Security Cost	Worker's Time Value (Rs./h)
Group C	24,009	1.20	140	30%	186
Group B	56,810	1.72	140	30%	307
Group A	186,164	1.90	140	30%	909
All	70,366	1.36	140	30%	479

Note: "Avg." stands for "average".

Source: CoMTrans Study Team

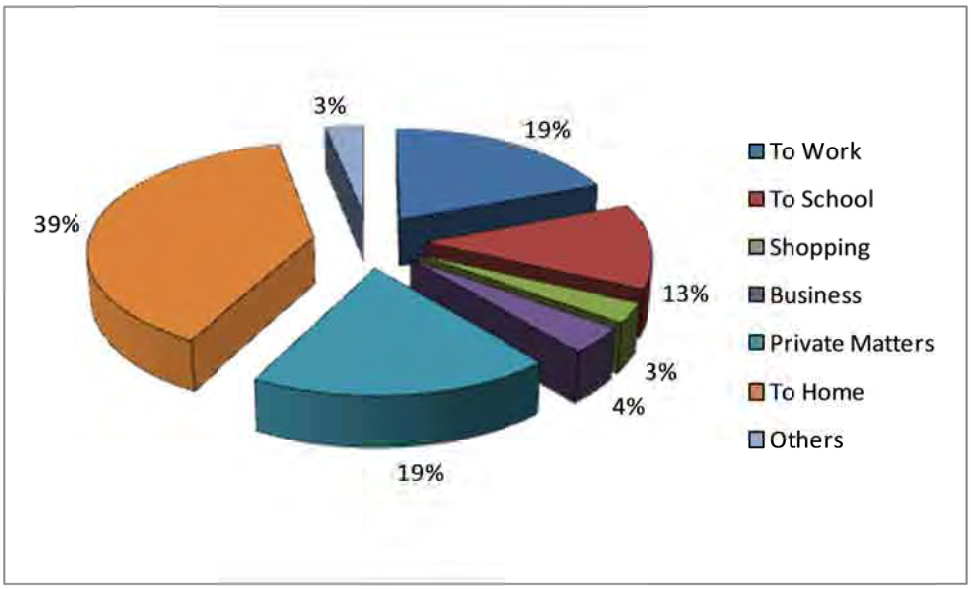
2.6 Trip Purpose for Demand Forecast

Table 2.6.1 and Figure 2.6.1 show the number of trips and composition of trip purposes in Western Province. To meet with the objective of the analyses and modelling hereafter, the trip purposes were rearranged in to seven home-based purposes considering their origin and destination (see Table 2.6.2 and Figure 2.6.2)

Table 2.6.1 Trip by Purpose in Western Province

Trip Purpose	No. of Trips ('000)	Share
1. To Work	1,940	19%
2. To School	1,288	13%
3. Shopping	299	3%
4. Business	393	4%
5. Private Matters	1,904	19%
6. To Home	3,944	39%
7. Others	322	3%
Total	10,089	100%

Source: CoMTrans Home Visit Survey, 2013



Source: CoMTrans Home Visit Survey, 2013

Figure 2.6.1 Trip Purpose Composition in Western Province

Table 2.6.2 Trip by Purpose in Western Province (Home-based Purpose)

Trip Purpose	No. of Trips ('000)	Share
1. Home to Work	1,350	13.4%
2. Home to School	1,174	11.6%
3. Home to Other	1,458	14.4%
4. Work to Home	1,356	13.4%
5. School to Home	1,157	11.5%
6. Other to Home	1,430	14.2%
7. Non-Home-Based (NHB)	2,164	21.5%
Total	10,089	100.0%

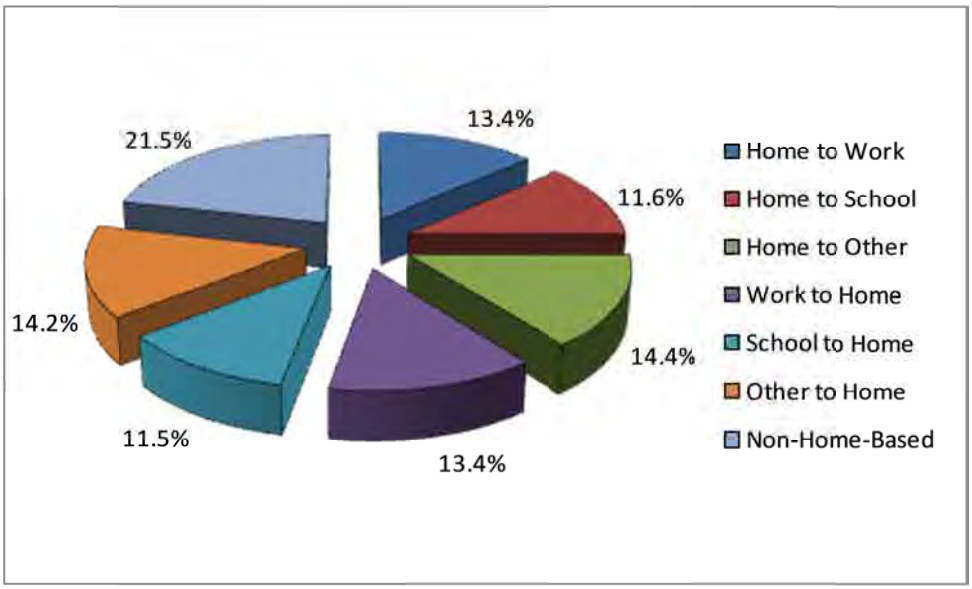
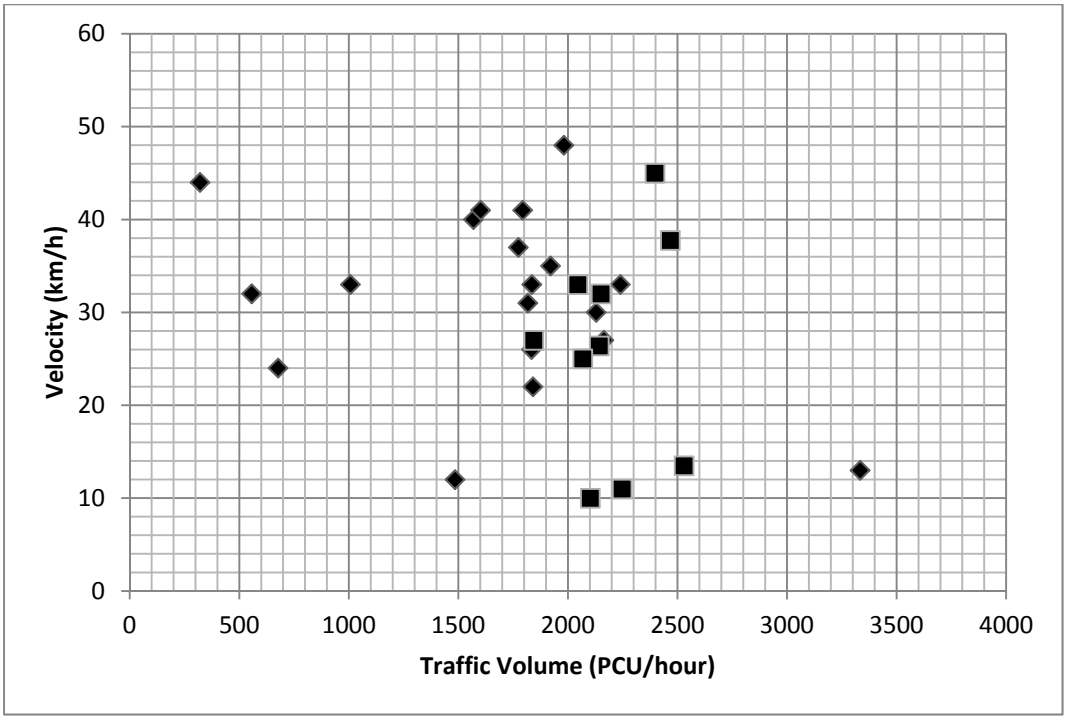


Figure 2.6.2 Trip Purpose Composition in Western Province (Home-based Purpose)

2.7 Present Road Network Development

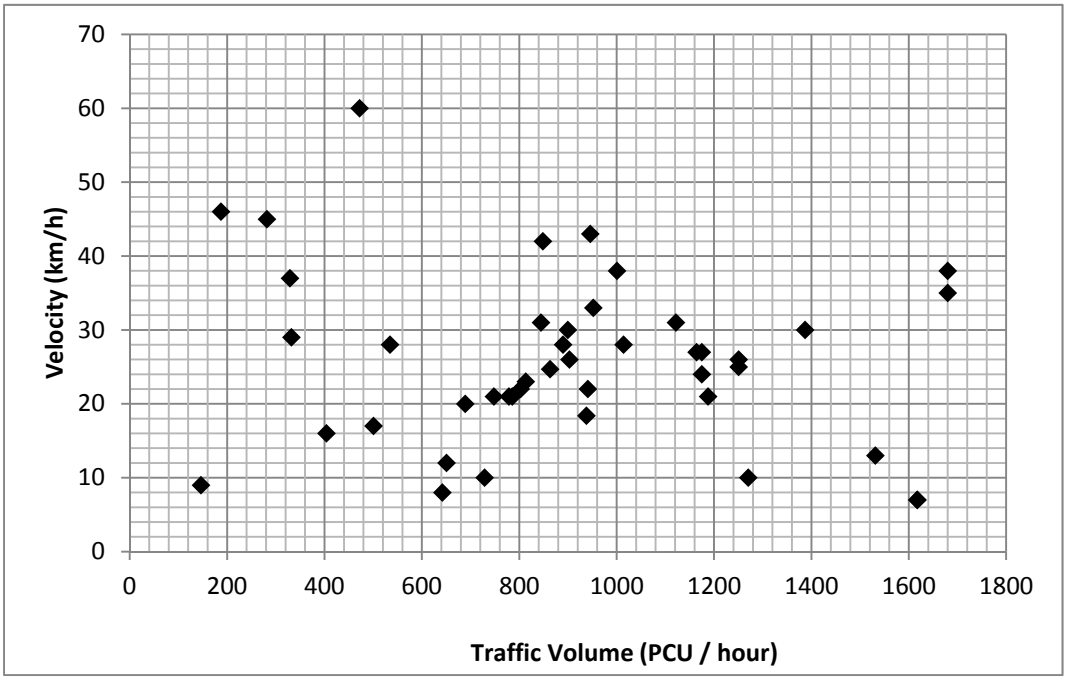
2.7.1 Capacity and Velocity Analysis

The capacity and velocity of the road network were determined by the results of the screen line survey and travel speed survey. The traffic count surveys of the screen line surveys were conducted during January –March 2013. A travel speed survey utilizing a global positioning system (GPS) was conducted with roughly 200 vehicles including taxies, passenger cars, school vans, office transport and trucks in the same duration. Therefore, some survey vehicles of the travel speed survey pass traffic count survey points. By matching traffic count survey data and travel speed survey data, scatter graphs of quantity – velocity distributions were prepared. The traffic volume capacity graphs are prepared by types of roads such as 4 lane suburban roads (see Figure 2.7.1), 4 lane urban roads (see Figure 2.7.2), 6 lane road (see Figure 2.7.3) , 2 lane urban road (see Figure 2.7.4) and 2 lane suburban roads (see Figure 2.7.5). The number of counted vehicles is converted to a passenger car equivalent unit.



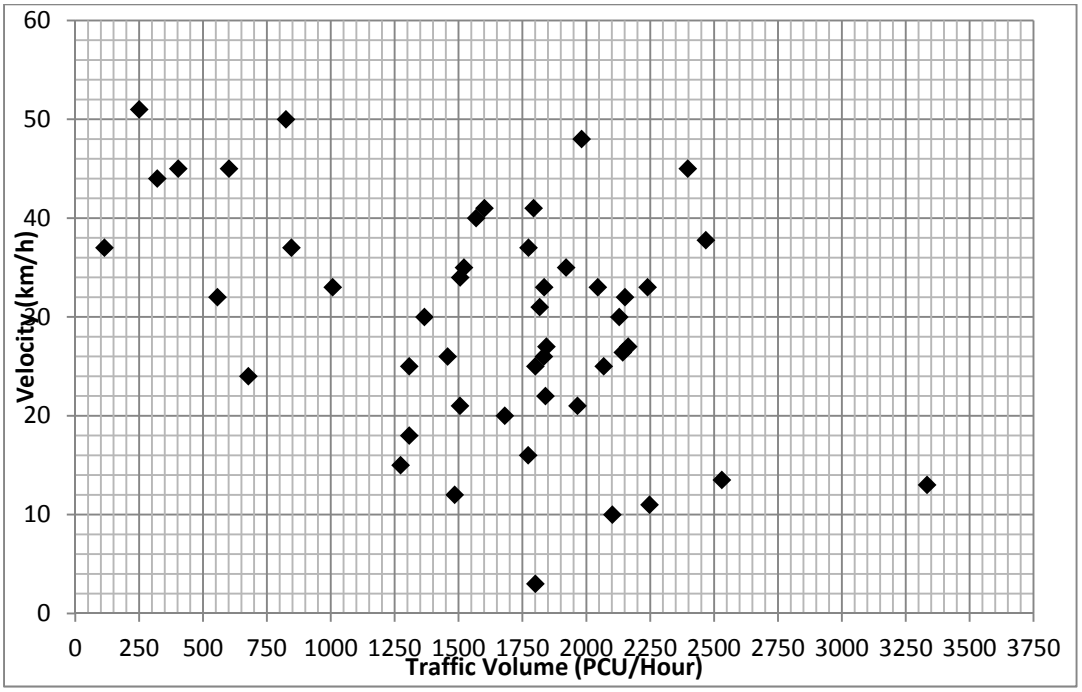
Source: CoMTrans Travel Speed Survey and Screen Line Survey, 2013

Figure 2.7.1 QV Graph- 4 Lane Suburban Roads



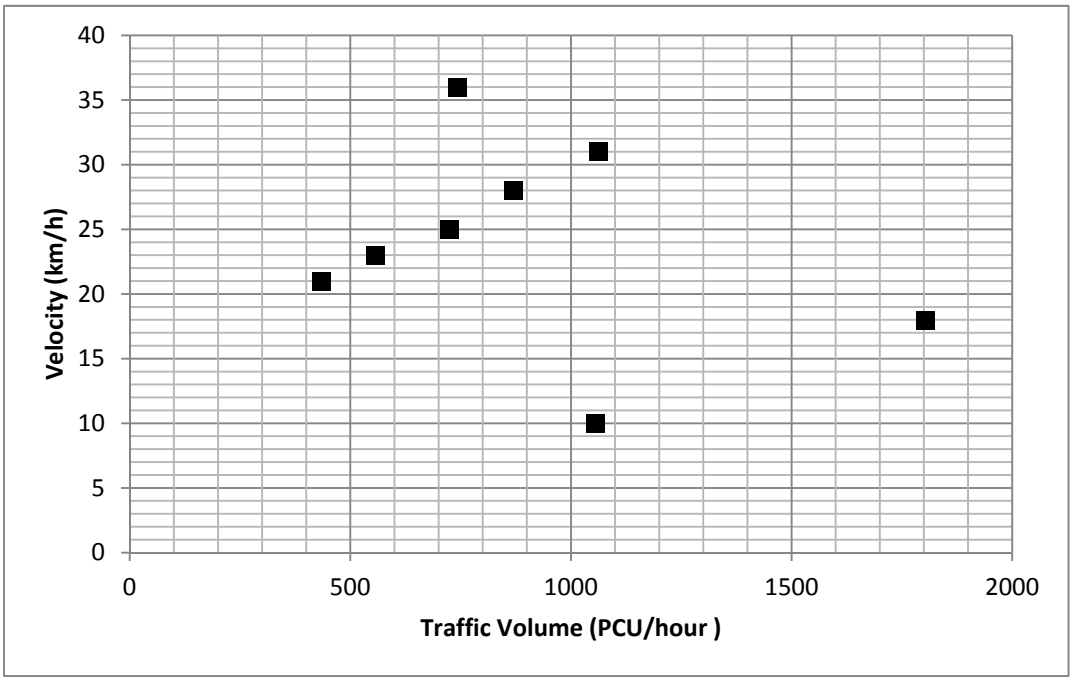
Source: CoMTrans Travel Speed Survey and Screen Line Survey, 2013

Figure 2.7.2 QV Graph- 2 Lane Suburban Roads



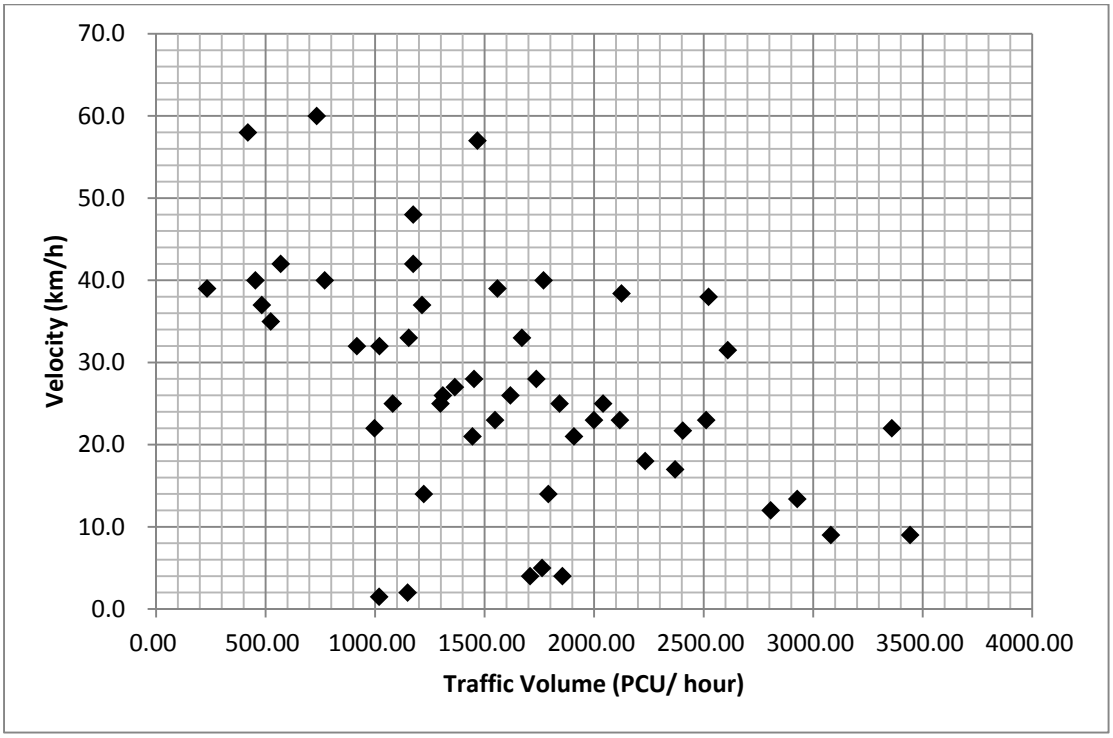
Source: CoMTrans Travel Speed Survey and Screen Line Survey, 2013

Figure 2.7.3 QV Graph- 4 Lane Urban Roads



Source: CoMTrans Travel Speed Survey and Screen Line Survey, 2013

Figure 2.7.4 QV Graph- 2 Lane Urban Road



Source: CoMTrans Travel Speed Survey and Screen Line Survey, 2013

Figure 2.7.5 QV Graph- 6 Lane Roads

The capacity and velocity was taken from the scatter plot. Table 2.7.1 shows the analysis of the capacity and velocity for each road. Finally, capacity was converted into PCUs/two directions/ day for the assignment.

Table 2.7.1 Capacity and Velocity Settings

	Observation	Standard	Observation			CMC Capacity
	Peak Ratio	Q day	Q peak	Q day	Velocity	Q day
		PCU /2dir/day	PCU /dir/hour	PCU /2dir/day	km/h	PCU/ 2dir/ day
4 Lane Expressway	8.90%	72,000	3,200	72,000	100	50,400
6 Lane Urban	8.90%	84,000	2,700	61,000	60	42,700
6 Lane (Suburban)	8.90%	57,000	3,500	79,000	60	55,300
4 Lane (Urban)	8.90%	57,000	1,774	40,000	45	28,000
4 Lane (Suburban)	8.90%	53,000	2,300	52,000	50	36,400
2 Lane (Urban)	8.90%	20,000	771	17,000	35	11,900
2 Lane (Suburban)	8.90%	20,000	1,000	22,000	45	15,400
2 Lane (Street)	8.90%	17,000		10,000	30	7,000
5 Lane (Urban, One way)				51,000	60	35,700

	Observation	Standard	Observation			CMC Capacity
	Peak Ratio	Q day	Q peak	Q day	Velocity	Q day
		PCU /2dir/day	PCU /dir/hour	PCU /2dir/day	km/h	PCU/ 2dir/ day
4 Lane (Urban, One way)				41,000	60	28,700
3 Lane (Urban, One way)	8.90%	36,000		30,500	60	21,350
2 Lane (Urban, One way)	8.90%	42,000		20,000	45	14,000
1 Lane (Urban, One way)	8.90%	28,000		8,000	35	5,600

Source: CoMTrans Study Team

Furthermore, the road capacity within the Colombo Municipal Council (CMC) was reduced by 30% and 10% decrement applied to roads between the Colombo Metropolitan Area (CMA) boundary and the Colombo Municipal Council (CMC) boundary due to the vehicles manoeuvring into parking spaces, the vehicles looking for available parking, and illegal parking. The capacity settings also differ for the urban expressways and the capacity shown in Table 2.7.1was applied only for the Southern Expressway and the Outer Circular Highway.

2.7.2 Road Classification

The existing road network of Sri Lanka has been divided into five classes from A to E. Classes A and B are applied to national roads, classes C and D are applied to provincial roads, and class E is applied to local authority roads. There are some arterial roads (national roads) in the Western Province of Sri Lanka such as Negombo Road (A3), Kandy Road (A9), Low Level Road (B435), Malabe Road (A0-B240), High Level Road (A4), Horana Road (B084), and Galle Road (A2) which are connecting to the Fort area.

Basic understanding of road classification and settings was obtained from the Road Development Authority (RDA). Roads are classified based on the number of lanes, and, the number of lanes is further classified into those in the Colombo Municipal Council (CMC) Area, Colombo Metropolitan Area (Except CMC) and other areas in Western Province (see Figure 2.7.6). According to the number of lanes, maximum velocity and maximum capacity for each section has been defined.

In the road network (JICA STRADA INT file) arterial roads can be identified from the user flag. User Flag 2 represents the two major categories of arterial roads and according to that number, 1 are minor arterial roads and number 2 are major arterial roads.

Special code was given to roads in user flag 5 in the network, to identify the roads and that function as shown in Table 2.7.2.

Table 2.7.2 Network Link Classifications

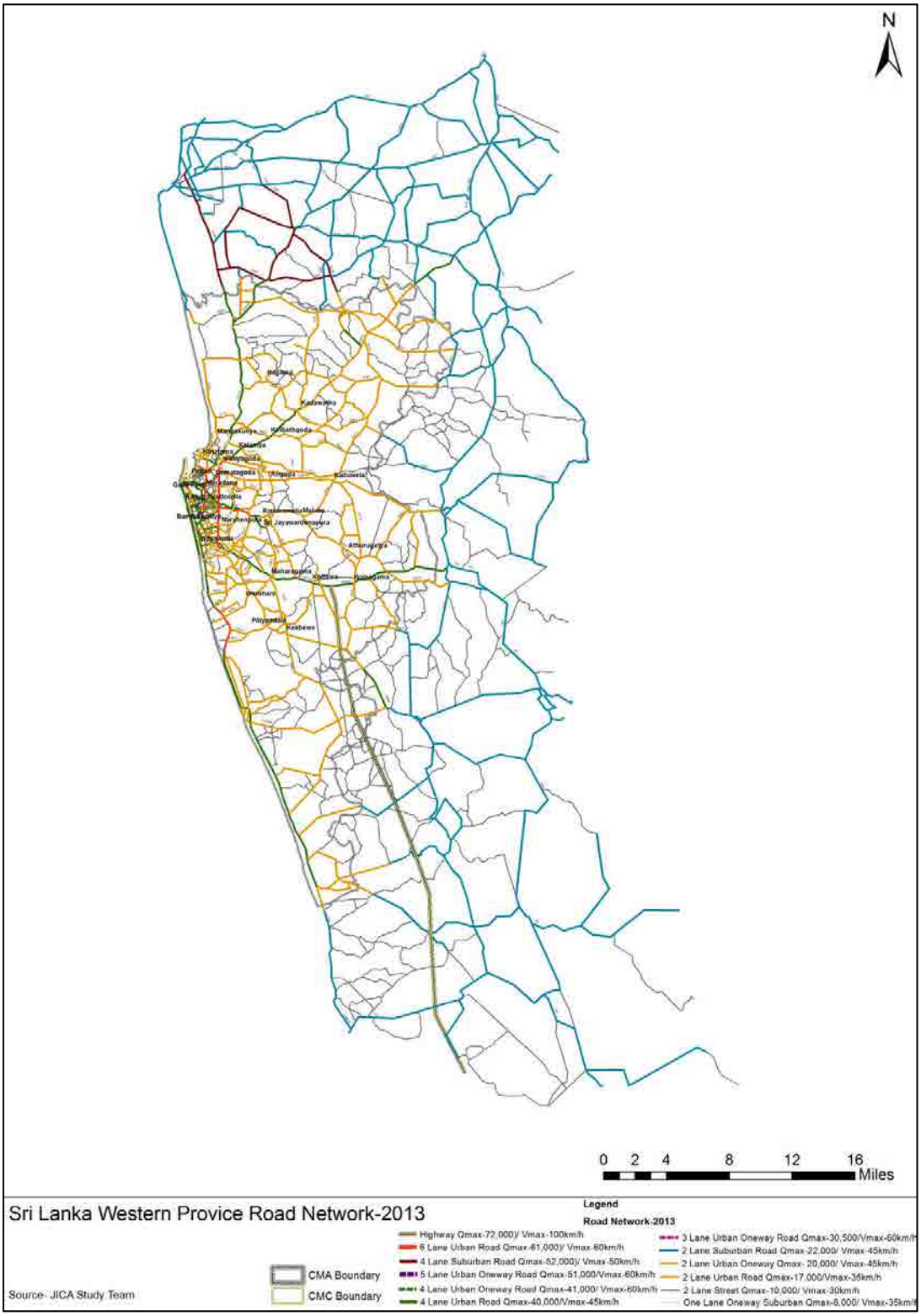
User Code	Descriptions
BRR	Roads connecting BRT stations and roads
BRT	Bus Rapid Transit Lines
MRR	Monorail stations to road connecting lines
MRT	Monorail transit lines
CC	Lines connecting zone centroid to road network.
CCN	Lines connecting zone centroid to road network
CCR	Lines connecting zone centroid to railway stations
DZ	Links used for a previous analysis
H	Highway
IC	Interchanges
RMP	Ramps
RL	Railway lines
RR	Links connecting railway stations and roads
RU	Rural roads
TRF	Links used to transfer between different modes
TZ/TZC	Links connecting zone centroid with BRT stations, monorail stations and railway stations
U	Urban roads

Source: CoMTrans Study Team

BRR, MRT, BRT and MRR lines were defined for future forecasting.

Road network data contains various attributes of each link that are necessary to run the assignment program. Links are named differently according to the user flag 5 and node *i* and node *j* are defined for each link. Node *i* represents the name of the node at one end of the link above and node *j* represents name of the node at the other end of the link. Link distance was defined in kilometres and maximum velocity and maximum capacity were designated as *Vmax* and *Qmax* respectively.

Modes are defined differently according the mode numbers (see Table 2.4.2).



Source: CoMTrans Study Team

Figure 2.7.6 Road Network, 2013

2.7.3 Expressway Toll

The Southern Expressway is Sri Lanka's first E class highway and it opened in 2011. The length of this section is 96km (Kottawa to Pinnaduwa). As of January 2013, only one expressway is in operation which is the Southern Expressway. Colombo -Katunayake Expressway and the Outer Circular Highways are under construction.

The user fee for modes is applied from the current user fee setting of the Southern Expressway. Expressway user fee settings are defined in the fare control column and defined differently according to the modes from mode 1 to mode 5 and fare settings are based on per. Motorbikes and three wheelers are not allowed to travel on the expressways. Table 2.7.3 shows the express toll from Kottawa to Pinnaduwa for cars and trucks.

Table 2.7.3 Current Southern Expressway Toll Price

Mode	Total Kilometres (km)	Total User Fee (Rs.)	User fee per Kilometre (Rs./km)	No of Lanes
Car	96 km	Rs. 400	Rs.4.20	Four Lanes
Truck	96 km	Rs. 1500	Rs. 15.60	

Source- Road Development Authority

2.7.4 Parameter Settings

(1) Time Equivalence

The time equivalence requires specifications per mode regarding the time value, the velocity factor, the passenger car unit and the average passengers per vehicle in the Time Value tab.

(2) Time Value

The time value is specified for each mode and expressed in the minute/cost unit. Multiplied by this coefficient, the fare or toll is converted to a time value of fare resistance (i.e., delay), and added to the impedance in the minimum route search. Table 4.4.2 shows the time value in Hour/ Rs units for 2013, 2020, 2025 and 2035. The time values for every mode are based on the Rs 0.1. When inputting the fare level into the STRADA all values should be converted into Rs 0.1 fare base.

BPR link cost function was used for the user equilibrium assignment and alpha and beta were defined as one and four respectively.

2.8 Present Public Transport Network Development

2.8.1 Railway Network

The railway network of Western Province consists of four major railway lines.

I. Costal Line –Starting from Fort Station and extends to Matara (under-construction to Hambantota and Kataragama), touches the Western province boundary at Aluthgama station.

II. Main Line - Starting from Fort Station and extends towards the North – East part of Sri Lanka connecting the rapidly developing centres of Ragama, Ganemulla Gampaha, Veyangoda, Mirigama Ambepussa and Polgahawela which touches the Western province boundary at Ambepussa station.

III. Puttalam Line - Starting from Fort Station and headed in the Northern direction, touches the Western province boundary at Kochchikade station.

IV. Kelani Valley Line - Starting from Fort Station and goes direct to the East boundary of the Province, ends at Avissawella which is where it touches the Western province.

Figure 2.8.1 shows the layout of the railway lines in the Western Province.

(1) Railway Operation Setting – Frequency

Initial understanding of the railway schedule is obtained from the website of the Government Information Centre (http://www.gic.gov.lk/gic/?option=com_findnearest&task=train). Information provided in the web site is limited. Some of the operations in up and down directions do not exactly conform to the schedule. The initial time table has been updated to minimise the contradicting information.

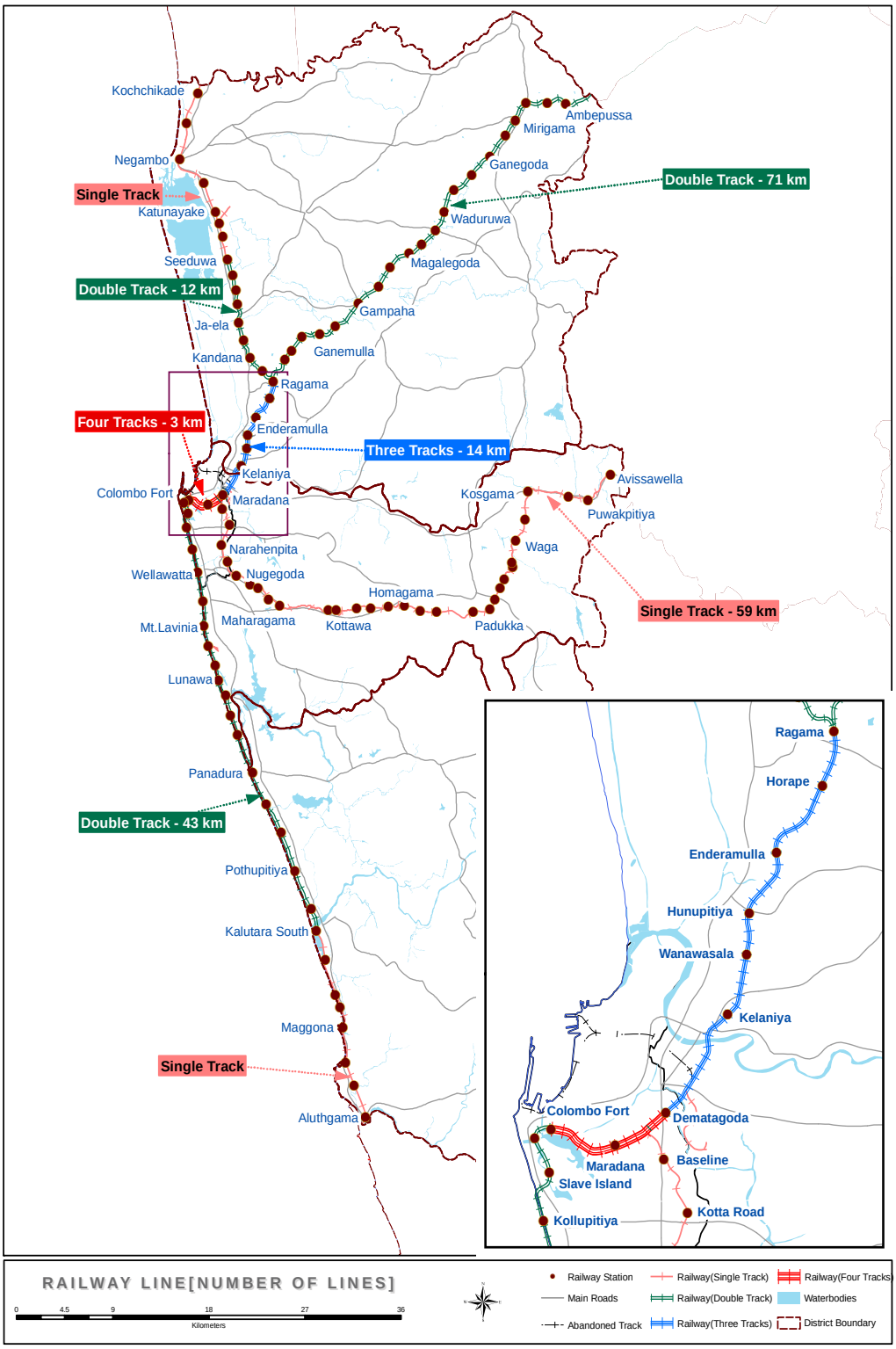
The railway time table indicates several types of railway operations classified as express, slow and short distance trains based on the service pattern and the number of station stops. Most of the express railways operations are inter provincial operations.

Two peaks and two off peaks have been considered in railway frequency settings. Table 2.8.1 shows the time durations considered for peaks and off peaks.

Table 2.8.1 Time of Peak and Off Peak

Hour Duration	Description
6 a.m. – 9 a.m.	Morning Peak
9 a.m. – 5 p.m.	Day Time (Off Peak)
5 p.m. - 8 p.m.	Evening Peak
8 p.m. - 6 a.m.	Night Time (Off Peak)

Source: CoMTrans Study Team



Source: Sri Lanka Railways, Illustrated by CoMTrans Study Team

Figure 2.8.1 Railway Lines in the Western Province

Railway operations along the four major railway lines differ from one to another, and train operations in night times and the starting time in the morning etc. are different. This has led to consider frequency calculations separately for each line. Table 2.8.2 shows the summary of railway frequency for the Western Province according to the operational time periods.

Table 2.8.2 Railway Average Operational Frequency (per direction, per hour) – 2013

Operational Line	Operation	Daily Peak (12 hours)	Mor Peak 6am-9am	Day Time 9am-5pm	Aft Peak 5pm-8pm	Night 8pm-6am
Kelani Valley Line	Slow to Avissawella	1	1	1	1	1
	Slow to Padukka	1	1	0	1	1
Puttalam Line	Slow to Chilaw	3	1	1	1	1
	Slow to Negambo	1	1	0	1	0
Coastal Line	Slow to Ambalangoda	1	1	1	1	0
	Slow to Panadura	2	0	3	1	1
	Express	1	0	2	0	0
Main Line	Slow to Ambepussa	2	2	1	2	1
	Slow to Veyangoda	1	1	0	1	0
	Express	1	1	0	1	0
	Inter Provincial	1	1	1	2	1

Source: Railway Time Table, CoMTrans Study Team

Note: Mor – Morning, Aft – Afternoon, hrs – hours

As shown in Table 2.8.2, some train lines show zero frequency in some operational segments. In public transport assignment, minimum frequency is assumed to be 1 train per hour although lower operational frequencies that take place in particular train operations are rounded off to zero in the calculation. The adjustment is undertaken to mitigate the issue with the JICA STRADA rejection of the whole operation when the frequency is entered as zero.

(2) Railway Operation Setting – Speed

Railway average speeds for each line are calculated separately with the consideration of average time for each operation. Relevant data was gathered from the railway time table and the distance was taken from the document published by the department of railways. Average speed of each operation is shown in Table 2.8.3.

Table 2.8.3 Average Speeds in each Railway Operation (km/hr)

Operational Line	Railway Operation	Distance* (km)	Average Time**	Time (hr)	Speed (km/hr)
Kelani Valley Line	Slow to Avissawella	60.81	02:15	2.25	27.03
	Slow to Padukka	36.24	01:35	1.58	22.89
Puttalam Line	Slow to Chilaw	46.3	01:35	1.58	29.24
	Slow to Negambo	39.2	01:25	1.42	27.67
Costal Line	Slow to Ambalangoda	60.24	02:00	2.00	30.12
	Slow to Panadura	26.21	00:50	0.83	31.45
	Express	60.24	01:20	1.33	45.18
Main line	Slow to Aluthgama	59.3	01:40	1.67	35.58
	Slow to Veyangoda	23.53	01:10	0.95	24.77
	Express	59.3	01:10	1.17	50.83
	Inter Provincial	59.3	00:57	0.95	62.42

Source: * - Department of Railway

** - Railway Time Table adjusted by the study team

(3) Train Operation Setting – Capacity

In the case of capacity setting, railway double track and single track operational lines are considered separately.

1. Double Track – Coastal Line, Main Line

2. Single Track – KV Line and Puttalam Line

Capacity setting is considered in two ways, the combination of seating and comfortable standing capacities are considered in the assignment as shown in Table 2.8.4. In peak hours, demand can be higher than these capacities which may lead to increase the load factor and hence create uncomfortable conditions. A discomfort factor is encountered when the modal share is calculated in the STARDA and details of the capacity setting are described in section 4.6.2.

Table 2.8.4 Capacity Settings for JICA STRADA – 2013

	Double Track Railway Operational Line (PPHPD)	Single Track Railway Operational Line (PPHPD)
Capacity	15,000	5,000

Note: PPHPD – passengers per hour per direction

(4) Railway Operation Setting -Fare Setting

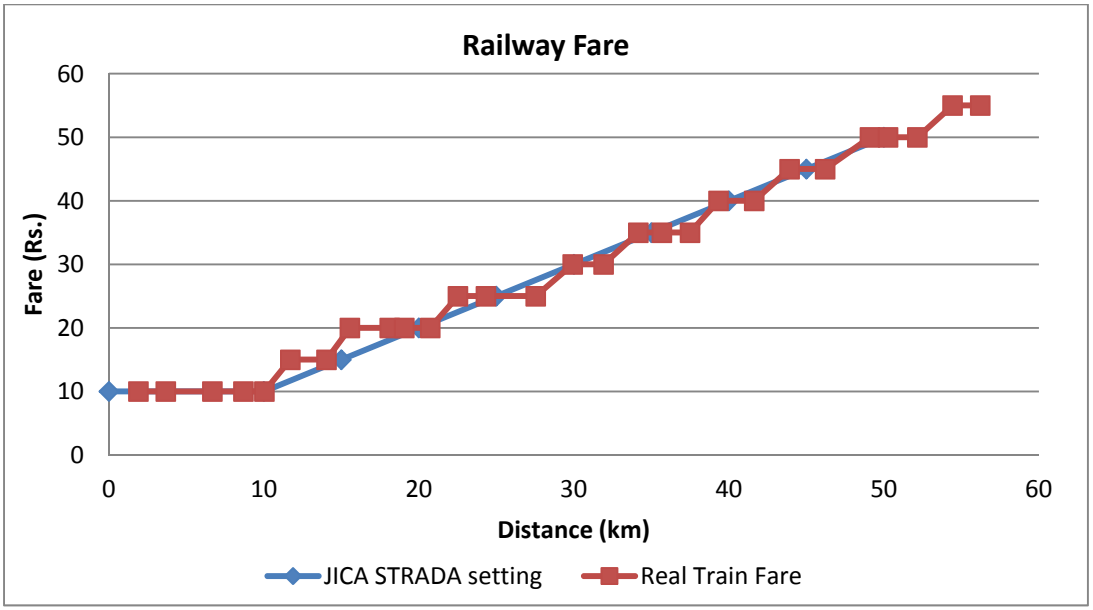
In fare setting, railway fare has been differentiated according to its defined operational classes. Latest revised fares (01/12/2008) for each class in the main line are shown in Table 2.8.5.

Table 2.8.5 Railway Fare for each Class

Distance	Fare – Class 1 (Rs.)	Fare – Class 2 (Rs.)	Fare - Class 3 (Rs.)
1.90	40	20	10
3.67	40	20	10
6.67	40	20	10
8.68	40	20	10
10.0	40	20	10
11.7	40	20	15
14.0	60	30	15
15.6	60	30	20
18.1	60	30	20
Distance	**Fare – Class 1 (Rs.)**	**Fare – Class 2 (Rs.)**	**Fare - Class 3 (Rs.)**
19.1	60	30	20
20.7	60	30	20
22.5	80	40	25
24.3	80	40	25
27.5	100	50	25
29.9	100	60	30
31.9	100	60	30
34.2	120	60	35
35.7	120	70	35
37.5	120	70	35
39.3	140	70	40
41.6	140	70	40

Source: Sri Lanka Railways

Railway fare setting for the first 10 kilometres is constant and then the fare is gradually increased with separately defined rates for each operational class. Most of the train trips inside the Western Province are short distance and the majority of the passengers use operational class 3. Figure 2.8.2shows the pattern of fare rate changeability of class 3 and a hypothetical line fix to JICA STRADA which considers fare per km rate as Rs. 1 per km.



Source: Sri Lanka Railways

Figure 2.8.2 Railway Fare vs. Distance for JICA STRADA Setting and Actual Operation

2.8.2 Bus Network

Four main references were used to build the bus network in Western Province as summarised in Table 2.8.6.

Table 2.8.6 Sources of Bus Information

Report / Source	Publisher	Purpose
Bus Fare for Each Bus Depot (Revised on 14/02/2012)	Western Province Road Passenger Transport Authority (WPRPTA)	Bus routes are traced on road network
Bus Time Table	Western Province Road Passenger Transport Authority (WPRPTA)	Frequency of bus operations
Intra-Provincial Bus Operations	National Transport Commission (NTC)	Bus route information
Bus Operating Kilometres for Each Depot in Western Province	Sri Lanka Transport Board (SLTB)	Frequency of bus operations in routes where data is not available in bus time table

Source: CoMTrans Study Team

Bus fare information consists of bus stops for each route section and sectional fare for each bus route in Western Province. Using this information, most of the bus routes are traced on existing maps (1:10,000 scale digital data, Department of Survey and Google Earth). Some of the bus routes in Western Province are shown in Figure 2.8.3**.** Total number of bus routes that were used for STRADA assignments are 780.

Table 2.8.7 shows the summary of bus routes.

(1) Bus Routes Setting - Frequency

Bus time table information by WPRPTA was used to calculate the frequency of each bus route. The missing information regarding the frequency is taken from the bus operation kilometre information. If the frequency is missing for any bus route, the lowest value 1 is taken for frequency.

(2) Bus Route Setting – Speed

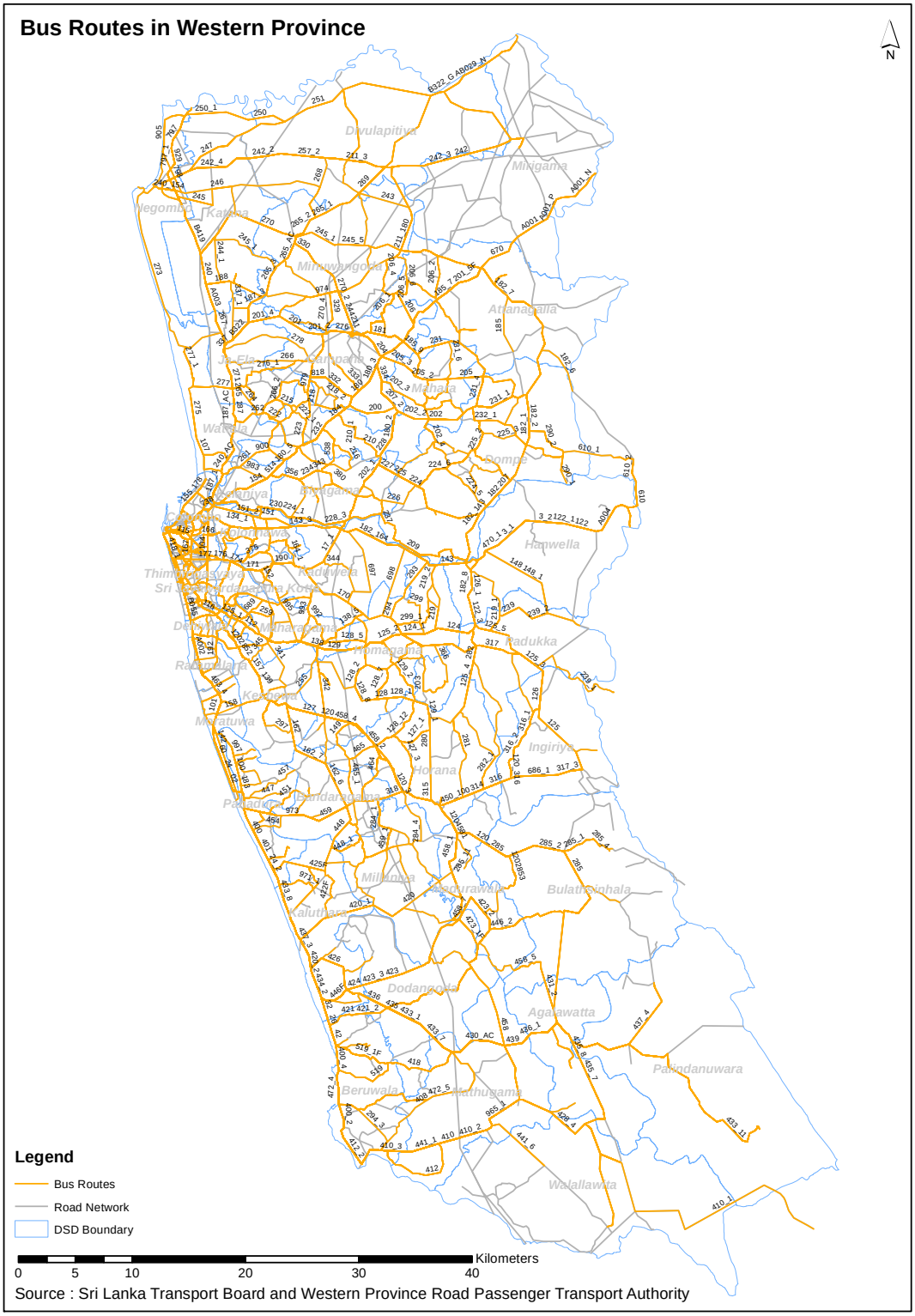
Details of the speed setting for JICA STRADA are described in section 4.6.2. For transit lines, maximum bus speed is assumed as 20 km/hr.

Table 2.8.7 Number of Bus Routes in each Depot

District	Number of Depots	File Name	Name of Depot	Number of Routes	Abbreviation for Depot
1.Colombo	11	AG RF Table	Angoda	14	AG
		HG RF Table	Homagama	48	HG
		KB RF Table	Kesbewa	29	KB
		MH RF Table	Maharagama	33	MH
		MK RF Table	Mattakuliya	8	MK
		MM RF Table	Methotamulla	11	MM
		MR RF Table	Moratuwa	13	MR
		RL RF Table	Ratmalana	12	RL
		TL RF Table	Thalangama	21	TL
		UM RF Table	Udahamulla	24	UM
		WP FT		**138**	WP
		Photocopy	Katubeddha	2	KT
Total number of routes in Colombo District (except WP FT)				215	DP
2.Gampaha	8	DP RF Table	Dilvulapitiya	13	GM
		GM RF Table	Gampaha	52	GM
		JL RF Table	Ja-Ela	15	JL
		Kadawatha FT	Kadawatha	32	**KD**
		KE RF Table	Kelaniya	3	KE
		Kirindiwela FT	Kirindiwela	30	**KW**
		Negombo FT	Negombo	18	NG
		WS RF Table	Welisara	16	WS
		NT RF Table	Nittambuwa	65	NT
Total number of routes in Gampaha District				244	
3 Kalutara	5	AL RF Table	Aluthgama	32	AL
		HR FT Table	Horana	61	HR
		KLT RF Table	Kalutara	38	**KT**
		MG FT	Mathugama	49	MG
		PN RF Table	Panadura	39	PN
Total number of routes in Kalutara District				219	
Total number of routes in Western Province				678	

Source: Western Province Road Passenger Transport Authority

Note: For the total number of route, Western Province Fare Table (WP FT) is not considered.



Source: CoMTrans Study Team

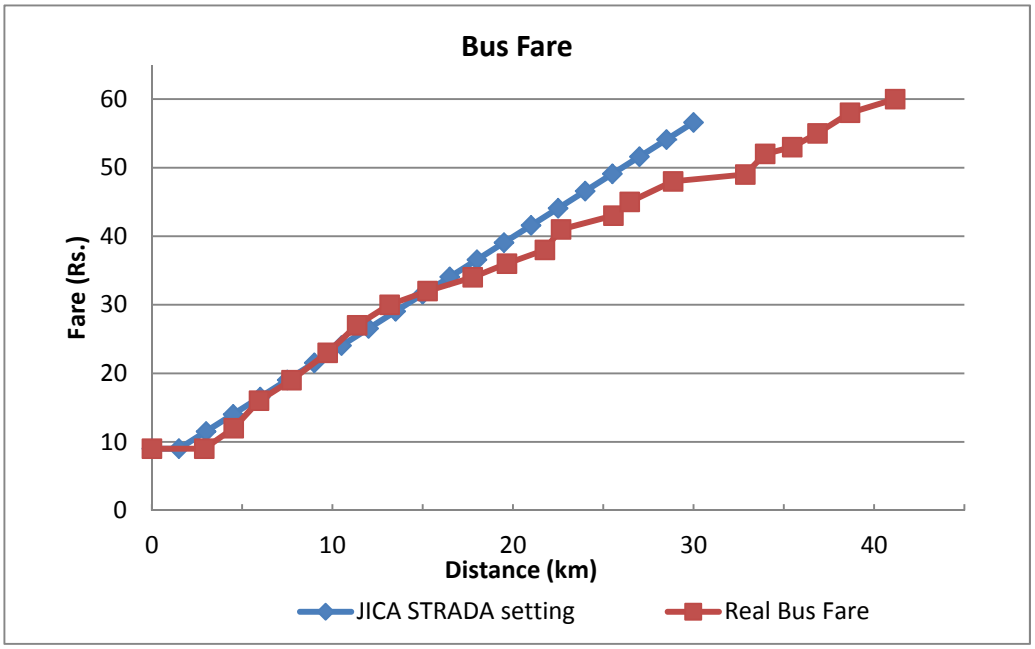
Figure 2.8.3 Bus Routes in Western Province

(3) Bus Routes Setting - Capacity

In bus operations, normal route buses and air conditioned buses for particular routes were considered. The screen line survey shows that larger buses are used as route buses and small buses are used as A/C buses. The capacity value used for both types of buses is 10,000 PPHDP, by considering average seating and comfortable standing capacity of a bus. When higher demand occurs, especially in peak hours, this capacity can be exceeded by increasing the load factor. This implied discomfort level is modal share calculation in the software.

(4) Bus Operation Setting -Fare Setting

In bus fare setting, Rs. 9 is charged for the initial 1.5km for normal buses and then the fare increases in 1 to 1.5 km sections. For the STRADA setting, the sectional length is 1.5km for fare increment and the fare is 1.67 per km. However, current fares for long distance trips on buses is less than this amount. According to the Home Visit Survey of the study, average length of a bus passenger trip is 9 km. Figure 2.8.4 shows the pattern of fare rate changeability of operational buses and the JICA STRAD.



Source: Western Province Road Passenger Transport Authority

Figure 2.8.4 Bus Fare vs. Distance for JICA STRADA Setting and Actual Operation

CHAPTER 3 Model Development

3.1 Trip Generation Model

3.1.1 Trip Generation

Trip generation rate is an important indicator to understand travel behaviour and it is also used for measuring future trip generation. Trip rate, defined as the average number of trips per resident per weekday, is characterised by two indicators: gross trip rate and net trip rate. Gross trip rate is calculated by dividing the total number of trips per weekday by the number of residents aged 5 years or older whereas net trip rate is calculated by dividing the total number of trips per weekday by the number of residents aged 5 years or older who made a trip.

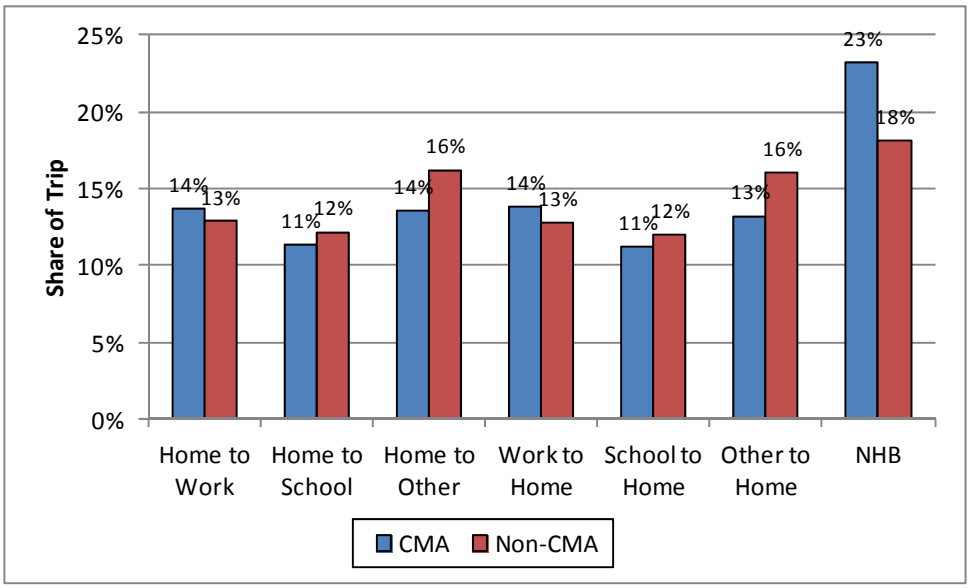
Trip rate by region obtained from the CoMTrans Home Visit Survey 2013 is presented in the table below which shows that the out-going ratio is relatively low in Western Province where only 64.5% is estimated to make a trip. There is only a small difference between the out-going ratio of CMA and that of Non-CMA; however, their trip rates are considerably different.

To show further differences of trip generation characteristics of residents in CMA and Non-CMA across income groups, Figure 3.1.1, Figure 3.1.2, and Figure 3.1.3are given.

Table 3.1.1 Out-going Ratio and Trip Rate by Region

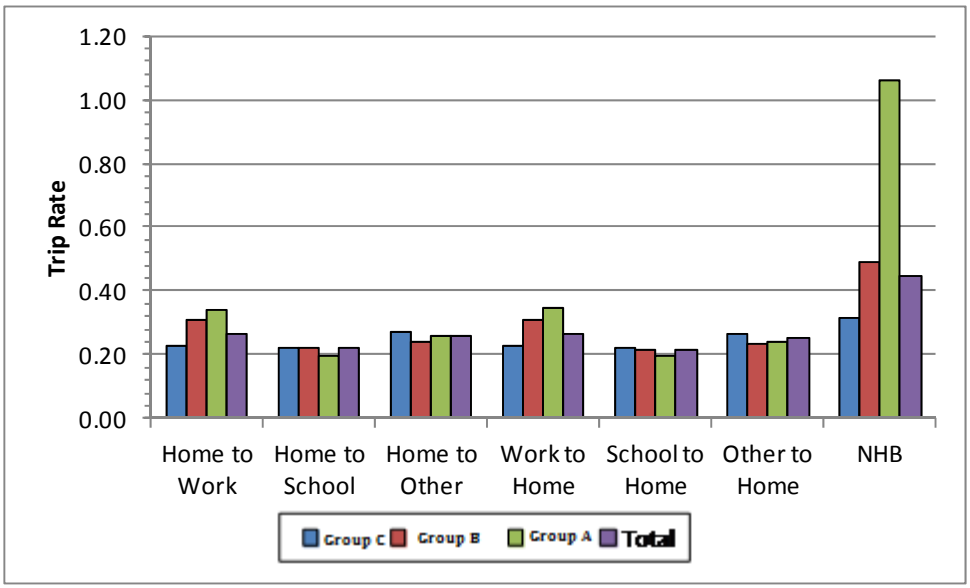
Region	Out-going Ratio	Gross Trip Rate	Net Trip Rate
CMA	65.2%	1.92	2.95
Non-CMA	63.3%	1.77	2.80
Western Province	64.5%	1.87	2.90

Source: CoMTrans Home Visit Survey, 2013



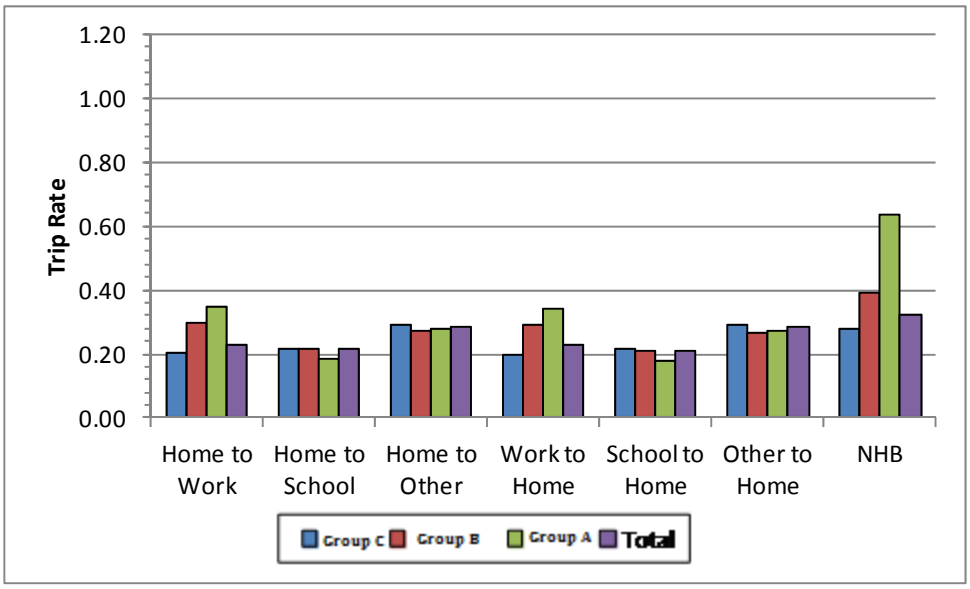
Source: CoMTrans Home Visit Survey, 2013

Figure 3.1.1 Trip Purpose Composition in CMA and Non-CMA



Source: CoMTrans Home Visit Survey, 2013

Figure 3.1.2 Trip Rate by Purpose by Income in CMA



Source: CoMTrans Home Visit Survey, 2013

Figure 3.1.3 Trip Rate by Purpose by Income in Non-CMA

3.1.2 Trip Production and Attraction Models

Trip generation is the first step in travel demand forecasting. Essential components of the trip generation include trip production and trip attraction in which zonal attributes such as population, land use and other economic forecast information are utilised to calculate how many person trips are produced from and attracted to each zone (i.e. TAZ).

Level of income strongly influences the trip generation, and the extent of influence differs by purposes of travel. In this respect, trip production and attraction models by income and purpose were developed separately for CMA and Non-CMA using multiple regression analysis to estimate the models' parameters. Three income groups were classified, namely:

- Group C: monthly household income less than Rs. 40,000
- Group B: monthly household income Rs. 40,000 – 79,999
- Group A: monthly household income Rs. 80,000 and more

Trip purposes were categorised in to seven distinct purposes, namely:

- Home to work;
- Home to school;
- Home to other;
- Work to home;

- School to home;
- Other to home;
- Non-home-based.

Moreover, the zonal attributes used as independent variables for the trip production and attraction model includes:

- Night time population by income;
- Employed population at the residential place by income;
- Student population at the residential place by income;
- Number of employees at work place by income by industrial sector;
- Number of students at school place by income level.

Table 3.1.2 Trip Production and Attraction Models by Income and Purpose for CMA

Model	Corr. Coef.	Adjusted R2	Std. Error	Intercept	Indep. Variable 1			Indep. Variable 2			Indep. Variable 3		
					Variable	Coef.	t-value	Variable	Coef.	t-value	Variable	Coef.	t-value
P_L_HTW	0.986	0.972	207.780	12.280	L_Emp_Res	0.802	103.804	-	-	-	-	-	-
P_L_WTH	0.993	0.986	275.614	-204.393	L_Emp_Wrk	0.904	148.240	-	-	-	-	-	-
P_L_HTS	0.996	0.992	113.597	-21.488	L_Std_Res	0.933	198.907	-	-	-	-	-	-
P_L_STH	0.996	0.992	155.757	37.223	L_Std_Sch	0.882	191.917	-	-	-	-	-	-
P_L_HTO	0.875	0.765	835.743	-50.635	L_Pop	0.276	31.556	-	-	-	-	-	-
P_L_OTH	0.760	0.575	1512.975	118.251	L_Emp_Wrk	0.420	11.538	L_Std_Sch	0.528	10.870	-	-	-
P_L_NHB	0.802	0.641	1591.146	148.413	L_Emp_Wrk	0.337	8.789	L_Std_Sch	0.838	16.407	-	-	-
A_L_HTW	0.995	0.990	238.627	-142.408	L_Emp_Wrk_Sec	0.826	47.789	L_Emp_Wrk_Ter	0.975	134.208	-	-	-
A_L_WTH	0.988	0.977	192.673	-1.968	L_Emp_Res_Sec	0.754	24.071	L_Emp_Res_Ter	0.916	51.980	-	-	-
A_L_HTS	0.997	0.994	139.715	30.249	L_Std_Sch	0.898	217.758	-	-	-	-	-	-
A_L_STH	0.995	0.991	123.852	-30.675	L_Std_Res	0.928	181.504	-	-	-	-	-	-
A_L_HTO	0.767	0.585	1500.585	117.227	L_Emp_Wrk	0.435	12.028	L_Std_Sch	0.521	10.815	-	-	-
A_L_OTH	0.871	0.758	839.132	-45.574	L_Pop	0.271	30.938	-	-	-	-	-	-
A_L_NHB	0.799	0.636	1635.301	218.733	L_Std_Sch	0.751	14.609	L_Emp_Wrk_Ter	0.576	11.736	-	-	-
P_M_HTW	0.983	0.967	136.668	-24.771	M_Emp_Res	0.831	94.618	-	-	-	-	-	-
P_M_WTH	0.997	0.993	151.490	-118.062	M_Emp_Wrk	0.921	215.137	-	-	-	-	-	-
P_M_HTS	0.991	0.982	74.793	-1.436	M_Std_Res	0.903	127.303	-	-	-	-	-	-
P_M_STH	0.996	0.992	105.018	8.965	M_Std_Sch	0.871	194.735	-	-	-	-	-	-
P_M_HTO	0.852	0.726	351.276	-14.716	M_Pop	0.247	28.430	-	-	-	-	-	-
P_M_OTH	0.740	0.543	670.319	31.682	M_Pop	0.068	4.103	M_Emp_Wrk	0.194	9.425	M_Std_Sch	0.34	10.97
P_M_NHB	0.863	0.993	151.490	-118.062	M_Emp_Wrk	0.921	215.137	-	-	-	-	-	-
A_M_HTW	0.996	0.993	156.442	-98.731	M_Emp_Wrk_Sec	0.847	35.508	M_Emp_Wrk_Ter	0.968	169.027	-	-	-
A_M_WTH	0.985	0.970	131.178	-10.232	M_Emp_Res	0.831	98.605	-	-	-	-	-	-
A_M_HTS	0.997	0.993	98.795	8.944	M_Std_Sch	0.885	210.114	-	-	-	-	-	-
A_M_STH	0.989	0.979	78.982	-2.514	M_Std_Res	0.893	119.098	-	-	-	-	-	-
A_M_HTO	0.751	0.559	660.660	216.544	M_Std_Sch	0.357	11.707	M_Emp_Wrk_Sec	0.369	3.645	M_Emp_Wrk_Ter	0.190	7.473
A_M_OTH	0.843	0.710	358.945	-30.893	M_Pop	0.243	27.353	-	-	-	-	-	-
A_M_NHB	0.842	0.707	1460.172	-105.591	M_Emp_Wrk	0.664	14.851	M_Std_Sch	1.033	15.337	-	-	-
P_H_HTW	0.973	0.947	100.294	-11.360	H_Emp_Res	0.788	73.859	-	-	-	-	-	-
P_H_WTH	0.994	0.988	111.051	-35.907	H_Emp_Wrk	0.859	158.013	-	-	-	-	-	-
P_H_HTS	0.981	0.963	57.452	-3.300	H_Std_Res	0.896	88.918	-	-	-	-	-	-
P_H_STH	0.997	0.993	56.800	2.815	H_Std_Sch	0.867	213.851	-	-	-	-	-	-
P_H_HTO	0.778	0.605	248.822	11.252	H_Pop	0.249	21.622	-	-	-	-	-	-
P_H_OTH	0.809	0.653	305.966	99.947	H_Emp_Wrk	0.198	11.832	H_Std_Sch	0.328	13.476	-	-	-
P_H_NHB	0.925	0.854	1325.207	-222.248	H_Emp_Wrk	1.550	21.420	H_Std_Sch	2.456	23.290	-	-	-
A_H_HTW	0.993	0.986	116.314	-25.528	H_Emp_Wrk_Sec	0.818	18.185	H_Emp_Wrk_Ter	0.896	116.211	-	-	-
A_H_WTH	0.977	0.954	96.058	-10.067	H_Emp_Res	0.808	79.091	-	-	-	-	-	-
A_H_HTS	0.996	0.993	59.914	1.833	H_Std_Sch	0.877	205.056	-	-	-	-	-	-
A_H_STH	0.981	0.962	57.064	-2.301	H_Std_Res	0.885	88.463	-	-	-	-	-	-
A_H_HTO	0.850	0.720	289.887	89.988	H_Std_Sch	0.388	16.596	H_Emp_Wrk_Sec	0.451	3.907	H_Emp_Wrk_Ter	0.181	9.072
A_H_OTH	0.783	0.612	235.402	3.564	H_Pop	0.240	21.954	-	-	-	-	-	-
A_H_NHB	0.931	0.866	1236.722	-196.247	H_Std_Sch	1.974	19.797	H_Emp_Wrk_Sec	1.633	3.315	H_Emp_Wrk_Ter	1.944	22.896

Note:

P	:Production	Pop	:Population
A	:Attraction	Emp	:Employed Population
L	:Low income	Std	:Student Population
M	:Middle income	Res	:Residential Place
H	:High income	Wrk	:Work Place
HTW	:Home to Work	Sch	:School Place
WTH	:Work to Home	Pri	:Primary Industry
HTS	:Home to School	Sec	:Secondary Industry
STH	:School to Home	Ter	:Tertiary Industry
HTO	:Home to Other		
OTH	:Other to Home		
NHB	:Non Home based		

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Table 3.1.3 Trip Production and Attraction Models by Income and Purpose for Non-CMA

Model	Corr. Coef.	Adjusted R2	Std. Error	Intercept	Indep. Variable 1			Indep. Variable 2			Indep. Variable 3		
					Variable	Coef.	t-value	Variable	Coef.	t-value	Variable	Coef.	t-value
G_L_HTW	0.972	0.945	322.470	31.810	L_Emp_Res	0.727	51.63	-	-	-	-	-	-
G_L_WTH	0.977	0.954	386.588	-231.928	L_Emp_Wrk	0.835	56.54	-	-	-	-	-	-
G_L_HTS	0.993	0.986	175.438	8.009	L_Std_Res	0.896	106.13	-	-	-	-	-	-
G_L_STH	0.996	0.993	160.514	50.693	L_Std_Sch	0.871	145.66	-	-	-	-	-	-
G_L_HTO	0.863	0.743	1,068.543	150.651	L_Pop	0.275	21.18	-	-	-	-	-	-
G_L_OTH	0.833	0.690	1,330.140	231.453	L_Emp_Wrk	0.356	6.05	L_Std_Sch	0.698	12.17	-	-	-
G_L_NHB	0.811	0.653	1,467.825	-5.763	L_Emp_Wrk	0.399	6.15	L_Std_Sch	0.679	10.72	-	-	-
A_L_HTW	0.968	0.936	459.440	-125.450	L_Emp_Wrk_Sec	0.837	22.42	L_Emp_Wrk_Ter	0.985	20.57	-	-	-
A_L_WTH	0.963	0.926	373.071	89.643	L_Emp_Res_Sec	0.734	12.98	L_Emp_Res_Ter	0.841	17.50	-	-	-
A_L_HTS	0.998	0.995	135.193	21.856	L_Std_Sch	0.900	178.60	-	-	-	-	-	-
A_L_STH	0.992	0.984	184.026	8.573	L_Std_Res	0.879	99.22	-	-	-	-	-	-
A_L_HTO	0.833	0.690	1,323.012	245.767	L_Emp_Wrk	0.370	6.33	L_Std_Sch	0.682	11.95	-	-	-
A_L_OTH	0.865	0.746	1,058.948	136.404	L_Pop	0.275	21.36	-	-	-	-	-	-
A_L_NHB	0.830	0.685	1,399.302	-84.239	L_Std_Sch	0.317	4.17	L_Emp_Wrk_Ter	1.586	9.25	-	-	-
G_M_HTW	0.982	0.964	119.159	17.791	M_Emp_Res	0.770	64.68	-	-	-	-	-	-
G_M_WTH	0.989	0.979	127.317	-71.772	M_Emp_Wrk	0.860	84.20	-	-	-	-	-	-
G_M_HTS	0.992	0.984	73.001	-5.728	M_Std_Res	0.899	97.15	-	-	-	-	-	-
G_M_STH	0.995	0.989	77.766	11.205	M_Std_Sch	0.872	119.44	-	-	-	-	-	-
G_M_HTO	0.853	0.726	393.568	-22.710	M_Pop	0.282	20.28	-	-	-	-	-	-
G_M_OTH	0.830	0.683	439.412	54.216	M_Pop	0.030	1.71	M_Emp_Wrk	0.319	7.68	M_Std_Sch	0.454	9.126
G_M_NHB	0.718	0.979	127.317	-71.772	M_Emp_Wrk	0.860	84.20	-	-	-	-	-	-
A_M_HTW	0.982	0.963	169.831	-61.746	M_Emp_Wrk_Sec	0.898	20.28	M_Emp_Wrk_Ter	0.922	28.29	-	-	-
A_M_WTH	0.983	0.967	114.994	14.322	M_Emp_Res	0.769	66.97	-	-	-	-	-	-
A_M_HTS	0.996	0.992	67.505	5.770	M_Std_Sch	0.897	141.47	-	-	-	-	-	-
A_M_STH	0.990	0.981	78.388	-6.666	M_Std_Res	0.885	89.08	-	-	-	-	-	-
A_M_HTO	0.835	0.693	437.132	107.781	M_Std_Sch	0.368	6.99	M_Emp_Wrk_Ter	0.697	9.21	-	-	-
A_M_OTH	0.841	0.705	398.296	-6.658	M_Pop	0.271	19.27	-	-	-	-	-	-
A_M_NHB	0.773	0.592	947.193	16.655	M_Std_Sch	0.680	5.96	M_Emp_Wrk_Ter	1.157	7.05	-	-	-
G_H_HTW	0.966	0.933	72.397	-8.542	H_Emp_Res	0.827	46.41	-	-	-	-	-	-
G_H_WTH	0.979	0.957	61.997	-3.854	H_Emp_Wrk	0.783	59.00	-	-	-	-	-	-
G_H_HTS	0.974	0.948	36.860	-2.701	H_Std_Res	0.878	53.10	-	-	-	-	-	-
G_H_STH	0.970	0.940	45.784	5.241	H_Std_Sch	0.792	49.11	-	-	-	-	-	-
G_H_HTO	0.779	0.604	151.242	3.935	H_Pop	0.271	15.41	-	-	-	-	-	-
G_H_OTH	0.742	0.545	192.217	31.482	H_Emp_Wrk	0.203	4.53	H_Std_Sch	0.741	10.04	-	-	-
G_H_NHB	0.722	0.516	482.646	-6.278	H_Emp_Wrk	0.602	5.35	H_Std_Sch	1.606	8.66	-	-	-
A_H_HTW	0.977	0.953	65.039	-3.762	H_Emp_Wrk_Sec	0.793	15.98	H_Emp_Wrk_Ter	0.818	39.51	-	-	-
A_H_WTH	0.963	0.927	74.787	-6.908	H_Emp_Res	0.814	44.23	-	-	-	-	-	-
A_H_HTS	0.984	0.968	34.596	3.896	H_Std_Sch	0.834	68.42	-	-	-	-	-	-
A_H_STH	0.961	0.923	44.711	-3.251	H_Std_Res	0.863	43.00	-	-	-	-	-	-
A_H_HTO	0.734	0.532	188.431	38.310	H_Emp_Wrk	0.193	4.40	H_Std_Sch	0.710	9.81	-	-	-
A_H_OTH	0.763	0.580	154.920	4.416	H_Pop	0.264	14.66	-	-	-	-	-	-
A_H_NHB	0.688	0.466	479.596	14.014	H_Std_Sch	1.193	6.47	H_Emp_Wrk_Ter	0.925	6.35	-	-	-

Note:

P	:Production	Pop	:Population
A	:Attraction	Emp	:Employed Population
L	:Low income	Std	:Student Population
M	:Middle income	Res	:Residential Place
H	:High income	Wrk	:Work Place
HTW	:Home to Work	Sch	:School Place
WTH	:Work to Home	Pri	:Primary Industry
HTS	:Home to School	Sec	:Secondary Industry
STH	:School to Home	Ter	:Tertiary Industry
HTO	:Home to Other		
OTH	:Other to Home		
NHB	:Non Home based		

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3.2 Trip Distribution Model

3.2.1 Modelling Approach

Trip distribution is the process by which the planner determines where the produced trips will be attracted. As a result, a trip table of the estimated number of trips from each TAZ to every other TAZ within the study area is produced.

There are several methods for distributing trips ranging from the growth factors method to the wide use of interactive travel models. In this study, the Fratar method, the most widely used of the growth factor techniques, and a Gravity model, the method derived from Newton's law of gravity, are simultaneously used to forecast the future trips between any pair of zones.

In principal, the Gravity model was applied to account for zones where limitations to the Fratar method exist due to its total reliance on the existing trip patterns. In particular, the zones which are now vacant but are expected to be developed, as well as the zones in which future land uses will be materially different from the existing land uses.

3.2.2 Fratar Method

Fratar method is based on the assumption that the change in the number of trips between an OD pair is directly proportional to the change in trips in the origin and destination zones contributing to that OD pair. This technique can be represented mathematically as follows:

$$T_{ij(k+1)} = (T_{ijk} . F_{jk}) F_{ik}$$

Where:

$$F_{jk} = A_j / \sum_{i=l}^{n} T_{ijk}$$

$$F_{ik} = P_i / \sum_{j=l}^{n} (T_{ijk} F_{jk})$$

Where:

T_{ijk}	trips between *i* and *j* at iteration *k*
F_{jk}	destination factor *j*
F_{ik}	origin factor *i*
P_i	trip production of zone *i*
A_j	trip attraction of zone *j*

3.2.3 Gravity Model

(1) Model Form

The Gravity Model assumes that the number of trips between two zones is 1) directly proportional to the trips produced by and attracted to both zones; and 2) inversely proportional to the impedance for traveling between the two zones. Formulation of the Gravity model is as follows:

$$Tij = K \cdot \frac{P_i^{\alpha} A_j^{\beta}}{d_{ij}^{\gamma}}$$

Where:

Tij	: Trip distribution from zone i to zone j
Pi	: Trip production of zone i
Aj	: Trip attraction of zone j
dij	: Impedance between zone i and zone j
α, β, γ	: Model parameters

(2) Attempts to Model the Trip Distribution using Gravity Model

Various attempts were made to model the trip distribution in the Western Province using the Gravity model, but there were no promising results.

In our earlier attempt, the models were developed separately for CMA and Non-CMA, by income and purpose at the level of TAZs (462 zones). The models yielded very low correlation coefficients indicating inability to replicate the trip distribution patterns of the study area. It is understood that when the zone size is small, negative impact on the model may exist because the number of samples is also small and this makes it insufficient for modelling. Taking the zone size into consideration, the following attempt was made to model trip distribution at a larger zone level where adjacent TAZs were grouped, resulting in 119 medium zones. Some improvements are observed for the Non-CMA models, but there is no improvement for the CMA models. A summary of the distribution models is shown in the table below.

Table 3.2.1 Summary of Failures of Gravity Models

Zoning Level	Models	Parameters of Distribution Models for CMA					Parameters of Distribution Models for Non-CMA				
		K	α	β	γ	Corr. Coef.	K	α	β	γ	Corr. Coef.
TAZ Level (462 Zones)	L_HBW	10.121	0.158	0.164	-0.352	0.453	4.596	0.243	0.244	-0.333	0.459
	L_HBS	0.740	0.358	0.351	-0.441	0.495	1.225	0.357	0.362	-0.391	0.483
	L_HBO	4.741	0.248	0.241	-0.497	0.509	3.153	0.304	0.286	-0.441	0.474
	L_NHB	6.295	0.286	0.251	-0.255	0.378	0.814	0.474	0.376	-0.043	0.613
	M_HBW	30.282	0.085	0.085	-0.227	0.332	10.976	0.176	0.181	-0.189	0.407
	M_HBS	4.248	0.239	0.236	-0.259	0.443	11.734	0.184	0.185	-0.199	0.352
	M_HBO	16.200	0.158	0.152	-0.285	0.384	13.193	0.181	0.195	-0.234	0.437
	M_NHB	3.524	0.305	0.296	0.033	0.475	1.480	0.363	0.422	0.146	0.581
	H_HBW	62.813	0.045	0.045	-0.185	0.252	19.157	0.129	0.151	-0.062	0.395
	H_HBS	9.426	0.200	0.185	-0.146	0.430	12.887	0.180	0.160	0.033	0.463
	H_HBO	18.070	0.177	0.147	-0.193	0.398	6.149	0.255	0.219	0.042	0.570
	H_NHB	36.175	0.121	0.206	-0.052	0.273	0.767	0.694	0.282	0.078	0.941
Medium Zone Level (119 Zones)	L_HBW	0.026	0.440	0.444	-0.768	0.574	0.422	0.357	0.366	-1.428	0.716
	L_HBS	0.001	0.597	0.610	-0.994	0.604	17.003	0.145	0.179	-1.615	0.679
	L_HBO	0.006	0.501	0.513	-1.049	0.599	13.869	0.173	0.174	-1.633	0.690
	L_NHB	26.761	0.162	0.134	-0.350	0.429	5.944	0.296	0.221	-0.518	0.433
	M_HBW	0.094	0.394	0.395	-0.442	0.508	14.432	0.157	0.161	-1.027	0.629
	M_HBS	0.041	0.449	0.449	-0.634	0.536	17.447	0.120	0.180	-1.074	0.581
	M_HBO	0.772	0.298	0.258	-0.572	0.449	13.777	0.171	0.155	-0.999	0.609
	M_NHB	18.704	0.184	0.203	-0.102	0.451	2.321	0.260	0.424	-0.237	0.590
	H_HBW	1.981	0.243	0.240	-0.218	0.438	8.822	0.201	0.188	-0.350	0.511
	H_HBS	1.066	0.289	0.298	-0.157	0.460	10.540	0.195	0.187	-0.244	0.379
	H_HBO	5.483	0.182	0.197	-0.307	0.400	5.310	0.259	0.233	-0.476	0.647
	H_NHB	22.915	0.194	0.196	-0.187	0.593	2.421	0.504	0.038	-0.096	0.421

Note: HBW : Home-based Work
HBS : Home-based School
HBO : Home-based Other
NHB : Non-Home-Based

L- Group C: monthly income less than Rs. 40,000
M-Group B: monthly income Rs. 40,000 – 79,999
H- Group A : monthly income Rs. 80,000 and more

Source: CoMTrans Estimates

(3) Trip Distribution Model for Selected TAZs

As it was difficult to obtain the equations that explain the trip distribution patterns of large areas with complex trip-making characteristics such as CMA and Non-CMA, only a number of TAZs where the forecast of socio-economic and population frameworks expect considerable growth were selected for modelling. In this case, only trips attracted to these selected TAZs are considered. The selected TAZs are shown in the figure below.

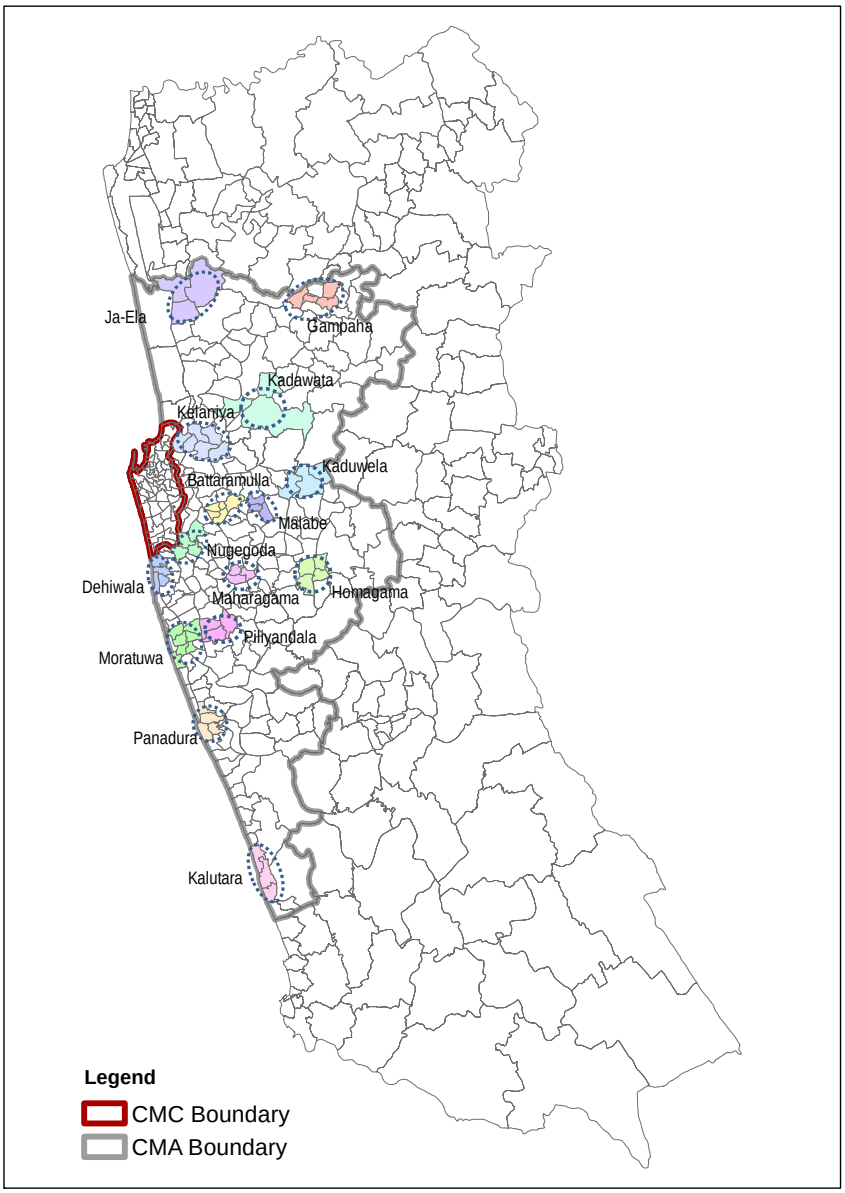


Figure 3.2.1 Selected TAZs for Gravity Model Application

With this technique, the number of relevant OD pairs was considerably small, and it was possible to check for outliers (i.e. the unexpected number of trips caused particularly by zone coding error or by too small sample size) when developing the model. Even though removing outliers would reduce the number of observations, this procedure yielded significant improvement in the performance of the models. A summary of model parameters is given in the table below.

Table 3.2.2 Parameters of Gravity Model for Selected TAZs

Model	Corr. Coef.	Adj. R2	Std. Error	K	α	*t-value*	β	*t-value*	γ	*t-value*
L_HBW	0.874	0.764	0.357	0.060	0.491	89.806	0.520	67.245	0.305	48.253
M_HBW	0.881	0.775	0.316	0.122	0.451	93.882	0.441	59.823	0.215	35.276
H_HBW	0.852	0.726	0.321	0.120	0.441	70.621	0.421	53.256	0.124	17.328
L_HBS	0.911	0.830	0.382	0.044	0.563	106.459	0.535	60.885	0.430	59.189
M_HBS	0.890	0.792	0.376	0.067	0.530	82.290	0.491	63.782	0.299	38.591
H_HBS	0.861	0.741	0.378	0.062	0.500	52.961	0.505	53.636	0.197	19.541
L_HBO	0.914	0.835	0.372	0.029	0.557	108.800	0.593	71.180	0.457	66.852
M_HBO	0.896	0.802	0.373	0.060	0.533	82.644	0.515	62.496	0.344	44.739
H_HBO	0.863	0.744	0.386	0.079	0.518	58.912	0.462	49.766	0.225	24.114
L_NHB	0.892	0.795	0.390	0.020	0.600	73.600	0.570	59.259	0.247	26.541
M_NHB	0.891	0.794	0.440	0.005	0.712	51.899	0.649	58.129	0.221	15.807
H_NHB	0.803	0.643	0.504	0.006	0.620	23.614	0.671	35.674	0.073	3.671

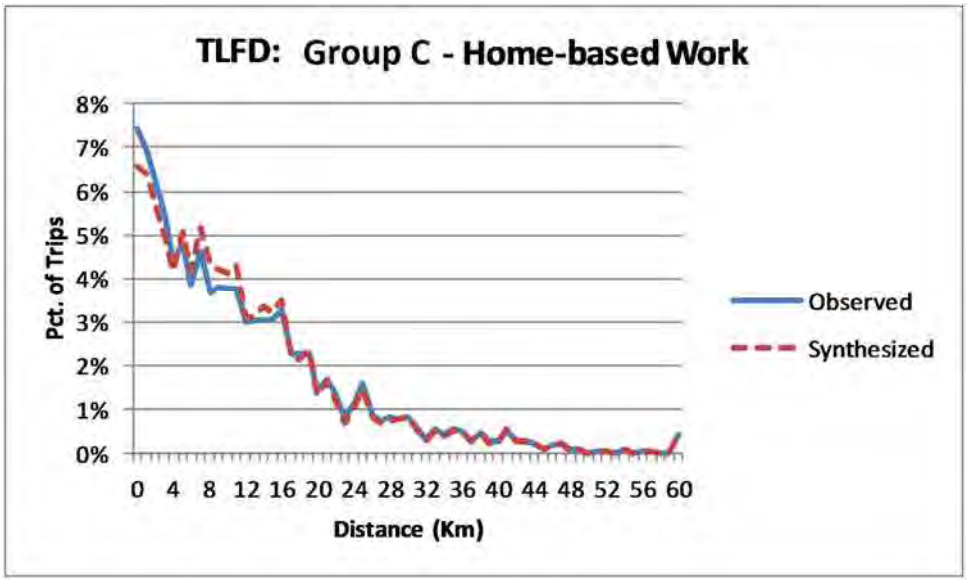
Note: HBW : Home-based Work
HBS : Home-based School
HBO : Home-based Other
NHB : Non-Home-Based

L- Group C: monthly income less than Rs. 40,000
M-Group B: monthly income Rs. 40,000 – 79,999
H- Group A : monthly income Rs. 80,000 and more

Source: CoMTrans Estimates

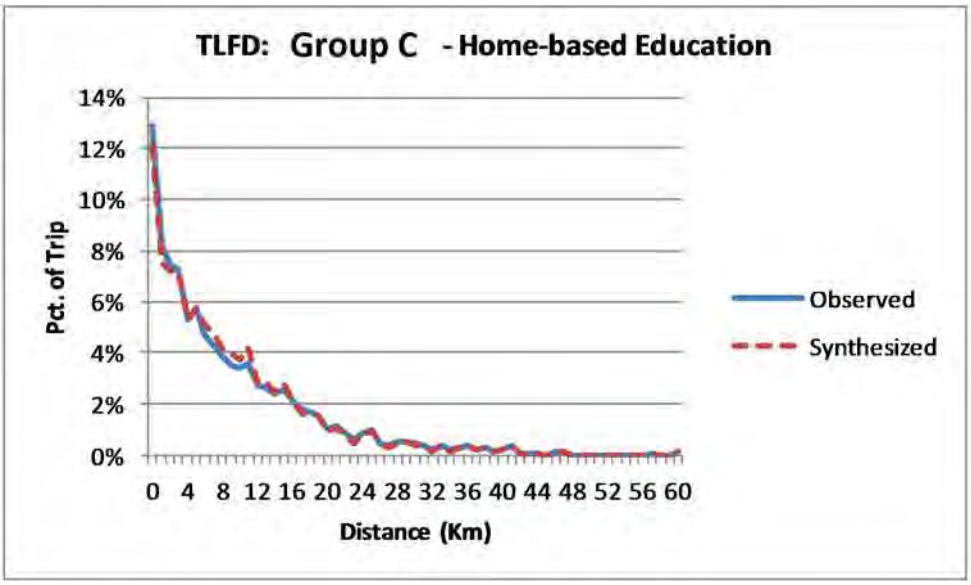
(4) Model Assessment

To assess the model's ability to reproduce the existing distribution characteristics, comparisons of observed and synthesised trip length frequency distributions (TLFD) were made. The figures below confirm that the curves of TLFD are very close.



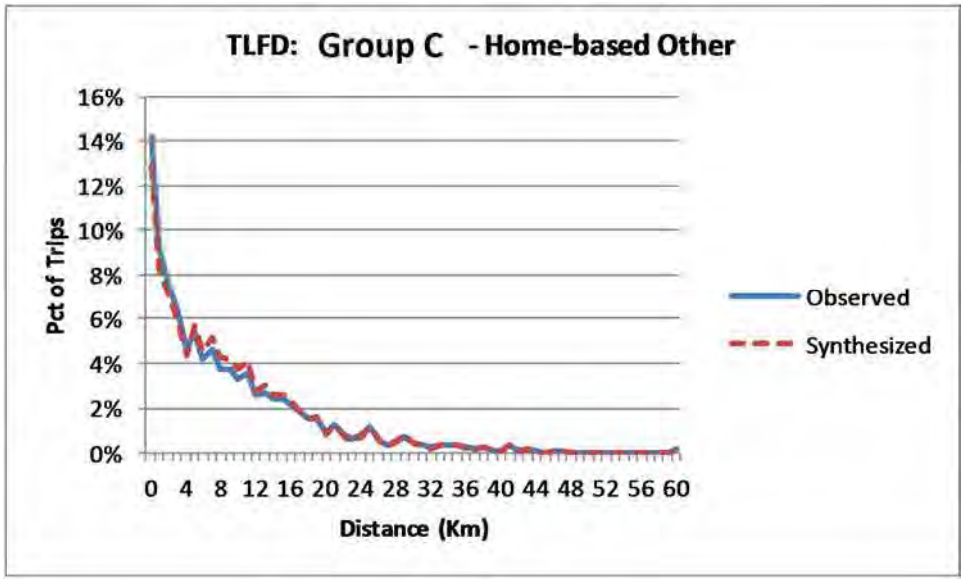
Source: CoMTrans Study Team

Figure 3.2.2 Trip Length Frequency Distribution: Group C – Home-based Work



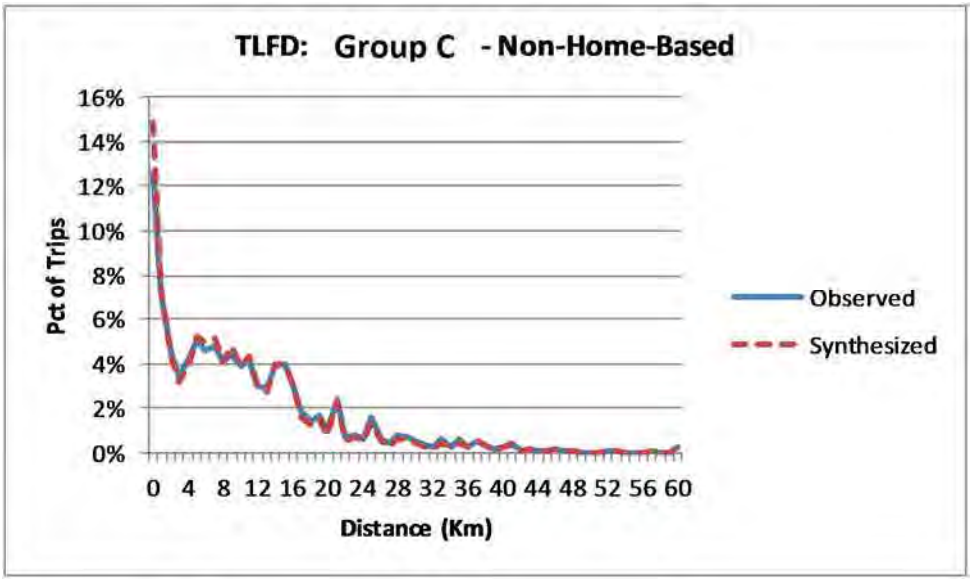
Source: CoMTrans Study Team

Figure 3.2.3 Trip Length Frequency Distribution: Group C – Home-based Education



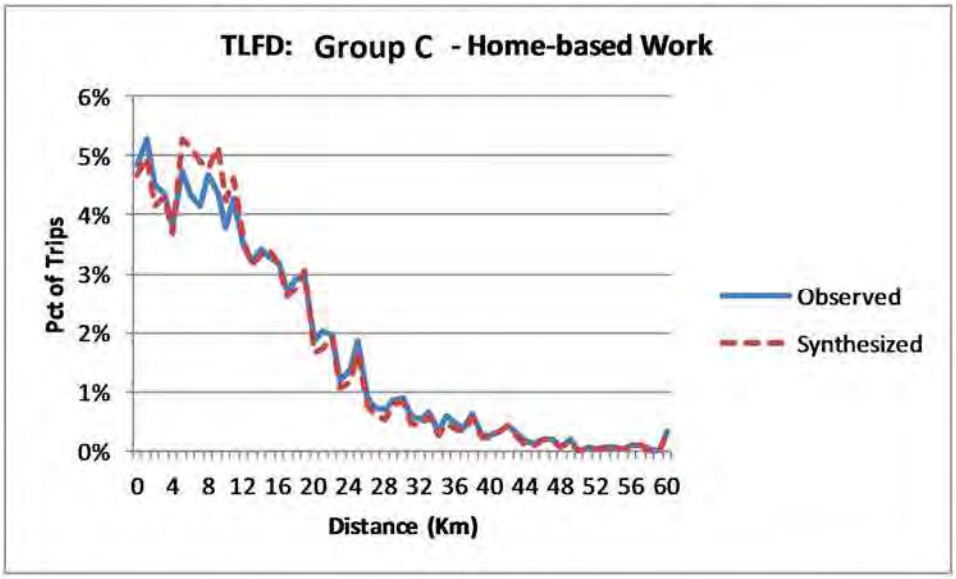
Source: CoMTrans Study Team

Figure 3.2.4 Trip Length Frequency Distribution: Group C – Home-based Other



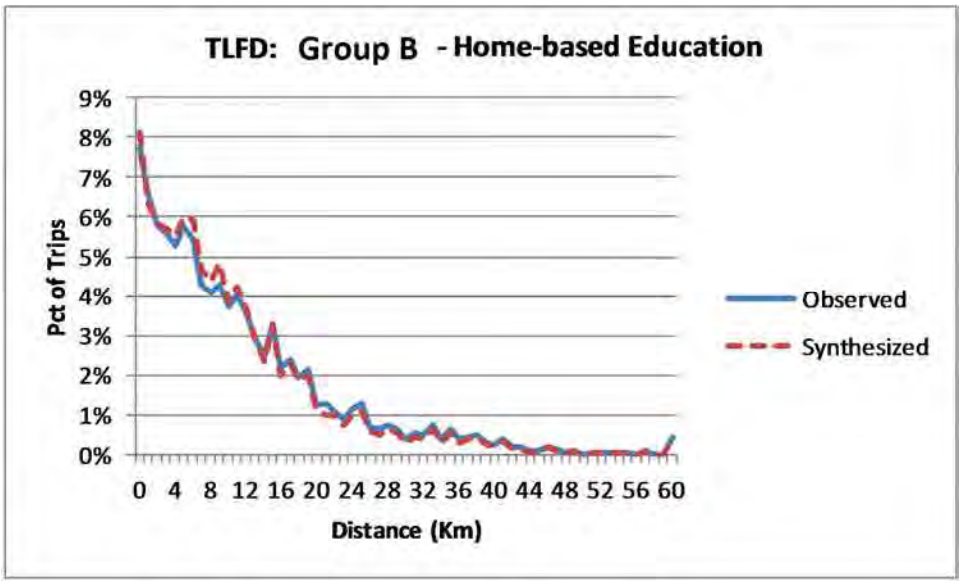
Source: CoMTrans Study Team

Figure 3.2.5 Trip Length Frequency Distribution: Group C – Non-Home-Based



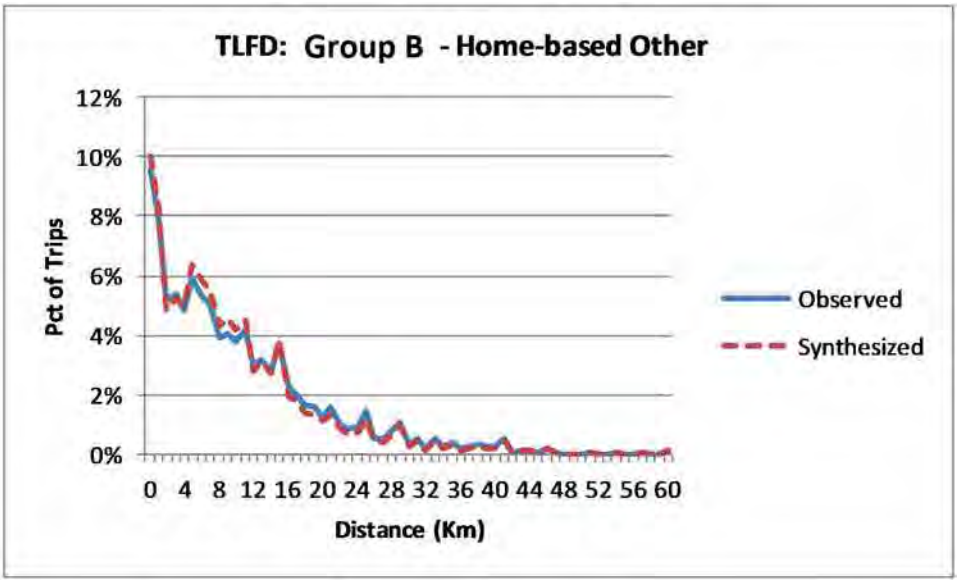
Source: CoMTrans Study Team

Figure 3.2.6 Trip Length Frequency Distribution: Group B – Home-based Work



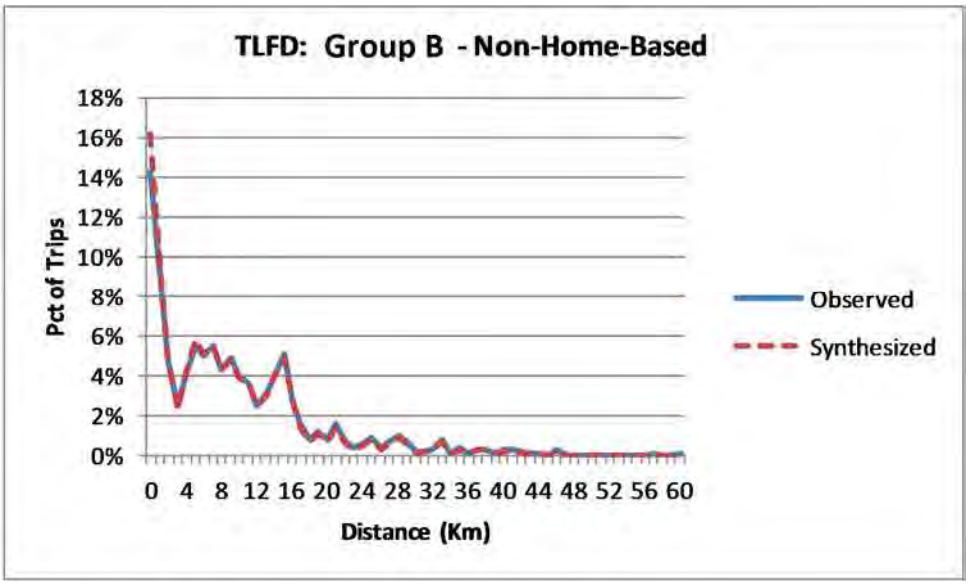
Source: CoMTrans Study Team

Figure 3.2.7 Trip Length Frequency Distribution: Group B – Home-based Education



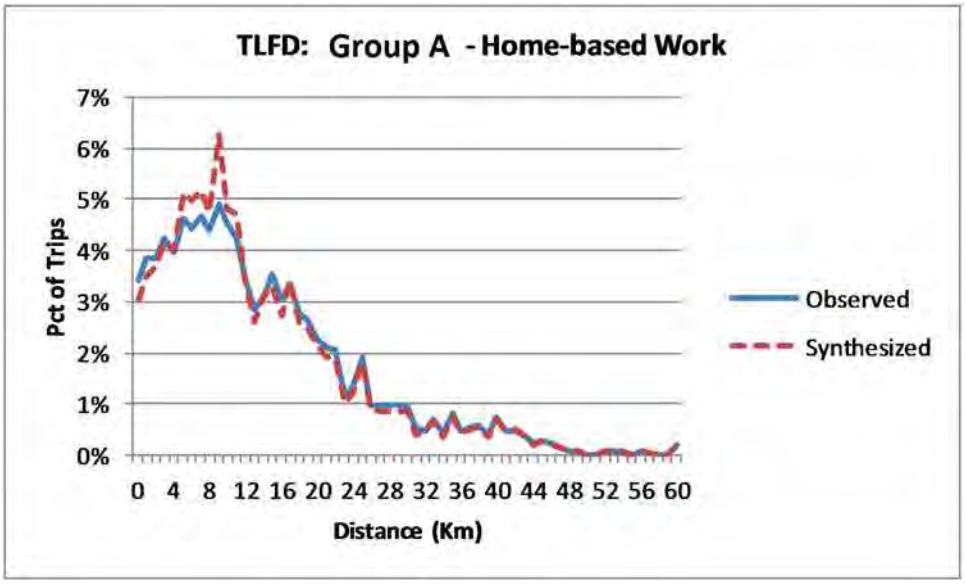
Source: CoMTrans Study Team

Figure 3.2.8 Trip Length Frequency Distribution: Group B– Home-based Other



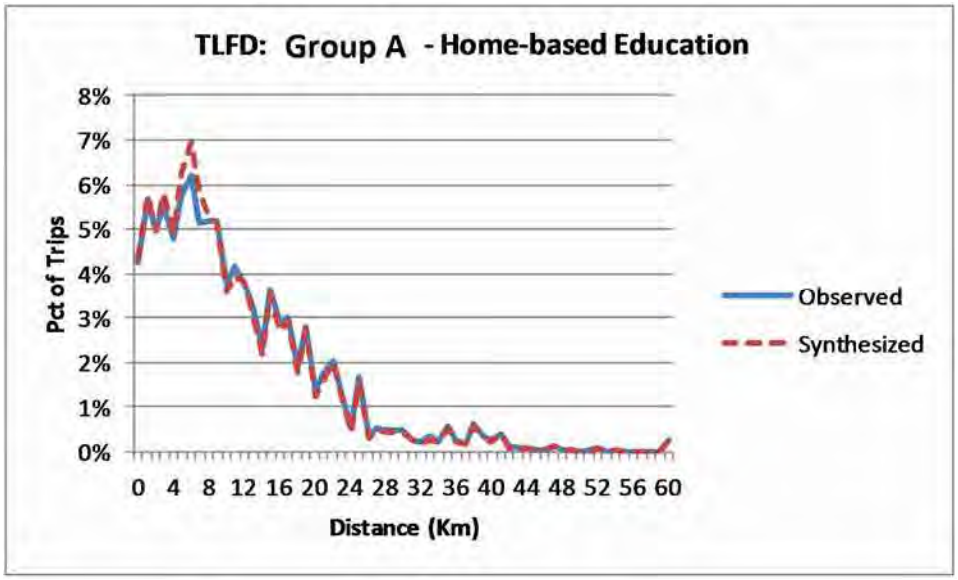
Source: CoMTrans Study Team

Figure 3.2.9 Trip Length Frequency Distribution: Group B – Non-Home-Based



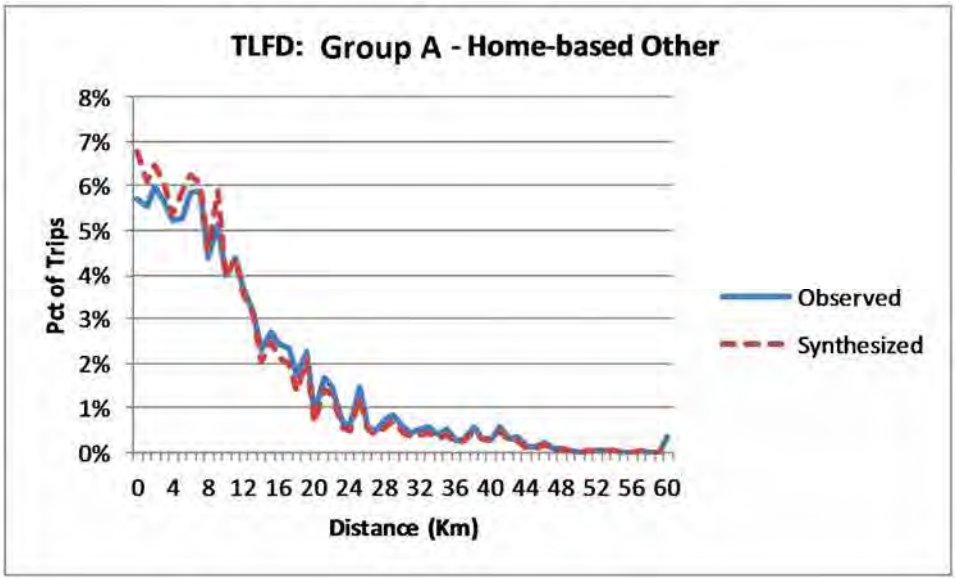
Source: CoMTrans Study Team

Figure 3.2.10 Trip Length Frequency Distribution: Group A – Home-based Work



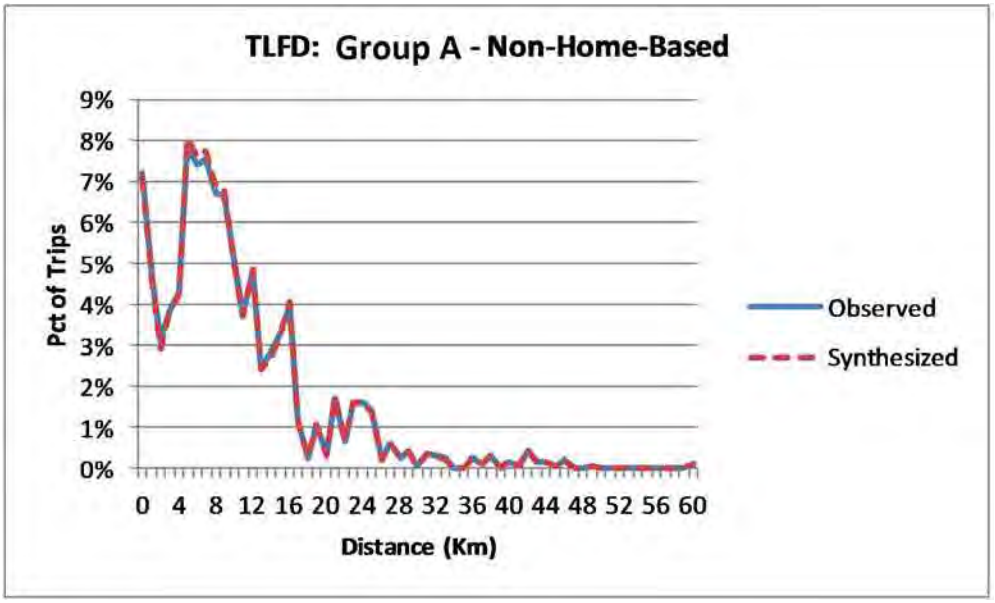
Source: CoMTrans Study Team

Figure 3.2.11 Trip Length Frequency Distribution: Group A – Home-based Education



Source: CoMTrans Study Team

Figure 3.2.12 Trip Length Frequency Distribution: Group A – Home-based Other



Source: CoMTrans Study Team

Figure 3.2.13 Trip Length Frequency Distribution: Group A – Non-Home-Based

3.3 Mode Choice Model

Since the monorail, bus rapid transit (BRT) and modernised railway are completely new transport modes in Sri Lanka, special attention should be paid to the transport modal choice. Electronic road pricing (ERP) is also a currently non-existing policy option for CMA. In addition to the conventional revealed preference survey such as the Home Visit Survey (HVS) on travel behaviour, a stated preference survey was conducted to estimate modal shift from conventional modes of transport.

3.3.1 Revealed Preference (RP) Based Modal Choice Model Development

Based on the Home Visit Survey (HVS) results, mode choice models were developed using the discrete choice theory. A modal choice model using the discrete choice theory is a relatively stable modelling method in terms of space and time differences. Even though spatial location or time is not equal, individual choice of a certain group of people in a specific condition such as travel time and fare is empirically stable. With regard to the mathematical structure, a prevalent "multi-nominal logit model", which can represent unique characteristics of each choice such as transportation mode, was employed for this study.

$$P_{in} = \frac{\exp(V_i)}{\sum_j \exp(V_j)}$$

P_{in} : probability to choose choice i of choice set n

V_i : a systematic component of utility for choice *i*

A utility of a choice is usually explained by a liner function of socio-economic attributes.

$$V_i = \beta_1 Z_{1i} + \beta_2 Z_{2i} + \cdots + \beta_k Z_{ki}$$

Z_{1i} : an explaining variable of choice *i* (socio-economic attributes are usually applied)

β_1 : a parameter for an explaining variable 1

Four models were developed by trip purpose for home-based work purpose, home-based education purpose, home-based others purpose and non-home-based trips for inter-zonal trips as shown in Table 3.3.1. In addition, one intra-zonal model was also developed. Zones used for the model development are consistent with traffic analysis zones of the Home Visit Survey. The detailed zoning system is described in the Technical Report No. 3, Characteristics of Current Transport Demand.

Parameters were estimated by the maximum likelihood method utilizing the Home Visit Survey (HVS) results. Biogeme 2.3, which is an open source software program for parameter estimation of discrete choice models developed by Prof. Bierlaire, M. of Écolepolytechniquefédérale de Lausanne (Bierlaire, 2003) was utilised for parameter estimation.

Bierlaire, M. (2003). BIOGEME: A free package for the estimation of discrete choice models, Proceedings of the 3rd Swiss Transportation Research Conference, Ascona, Switzerland.

Table 3.3.1 List of RP-Based Modal Shift Models

Target Zone	Trip Purpose	Model Name
Inter-zonal trips	Home-based work trip	HBW
Inter-zonal trips	Home-based education trip	HBS
Inter-zonal trips	Home-based others trip	HBO
Inter-zonal trips	Non-home-based trip	NHB
Intra-zonal trips	All trip purpose	ITZ

Source: CoMTrans Study Team

The list of parameter estimation indexes, explaining variables and utility functions of the five models are shown from Table 3.3.2 to Table 3.3.16. Since the adjusted rho-squares which indicate the fitness of models were in the range of expected value for transport mode choice, it can be concluded that this model has enough accuracy for the mode choice analysis.

(1) Parameter Estimation of Inter-Zonal Home-Based Work Model (HBW)

Table 3.3.2 Parameter Estimation Summary of Home-Based Work Trip Model

Number of estimated parameters:	13
Number of observations:	39,210
Initial log-likelihood:	-50,173.551
Final log-likelihood:	-31,867.354
Likelihood ratio test:	36,612.394
Rho-square:	0.365
Adjusted rho-square:	0.365

Source: Estimates of CoMTrans Study Team

Table 3.3.3 List of Variables and Parameter Estimation Results of Inter-Zonal Home-Based Work Trip Model

Name	Value	Std err	t-test	Notes
ASC_3W	-0.827	0.0729	-11.33	Alternative specific constant for three wheelers
ASC_Car	-1.81	0.0593	-30.47	Alternative specific constant for passenger cars
ASC_Mc	-0.266	0.0577	-4.61	Alternative specific constant for motorcycles
ASC_NMT	0.00	fixed		Alternative specific constant for non-motorised transport
ASC_Pub	0.626	0.0567	11.03	Alternative specific constant for public transport (Bus and Railway)
B_AvgInc	1.26	0.0222	56.72	Parameter of average monthly household income in 100,000 rupees
B_AvgPopD	0.511	0.0345	14.79	Parameter of average population density of origin and destination zones in persons per are (1 are = 100 m^2)
B_Dist	-0.301	0.00687	-43.81	Parameter of trip distance for non-motorised transport in km
B_Dist3W	-0.159	0.00559	-28.35	Parameter of trip distance for three wheelers in km
B_DistMc	-0.0354	0.00164	-21.63	Parameter of trip distance for motorcycles in km
B_HSRail	0.130	0.0346	3.76	Parameter of dummy variable of availability of high-service-level railway
B_LowInc	0.886	0.0507	17.48	Parameter of dummy variable of Group C (less than 40,000 rupees per month)
B_RGT	0.246	0.0781	3.15	Parameter of ratio of generalised time (generalised time of private mode / generalised time of public transport)
B_Rrl2Rrl	0.415	0.0330	12.56	Parameter of dummy variable of non-CMA trip

Source: Estimates of CoMTrans Study Team

Table 3.3.4 List of Alternatives and Utility Function of Inter-Zonal Home-Based-Work Trip Model

Name	Mode	Specification
A1_Car	Passenger Car	ASC_Car * one + B_AvgInc * Avg_Inc3
A2_Mc	Motorcycle	ASC_Mc * one + B_Rrl2Rrl * Rrl2Rrl + B_DistMc * Distance
A3_3W	Three Wheeler	ASC_3W * one + B_Dist3W * Distance + B_AvgPopD * AvgPopD
A4_Pub	Rail and Bus	ASC_Pub * one + B_RGT * RGT + B_HSRail * RailRail
A5_NMT	Non-motorised transport	ASC_NMT * one + B_Dist * Distance + B_LowInc * LowInc

Note: 'one' stands for 1. 'Avg_Inc3' stands for average monthly household income in Rs. 100,000. 'Distance' stands for trip distance in km. 'RailRail' is a dummy variable if both origin and destination zones are accessible to high-service- level railway.

Source: Estimates of CoMTrans Study Team

Parameter Estimation of Home-Based Education Trip Model (HBS)

Table 3.3.5 Parameter Estimation Summary of Inter-Zonal Home-Based Education Trip Model

Number of estimated parameters:	12
Number of observations:	29048
Initial log-likelihood:	-37435.832
Final log-likelihood:	-19288.171
Likelihood ratio test:	36295.322
Rho-square:	0.485
Adjusted rho-square:	0.484

Source: Estimates of CoMTrans Study Team

Table 3.3.6 List of Variables and Parameter Estimation Results of Inter-Zonal Home-Based Education Trip Model

Name	Value	Std err	t-test	Notes
ASC_3W	-0.336	0.0692	-4.86	Alternative specific constant for three wheelers
ASC_Car	-2.58	0.0709	-36.39	Alternative specific constant for passenger cars
ASC_Mc	-1.18	0.0777	-15.16	Alternative specific constant for motorcycles
ASC_NMT	0.00	fixed		Alternative specific constant for non-motorised transport
ASC_Pub	0.892	0.0590	15.11	Alternative specific constant for public transport (Bus and Railway)
B_AvgInc	1.21	0.0399	30.32	Parameter of average monthly household income in 100,000 rupees
B_AvgPopD	0.599	0.0287	20.85	Parameter of average population density of origin and destination zones in persons per are (1 are = 100 m^2)
B_Dist	-0.286	0.00806	-35.54	Parameter of trip distance for non-motorised transport in km
B_Dist3W	-0.170	0.00656	-25.87	Parameter of trip distance for three wheelers in km
B_DistMc	-0.144	0.00892	-16.13	Parameter of trip distance for motorcycles in km
B_LowInc	0.756	0.0518	14.60	Parameter of dummy variable of Group C (less than 40,000 rupees per month)
B_RGT	0.720	0.117	6.16	Parameter of ratio of generalised time (generalised time of private mode / generalised time of public transport)
B_Rrl2Rrl	0.447	0.0671	6.67	Parameter of dummy variable of non-CMA trip

Source: Estimates of CoMTrans Study Team

Table 3.3.7 List of Alternatives and Utility Function of Inter-Zonal Home-Based Education Trip Model

Name	Mode	Specification
A1_Car	Passenger Car	ASC_Car * one + B_AvgInc * Avg_Inc3
A2_Mc	Motorcycle	ASC_Mc * one + B_Rrl2Rrl * Rrl2Rrl + B_DistMc * Distance
A3_3W	Three Wheeler	ASC_3W * one + B_Dist3W * Distance + B_AvgPopD * AvgPopD
A4_Pub	Rail and Bus	ASC_Pub * one + B_RGT * RGT
A5_NMT	Non-motorised transport	ASC_NMT * one + B_Dist * Distance + B_LowInc * LowInc

Note: 'one' stands for 1. 'Avg_Inc3' stands for average monthly household income in Rs. 100,000. 'Distance' stands for trip distance in km. 'RailRail' is a dummy variable if both origin and destination zones are accessible to high-service- level railway.

Source: Estimates of CoMTrans Study Team

(2) Parameter Estimation of Home-Based Others Trip Model (HBO)

Table 3.3.8 Parameter Estimation Summary of Inter-Zonal Home-Based Others Trip Model

Number of estimated parameters:	15
Number of observations:	32301
Initial log-likelihood:	-44732.572
Final log-likelihood:	-36631.567
Likelihood ratio test:	16202.012
Rho-square:	0.181
Adjusted rho-square:	0.181

Source: Estimates of CoMTrans Study Team

Table 3.3.9 List of Variables and Parameter Estimation Results of Inter-Zonal Home-Based Others Trip Model

Name	Value	Std err	t-test	Notes
ASC_3W	0.129	0.0601	2.15	Alternative specific constant for three wheelers
ASC_Car	-1.36	0.0669	-20.36	Alternative specific constant for passenger cars
ASC_Mc	0.238	0.0668	3.57	Alternative specific constant for motorcycles
ASC_NMT	0	fixed		Alternative specific constant for non-motorised transport
ASC_Pub	0.741	0.0567	13.08	Alternative specific constant for public transport (Bus and Railway)
B_AvgInc	1.35	0.026	51.95	Parameter of average monthly household income in 100,000 rupees
B_AvgPopD_3W	0.412	0.0297	13.87	Parameter of average population density of origin and destination zones in persons per are (1 are = 100 m^2) for three wheeler trip
B_AvgPopD_Mc	-0.468	0.0515	-9.09	Parameter of dummy variable of Group C (less than 40,000 rupees) for motorcycle trip
B_CMA2CMA	0.668	0.0452	14.77	Parameter of dummy variable of within CMA trip
B_Dist	-0.212	0.00611	-34.7	Parameter of trip distance for non-motorised transport in km
B_Dist3W	-0.0542	0.00262	-20.72	Parameter of trip distance for three wheelers in km
B_DistMc	-0.0541	0.00277	-19.55	Parameter of trip distance for motorcycles in km
B_LowInc	0.873	0.052	16.78	Parameter of dummy variable of Group C (less than 40,000 rupees per month)

Name	Value	Std err	t-test	Notes
B_MedInc_Mc	0.256	0.0366	6.99	Parameter of dummy variable of Group B (40,000 – 79,999 rupees per month) for motorcycle trip
B_RGT	0.715	0.0932	7.68	Parameter of ratio of generalised time (generalised time of private mode / generalised time of public transport)
B_Rrl2Rrl	0.319	0.0374	8.54	Parameter of dummy variable of non-CMA trip

Source: Estimates of CoMTrans Study Team

Table 3.3.10 List of Alternatives and Utility Function of Inter-Zonal Home-Based Others Trip Model

Name	Mode	Specification
A1_Car	Passenger Car	ASC_Car * one + B_AvgInc * Avg_Inc3 + B_CMA2CMA * CMA2CMA
A2_Mc	Motorcycle	ASC_Mc * one + B_Rrl2Rrl * Rrl2Rrl + B_MedInc_Mc * MedInc + B_DistMc * Distance + B_AvgPopD_Mc * AvgPopD
A3_3W	Three Wheeler	ASC_3W * one + B_Dist3W * Distance + B_AvgPopD_3W * AvgPopD
A4_Pub	Rail and Bus	ASC_Pub * one + B_RGT * RGT
A5_NMT	Non-motorised transport	ASC_NMT * one + B_Dist * Distance + B_LowInc * LowInc

Note: 'one' stands for 1. 'Avg_Inc3' stands for average monthly household income in Rs. 100,000. 'Distance' stands for trip distance in km. 'RailRail' is a dummy variable if both origin and destination zones are accessible to high-service- level railway.

Source: Estimates of CoMTrans Study Team

(3) Parameter Estimation of Inter-Zonal Non-Home-Based Trip Model (NHB)

Table 3.3.11 Parameter Estimation Summary of Inter-Zonal Home-Based Others Trip Model

Number of estimated parameters:	13
Number of observations:	2938
Initial log-likelihood:	-36164.504
Final log-likelihood:	-29167.884
Likelihood ratio test:	13993.241
Rho-square:	0.193
Adjusted rho-square:	0.193

Source: Estimates of CoMTrans Study Team

Table 3.3.12 List of Variables and Parameter Estimation Results of Inter-Zonal Home-Based Others Trip Model

Name	Value	Std err	t-test	Notes
ASC_3W	0.483	0.221	2.19	Alternative specific constant for three wheelers
ASC_Car	-0.308	0.217	-1.42	Alternative specific constant for passenger cars
ASC_Mc	0.569	0.202	2.82	Alternative specific constant for motorcycles
ASC_NMT	0	fixed		Alternative specific constant for non-motorised transport
ASC_Pub	0.428	0.211	2.03	Alternative specific constant for public transport (Bus and Railway)
B_AvgInc	1.37	0.0596	22.92	Parameter of average monthly household income in 100,000 rupees
B_AvgPopD_3W	0.798	0.0964	8.28	Parameter of average population density of origin and destination zones in persons per are (1 are = 100 m^2) for three wheeler trip
B_AvgPopD_Car	0.334	0.114	2.93	Parameter of dummy variable of Group C (less than 40,000 rupees) for car trip
B_CMA2Rul	0.595	0.141	4.21	Parameter of dummy variable of a trip between CMA and area outside of CMA
B_Dist	-0.28	0.0304	-9.21	Parameter of trip distance for non-motorised transport in km
B_Dist3W	-0.1	0.012	-8.33	Parameter of trip distance for three wheelers in km
B_LowInc	1.04	0.189	5.5	Parameter of trip distance for motorcycles in km
B_MaxEmpD	0.149	0.028	5.32	Parameter of higher employment population density of origin and destination zones in persons per are (1 are = 100 m^2)
B_RGT	0.83	0.301	2.75	Parameter of ratio of generalised time (generalised time of private mode / generalised time of public transport)

Source: Estimates of CoMTrans Study Team

Table 3.3.13 List of Alternatives and Utility Function of Inter-Zonal Home-Based Others Trip Model

Name	Mode	Specification
A1_Car	Passenger Car	ASC_Car * one + B_AvgInc * Avg_Inc3 + B_MaxEmpD * MaxEmpD + B_AvgPopD_Car * AvgPopD
A2_Mc	Motorcycle	ASC_Mc * one
A3_3W	Three Wheeler	ASC_3W * one + B_Dist3W * Distance + B_AvgPopD_3W * AvgPopD
A4_Pub	Rail and Bus	ASC_Pub * one + B_RGT * RGT + B_CMA2Rul * CMA2Rul
A5_NMT	Non-motorised transport	ASC_NMT * one + B_Dist * Distance + B_LowInc * LowInc

Note: 'one' stands for 1. 'Avg_Inc3' stands for average monthly household income in Rs. 100,000. 'Distance' stands for trip distance in km.

Source: Estimates of CoMTrans Study Team

(4) Parameter Estimation of Intra-Zonal Trip Model (ITZ)

Table 3.3.14 Parameter Estimation Summary of Intra-Zonal Trip Model

Number of estimated parameters:	12
Number of observations:	50236
Initial log-likelihood:	-75979.810
Final log-likelihood:	-57111.799
Likelihood ratio test:	37736.021
Rho-square:	0.248
Adjusted rho-square:	0.248

Source: Estimates of CoMTrans Study Team

Table 3.3.15 List of Variables and Parameter Estimation Results of Intra-Zonal Trip Model

Name	Value	Std err	t-test	Notes
ASC_3W	-1.48	0.0268	-55.16	Alternative specific constant for three wheelers
ASC_Car	-3.9	0.0518	-75.3	Alternative specific constant for passenger cars
ASC_Mc	-1.14	0.0295	-38.74	Alternative specific constant for motorcycles
ASC_NMT	0	fixed		Alternative specific constant for non-motorised transport
ASC_Pub	-1.31	0.0257	-50.92	Alternative specific constant for public transport (Bus and Railway)
B_AreaKm2	-0.00666	0.000497	-13.42	Area of zone in square kilometres
B_AvgEmpD	0.388	0.0247	15.7	Parameter of average employment population density of origin and destination zones in persons per are (1 are = 100 m^2)
B_AvgInc	2.4	0.075	32.03	Parameter of average monthly household income in 100,000 rupees
B_AvgPopD_3W	0.202	0.0194	10.41	Parameter of average population density of origin and destination zones in persons per are (1 are = 100 m^2) for three wheeler trip
B_AvgPopD_Mc	-1.08	0.0545	-19.91	Parameter of average population density of origin and destination zones in persons per are (1 are = 100 m^2) for three motorcycle trip
B_HBS	0.66	0.0251	26.3	Parameter of dummy parameter for home-based education trip
B_LowInc	0.431	0.0237	18.19	Parameter of trip distance for motorcycles in km
B_NHB	-1.16	0.0567	-20.38	Parameter of dummy parameter for non-home-based trip

Source: Estimates of CoMTrans Study Team

Table 3.3.16 List of Alternatives and Utility Function of Intra-Zonal Trip Model

Name	Mode	Specification
A1_Car	Passenger Car	ASC_Car * one + B_AvgInc * Avg_Inc + B_AvgEmpD * AvgEmpD
A2_Mc	Motorcycle	ASC_Mc * one + B_AvgPopD_Mc * AvgPopD
A3_3W	Three Wheeler	ASC_3W * one + B_AvgPopD_3W * AvgPopD
A4_Pub	Rail and Bus	ASC_Pub * one + B_HBS * HBS + B_NHB * NHB
A5_NMT	Non-motorised transport	ASC_NMT * one + B_AreaKm2 * AreaKm2 + B_LowInc * LowInc + B_NHB * NHB

Note: 'one' stands for 1. 'Avg_Inc3' stands for average monthly household income in Rs. 100,000. 'Distance' stands for trip distance in km.

Source: Estimates of CoMTrans Study Team

3.3.2 Stated Preference Survey

The stated preference (SP) survey for monorail, bus rapid transit (BRT) and modernised railway as well as electronic road pricing (ERP) was conducted for the evaluation of new transport policies. Respondents to the SP survey were sampled from the respondents of the Home Visit Survey in 2013 who provided their phone number. A surveyor telephones a potential respondent and requests cooperation with the survey. After approval of the respondent, the surveyor made an appointment and visited the respondent for an interview survey. For the purpose of evaluating the proposed monorail project and modernised railway, respondents were sampled from areas within roughly 1km from Malabe corridor where the monorail is proposed and Galle corridor where modernised railway and BRT are proposed. Total sample size was 1,150 individuals. The survey was conducted in February and March, 2014. The survey form consists of the 3 sections below.

Section 1: General information relevant to the present trips made by the respondent. Two different questionnaires for this section were prepared: 1) Commuter; and 2) Non-Commuter.

Section 2: Mode choice behaviour under hypothetical situations in which different future transport systems are shown to the respondents based on the main modes of transport they use at present.

Section 3: General opinion.

3.3.3 SP-Based Modal Shift Model Development

Modal shift from conventional modes of transport to new transport modes of monorail, BRT and modernised railway were surveyed in the abovementioned SP survey. After data input and data verification, modal shift models were developed. Seven models were developed by existing mode and policy options. Table 3.3.18 is a list of the developed models. Choice set is binary; an existing transport mode and a new transport mode. Thus, a Binary Probit model was employed. The following formula is the probability function of the Binary Probit model.

$$P_n(i) = \int_{-\infty}^{V_{in}-V_{jn}} \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[-\frac{1}{2}\left(\frac{\varepsilon}{\sigma}\right)^2\right] d\varepsilon = \Phi\left(\frac{V_{in}-V_{jn}}{\sigma}\right)$$

where

$P_n(i)$: probability to choose choice *i* of choice set *n*

V_i : a systematic component of utility for choice *i*

ε_n : difference of random utility of choice *i* and choice *j*

σ : standard deviation of ε_n

Φ : cumulative distribution function (CDF) of normal distribution

A utility of a choice is the same as a logit model.

Parameters were estimated by the maximum likelihood method utilizing the Stated Preference Survey (HVS) results. Biogeme 2.3 was utilised for parameter estimation. The list of parameter estimation indexes, explaining variables and utility functions of the five models are shown from Table 3.3.18 to Table 3.3.38. Since the adjusted rho-squares which indicate the fitness of models were in the range of expected value for transport mode choice, it can be concluded that this model has enough accuracy for the mode choice analysis.

Table 3.3.17 List of SP-Based Modal Shift Model

Model Name	Current Mode	New Policy Option
Car-Mono	Passenger Car	Monorail
Car-Rail	Passenger Car	Modernised railway
Mc-Mono	Motorcycle	Monorail
Mc-Rail	Motorcycle	Modernised railway
3W-Mono	Three Wheeler	Monorail
3W-Rail	Three Wheeler	Modernised railway
Pub-Mono & Rail	Public Transport	Both monorail and modernised railway

Source: CoMTrans Study Team

(1) Parameter Estimation of Car to Monorail Modal Shift Model

Table 3.3.18 Parameter Estimation Summary of Car to Monorail Modal Shift Model

Model:	**Binary Probit**
Number of estimated parameters:	11
Number of observations:	4,555
Null log-likelihood:	-3,157.285
Cte log-likelihood:	-2,951.434
Init log-likelihood:	-3,157.285
Final log-likelihood:	-2,298.848
Likelihood ratio test:	1,716.874
Rho-square:	0.272
Adjusted rho-square:	0.268

Source: Estimates of CoMTrans Study Team

Table 3.3.19 List of Variables and Parameter Estimation Results of Car-Monorail Model

Name	Value	Std err	t-test	Notes
ASC_NEW	0.00	fixed		Alternative specific constant for monorail
ASC_NOCHANGE	0.00	fixed		Alternative specific constant for current mode
B_AGE	-0.0180	0.00162	-11.09	Parameter of age
B_AvgEmpD	1.43	0.223	6.43	Parameter of average employed population density of origin and destination zones in persons/are
B_AvgPopD	1.12	0.250	4.46	Parameter of average population density of origin and destination zones in persons/are
B_COST	-0.00680	0.000460	-14.78	Parameter of total fare of monorail in rupees
B_DTYPE_13	0.532	0.0663	8.02	Parameter of dummy variable of destination type (workplace or other company)
B_ERP	-0.00880	0.000289	-30.43	Parameter of ERP price in Rupees
B_INCOME	-2.95e-006	2.93e-007	-10.07	Parameter of average household income in Rupees
B_MaxEmpD	-0.575	0.115	-4.99	Parameter of higher population density of origin or destination zones in persons/are
B_MaxPopD	-0.653	0.148	-4.42	Parameter of higher employed population density of origin or destination zones in persons/are
B_RailOr	-0.425	0.0538	-7.90	Parameter of dummy variable of high service railway (either origin or destination)
B_TIME	-0.00316	0.00109	-2.91	Parameter of travel time in minutes

Source: Estimates of CoMTrans Study Team

Table 3.3.20 List of Alternatives and Utility Function of Car-Monorail Modal Shift Model

Name	Mode	Specification
A1_NEW	New Transit Mode (Monorail)	ASC_NEW * one + B_TIME * TOTAL_T_NEW + B_COST * TOTAL_COST_NEW + B_AGE * AGE_HVS + B_DTYPE_13 * DEST_TYPE_1_3 + B_RailOr * RailOr + B_AvgPopD * AvgPopD + B_MaxPopD * MaxPopD + B_AvgEmpD * AvgEmpD + B_MaxEmpD * MaxEmpD + B_INCOME * INCOME
A2_NOCHANGE	Current mode	ASC_NOCHANGE * one + B_TIME * TOTAL_TT_RP_ERP + B_ERP * ERP

Note: Total_T_New and Total_Cost_New stands for total travel time and cost including access and egress.
AGE_HVS means age; Dest_Type_1_3 is a dummy variable of destination type. 1 if destination is workplace or other companies and 0 if not. TOTAL_TT_RP_ERP means total travel time in the case of the existing transport mode.

Source: Estimates of CoMTrans Study Team

(2) Parameter Estimation of Car to Modernised Railway Modal Shift Model

Table 3.3.21 Parameter Estimation Summary of Car to Modernised Railway Modal Shift Model

Model:	**Binary Probit**
Number of estimated parameters:	14
Number of observations:	2,252
Null log-likelihood:	-1,560.97
Cte log-likelihood:	-1,560.97
Init log-likelihood:	-1,560.97
Final log-likelihood:	-1,304.84
Likelihood ratio test:	512.25
Rho-square:	0.164
Adjusted rho-square:	0.155

Source: Estimates of CoMTrans Study Team

Table 3.3.22 List of Variables and Parameter Estimation Results of Car-Modernised Railway Model

Name	**Value**	**Std err**	**t-test**	**p-value**
ASC_NEW	0	fixed		Alternative specific constant for monorail
ASC_NOCHANGE	0	fixed		Alternative specific constant for current mode
B_ACC	0.0264	0.00618	4.27	Parameter of access time in minutes
B_AGE	0.00455	0.00168	2.71	Parameter of age
B_AvgEmpD	-2.72	0.614	-4.43	Parameter of average employed population density of origin and destination zones in persons/are
B_AvgPopD	1.51	0.295	5.11	Parameter of average population density of origin and destination zones in persons/are
B_COST	-0.000111	0.000386	-0.29	Parameter of total fare of monorail in rupees
B_ERP	-0.00465	0.000342	-13.6	Parameter of ERP price in Rupees
B_INCM	-3.49E-06	4.49E-07	-7.78	Parameter of average household income in Rupees
B_MALE	0.314	0.0807	3.88	Parameter of dummy variable of male
B_MaxEmpD	1.37	0.309	4.44	Parameter of higher population density of origin or destination zones in persons/are
B_MaxPopD	-1.87	0.219	-8.53	Parameter of higher employed population density of origin or destination zones in persons/are
B_PURPOSE1	-2.41E-01	1.02E-01	-2.36	Parameter of dummy variable of trip purpose is "to work"
B_PURPOSE3	-0.517	0.133	-3.88	Parameter of dummy variable of trip purpose is "to work"

Name	Value	Std err	t-test	p-value
B_RailRail	0.405	0.0795	5.1	Parameter of dummy variable of high service railway (both origin and destination)
B_TIME	-0.00734	0.00199	-3.68	Parameter of travel time in minutes

Source: Estimates of CoMTrans Study Team

Table 3.3.23 List of Alternatives and Utility Function of Car-Modernised Railway Modal Shift Model

Name	Mode	Specification
A1_NEW	Modernised railway	ASC_NEW * one + B_TT * TOTAL_T_NEW + B_COST * TOTAL_COST_NEW + B_ACC * ACC_TIME_NEW + B_INCM * INCOME + B_AGE * AGE_HVS + B_MALE * MALE + B_RailRail * RailRail + B_AvgPopD * AvgPopD + B_MaxPopD * MaxPopD + B_AvgEmpD * AvgEmpD + B_MaxEmpD * MaxEmpD + B_PURPOSE1 * PURPOSE_1 + B_PURPOSE3 * PURPOSE_3
A2_NOCHANGE	Current mode	ASC_NOCHANGE * one + B_TIME * TOTAL_TT_RP_ERP + B_ERP * ERP

Note: Total_T_New and Total_Cost_New stands for total travel time and cost including access and egress; ACC_TIME_NEW is access time; INCOME means income;AGE_HVS means age; MALE is male; RailRail stands for high service railway (both origin and destination); AvgPopD (MaxPopD) means average (max) population density of origin and destination zones; AvgEmpD (MaxEmpD) means average (max)employees density of origin and destination zones; PURPOSE_1 is a dummy variable of purpose of trip "to work"; PURPOSE_3 is a dummy variable of purpose of trip "to business". TOTAL_TT_RP_ERP means total travel time in the case of the existing transport mode; ERP is ERP.

Source: Estimates of CoMTrans Study Team

(3) Parameter Estimation of Motorcycle to Monorail Modal Shift Model

Table 3.3.24 Parameter Estimation Summary of Motorcycle to Monorail Modal Shift Model

Model:	Binary Probit
Number of estimated parameters:	9
Number of observations:	1,839
Null log-likelihood:	-1,274.70
Cte log-likelihood:	-1,214.23
Init log-likelihood:	-1,274.70
Final log-likelihood:	-1,032.30
Likelihood ratio test:	484.80
Rho-square:	0.19
Adjusted rho-square:	0.183

Source: Estimates of CoMTrans Study Team

Table 3.3.25 List of Variables and Parameter Estimation Results of Motorcycle -Monorail Model

Name	Value	Std err	t-test	p-value
ASC_NEW	0	fixed		Alternative specific constant for monorail
ASC_NOCHANGE	0	fixed		Alternative specific constant for current mode
B_AvgPopD	-0.404	0.0754	-5.36	Parameter of average population density of origin and destination zones in persons/are
B_COST	-0.00326	0.000842	-3.87	Parameter of total fare of monorail in rupees
B_DIST	0.066	0.0104	6.35	Parameter of total distance in kilometres
B_ERP	-0.0179	0.0011	-16.22	Parameter of ERP price in Rupees
B_RailOr	-0.162	0.0772	-2.09	Parameter of dummy variable of high service railway (either origin or destination)
B_TT_H	-0.0103	0.00806	-1.27	Parameter of travel time in minutes for Group A
B_TT_L	6.76E-03	1.58E-03	4.27	Parameter of travel time in minutes for Group C
B_TT_M	-0.000999	0.00302	-0.33	Parameter of travel time in minutes for Group B
B_WAIT	-0.0792	0.0133	-5.94	Parameter of waiting time in minutes

Source: Estimates of CoMTrans Study Team

Table 3.3.26 List of Alternatives and Utility Function of Motorcycle -Monorail Modal Shift Model

Name	Mode	Specification
A1_NEW	New Transit Mode (Monorail)	ASC_NEW * one + B_TT_H * TT_NEW_H + B_TT_M * TT_NEW_M + B_TT_L * TT_NEW_L + B_COST * TOTAL_COST_NEW + B_DIST * DISTANCE + B_WAIT * WAIT_TIME_NEW + B_RailOr * RailOr + B_AvgPopD * AvgPopD
A2_NOCHANGE	Current mode	ASC_NOCHANGE * one + B_TT_H * TT_RP_H + B_TT_M * TT_RP_M + B_TT_L * TT_RP_L + B_ERP * ERP

Note: Total_TT_H (M, L) stands for total travel time including access and egress for Group A (Group B, Group C) income group.

Total_Cost_Newstands for total travel cost including access and egress; DISTANCE is distance; WAIT_TIME_NEW means waiting time; RailOr stands for high service railway (either origin or destination); AvgPopD means average population density of origin and destination zones

Total_TT_H (M, L) stands for total travel time including access and egress in the case of the existing transport mode for Group A (Group B, Group C) income group;ERP is ERP.

Source: Estimates of CoMTrans Study Team

(4) Parameter Estimation of Motorcycle to Modernised Railway Modal Shift Model

Table 3.3.27 Parameter Estimation Summary of Motorcycle to Modernised Railway Modal Shift Model

Model:	Binary Probit
Number of estimated parameters:	11
Number of observations:	1,515
Null log-likelihood:	-1,050.12
Cte log-likelihood:	-1,002.20
Init log-likelihood:	-1,050.12
Final log-likelihood:	-865.96
Likelihood ratio test:	368.32
Rho-square:	0.175
Adjusted rho-square:	0.165

Source: Estimates of CoMTrans Study Team

Table 3.3.28 List of Variables and Parameter Estimation Results of Motorcycle -Modernised Railway Model

Name	Value	Std err	t-test	p-value
ASC_NEW	1.65	0.227	7.24	Alternative specific constant for monorail
ASC_NOCHANGE	0	fixed		Alternative specific constant for current mode
B_AvgEmpD	-4.01	0.496	-8.08	Parameter of average employed population density of origin and destination zones in persons/are
B_AvgPopD	-0.967	0.319	-3.03	Parameter of average population density of origin and destination zones in persons/are
B_COST	-0.0146	0.00148	-9.91	Parameter of total fare of monorail in rupees
B_DIST	0.0232	0.0102	2.28	Parameter of total distance in kilometres
B_ERP	-0.0165	0.00135	-12.22	Parameter of ERP price in Rupees
B_MaxEmpD	1.85	0.248	7.45	Parameter of higher population density of origin or destination zones in persons/are
B_MaxPopD	6.28E-01	2.43E-01	2.59	Parameter of higher employed population density of origin or destination zones in persons/are
B_PURPOSE1	0.391	0.102	3.85	Parameter of dummy variable of trip purpose is "to work"
B_TT_NEW	-0.0204	0.00388	-5.26	Parameter of travel time of new transit system in minutes
B_TT_RP	0.00302	0.00213	1.42	Parameter of travel time of current transit system in minutes

Source: Estimates of CoMTrans Study Team

Table 3.3.29 List of Alternatives and Utility Function of Motorcycle -Modernised Railway Modal Shift Model

Name	Mode	Specification
A1_NEW	Modernised railway	ASC_NEW * one + B_TT_NEW * TOTAL_T_NEW + B_COST * TOTAL_COST_NEW + B_DIST * DISTANCE + B_AvgPopD * AvgPopD + B_MaxPopD * MaxPopD + B_AvgEmpD * AvgEmpD + B_MaxEmpD * MaxEmpD + B_PURPOSE1 * PURPOSE_1
A2_NOCHANGE	Current mode	ASC_NOCHANGE * one + B_TT_RP * TOTAL_TT_RP_ERP + B_ERP * ERP

Note: Total_T_New and Total_Cost_New stands for total travel time and cost including access and egress.

DISTANCE is distance;AvgPopD (MaxPopD) means average (max) population density of origin and destination zones.

AvgEmpD (MaxEmpD) means average (max) employees density of origin and destination zones; PURPOSE_1 is a dummy variable of purpose of trip “to work”.

TOTAL_TT_RP_ERP means total travel time in the case of the existing transport mode; ERP is ERP.

Source: Estimates of CoMTrans Study Team

(5) Parameter Estimation of Three Wheeler to Monorail Modal Shift Model

Table 3.3.30 Parameter Estimation Summary of Three Wheeler to Monorail Modal Shift Model

Model:	Binary Probit
Number of estimated parameters:	9
Number of observations:	391
Null log-likelihood:	-271.02
Cte log-likelihood:	-263.78
Init log-likelihood:	-271.02
Final log-likelihood:	-143.83
Likelihood ratio test:	254.38
Rho-square:	0.469
Adjusted rho-square:	0.436

Source: Estimates of CoMTrans Study Team

Table 3.3.31 List of Variables and Parameter Estimation Results of Three Wheeler -Monorail Model

Name	Value	Std err	t-test	p-value
ASC_NEW	-1.01	0.43	-2.36	Alternative specific constant for monorail
ASC_NOCHANGE	0	fixed		Alternative specific constant for current mode
B_AvgPopD	-1.09	0.242	-4.51	Parameter of average population density of origin and destination zones in persons/are
B_COST	-0.00515	0.00269	-1.92	Parameter of total fare of monorail in rupees
B_DIST	-0.224	0.0389	-5.77	Parameter of total distance in kilometres
B_ERP	-0.0194	0.00196	-9.9	Parameter of ERP price in Rupees
B_INCOME	2.34E-05	5.88E-06	3.98	Parameter of average household income in Rupees
B_RailOr	1.84	0.272	6.76	Parameter of dummy variable of high service railway (either origin or destination)
B_TIME	-2.64E-04	4.13E-03	-0.06	Parameter of travel time in minutes
B_WAIT	0.34	0.0827	4.11	Parameter of waiting time in minutes

Source: Estimates of CoMTrans Study Team

Table 3.3.32 List of Alternatives and Utility Function of Three Wheeler -Monorail Modal Shift Model

Name	Mode	Specification
A1_NEW	New Transit Mode (Monorail)	ASC_NEW * one + B_TIME * TOTAL_T_NEW + B_COST * TOTAL_COST_NEW + B_DIST * DISTANCE + B_RailOr * RailOr + B_AvgPopD * AvgPopD + B_INCOME * INCOME + B_WAIT * WAIT_TIME_NEW
A2_NOCHANGE	Current mode	ASC_NOCHANGE * one + B_TIME * TOTAL_TT_RP_ERP + B_ERP * ERP

Note: Total_T_New and Total_Cost_New stands for total travel time and cost including access and egress.

DISTANCE is distance;DISTANCE is distance;AvgPopD means averagepopulation density of origin and destination zones. INCOME is income; WAIT_TIME_NEW means waiting time.

TOTAL_TT_RP_ERP means total travel time in the case of the existing transport mode; ERP is ERP.

Source: Estimates of CoMTrans Study Team

(6) Parameter Estimation of Three Wheeler to Modernised Railway Modal Shift Model

Table 3.3.33 Parameter Estimation Summary of Three Wheeler to Modernised Railway Modal Shift Model

Model:	**Binary Probit**
Number of estimated parameters:	9
Number of observations:	934
Null log-likelihood:	-647.40
Cte log-likelihood:	-595.65
Init log-likelihood:	-647.40
Final log-likelihood:	-525.74
Likelihood ratio test:	243.32
Rho-square:	0.188
Adjusted rho-square:	0.174

Source: Estimates of CoMTrans Study Team

Table 3.3.34 List of Variables and Parameter Estimation Results of Three Wheeler -Modernised Railway Model

Name	**Value**	**Std err**	**t-test**	**p-value**
ASC_NEW	0.707	0.254	2.79	Alternative specific constant for monorail
ASC_NOCHANGE	0	fixed		Alternative specific constant for current mode
B_AGE	-0.0265	0.00371	-7.14	Parameter of age
B_AvgEmpD	1.85	0.573	3.23	Parameter of average employed population density of origin and destination zones in persons/are
B_COST	-0.0133	0.00218	-6.12	Parameter of total fare of monorail in rupees
B_ERP	-0.00737	0.000863	-8.55	Parameter of ERP price in Rupees
B_INCOME	2.55E-06	1.24E-06	2.05	Parameter of average household income in Rupees
B_MaxEmpD	-1.15	0.299	-3.84	Parameter of higher population density of origin or destination zones in persons/are
B_PURPOSE2	-4.17E-01	1.63E-01	-2.56	Parameter of dummy variable of trip purpose is "to school"
B_TIME	-0.00346	0.00255	-1.36	Parameter of travel time in minutes

Source: Estimates of CoMTrans Study Team

Table 3.3.35 List of Alternatives and Utility Function of Three Wheeler -Modernised Railway Modal Shift Model

Name	Mode	Specification
A1_NEW	Modernised railway	ASC_NEW * one + B_TIME * TOTAL_T_NEW + B_COST * TOTAL_COST_NEW + B_AGE * AGE_HVS + B_AvgEmpD * AvgEmpD + B_MaxEmpD * MaxEmpD + B_INCOME * INCOME + B_PURPOSE2 * PURPOSE_2
A2_NOCHANGE	Current mode	ASC_NOCHANGE * one + B_TIME * TOTAL_TT_RP_ERP + B_ERP * ERP

Note: Total_T_New and Total_Cost_New stands for total travel time and cost including access and egress.

AGE_HVS means age;AvgEmpD (MaxEmpD) means average (max)employees density of origin and destination zones; INCOME is income; PURPOSE_2 is a dummy variable of purpose of trip "to school"

TOTAL_TT_RP_ERP means total travel time in the case of the existing transport mode; ERP is ERP.

Source: Estimates of CoMTrans Study Team

(7) Parameter Estimation of Public Transport to Either Monorail or Modernised Railway Modal Shift Model

Table 3.3.36 Parameter Estimation Summary of Public Transport to Either Monorail or Modernised Railway Modal Shift Model

Model:	Binary Probit
Number of estimated parameters:	11
Number of observations:	9,106
Null log-likelihood:	-6,311.80
Cte log-likelihood:	-6,300.87
Init log-likelihood:	-6,311.80
Final log-likelihood:	-5,246.86
Likelihood ratio test:	2,129.89
Rho-square:	0.169
Adjusted rho-square:	0.167

Source: Estimates of CoMTrans Study Team

Table 3.3.37 List of Variables and Parameter Estimation Results of Public Transport -Either Monorail or Modernised Railway Model

Name	Value	Std err	t-test	p-value
ASC_NEW	1.12	0.0692	16.12	Alternative specific constant for monorail
ASC_NOCHANGE	0	fixed		Alternative specific constant for current mode
B_AvgEmpD	-1.37	0.152	-8.96	Parameter of average employed population density of origin and destination zones in persons/are
B_AvgPopD	-0.245	0.0356	-6.88	Parameter of average population density of origin and destination zones in persons/are
B_COST	-0.00233	0.000613	-3.8	Parameter of total fare of monorail in rupees
B_DIST	0.0104	0.00332	3.15	Parameter of total distance in kilometres
B_DTYPE_13	0.186	0.0364	5.11	Parameter of dummy variable of destination type (workplace or other company)
B_GT	-0.00208	0.000462	-4.51	Parameter of generalised time in minutes
B_INCOME_L	-1.50E-02	7.13E-04	-21.01	Parameter of dummy variable of Group C
B_MaxEmpD	0.714	0.0758	9.43	Parameter of higher population density of origin or destination zones in persons/are
B_PURPOSE_2	0.0548	0.0428	1.28	Parameter of dummy variable of trip purpose is "to school"
B_TT_LESS15	-0.551	0.0933	-5.9	Parameter of dummy variable of travel time less than 15 minutes

Source: Estimates of CoMTrans Study Team

Table 3.3.38 List of Alternatives and Utility Function of Public Transport-Either Monorail or Modernised Railway Shift Model

Name	Mode	Specification
A1_NEW	Monorail and modernised railway	ASC_NEW * one + B_GT * GT_NEW + B_COST * TOTAL_COST_NEW + B_DIST * DISTANCE + B_AvgPopD * AvgPopD + B_AvgEmpD * AvgEmpD + B_MaxEmpD * MaxEmpD + B_INCOME_L * COST_NEW_L + B_DTYPE_13 * DEST_TYPE_1_3 + B_PURPOSE_2 * PURPOSE_2
A2_NOCHANGE	Current mode	ASC_NOCHANGE * one + B_COST * FARE_RP + B_GT * GT_RP + B_TT_LESS15 * TT_RP_LESS15

Note: GT_NEW stands for total generalised time including access and egress; Total_Cost_Newstands for total travel cost including access and egress; DISTANCE is distance; AvgPopD (MaxPopD) means average (max) population density of origin and destination zones; AvgEmpD (MaxEmpD) means average (max) employees density of origin and destination zones; COST_NEW_L means total travel cost for Group C; Dest_Type_1_3 is a dummy variable of destination type. 1 if destination is workplace or other companies and 0 if not. PURPOSE_2 is a dummy variable of purpose of trip “to school”.

FARE_RP is fare; GT_RP means total generalised time including access and egress; TT_RP_LESS15 stands for dummy variable of total travel time less than 15 min.

Source: Estimates of CoMTrans Study Team

3.4 Freight Transport and Intercity Transport

Truck Origin-Destination (OD) demand is required for traffic assignment. In the traffic assignment, two kinds of traffic demand are required. First is internal OD demand between the 462 zones inside Western Province (TAZ462). Second is the OD between each of the 462 TAZ zones and Colombo port. While many trucks enter and leave Colombo port, it is considered as an additional zone. The truck OD in 2006 is updated based on the following data.

- Truck OD Interview Survey (TODIS) in 2013
- Screen Line Survey (SLS) in 2013
- Home Visit Survey (HVS) in 2013

3.4.1 Internal OD Demand in 462 TAZ

(1) Accuracy Validation of Screen Line Survey Result

In general, when a reliable OD table is available, the OD table is updated by using the latest survey results. In this case, the truck OD in 2006 should be updated based on traffic volume in the SLS results. However, before updating the truck OD, the accuracy of both the SLS result and truck OD in 2006 should be validated. In the following, SLS results are compared with the traffic assignment result which was conducted based on the truck OD in 2006. Table 3.4.1 shows the number of trucks at Gampaha Screen Line, Kalutara Screen Line and CMC boundary in both the SLS result and the traffic assignment. The number at Gampaha Screen Line and CMC boundary in SLS is 12 percent and 19 percent, respectively, smaller than the traffic assignment result in 2006. On the other hand, the number at Kalutara Screen Line is 12 percent larger in the SLS. It can be said that the difference and deformation is not so significant. It is possible to adjust the OD in 2006 by using SLS result, to make it more suitable for the actual traffic volume. However, such adjustment sometimes makes the OD unsound. Therefore, the OD in 2006 is adopted as the basic structure to build the new truck OD without adjustment.

Table 3.4.1 Comparison between SLS Result and Traffic Assignment Result

		Gampaha SL			Kalutara SL			CMC		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
A. Number of Trucks in the result of SLS in 2013 (veh)	Medium Truck	13,786	11,778	25,564	5,357	5,872	11,229	15,838	16,502	32,340
	Large Truck	1,687	1,880	3,567	159	199	358	2,719	2,827	5,546
	Container Trailer	1,758	1,955	3,713	123	103	226	2,813	2,927	5,740
	Total	**17,231**	**15,613**	**32,844**	**5,639**	**6,174**	**11,813**	**21,370**	**22,256**	**43,626**
B. Number of Trucks in the result of Traffic Assignment with 2006 OD and Network (veh)	Truck General	**17,669**	**19,792**	**37,461**	**4,958**	**5,591**	**10,549**	**24,040**	**29,532**	**53,572**
Ratio (A/B)		**98%**	**79%**	**88%**	**114%**	**110%**	**112%**	**89%**	**75%**	**81%**

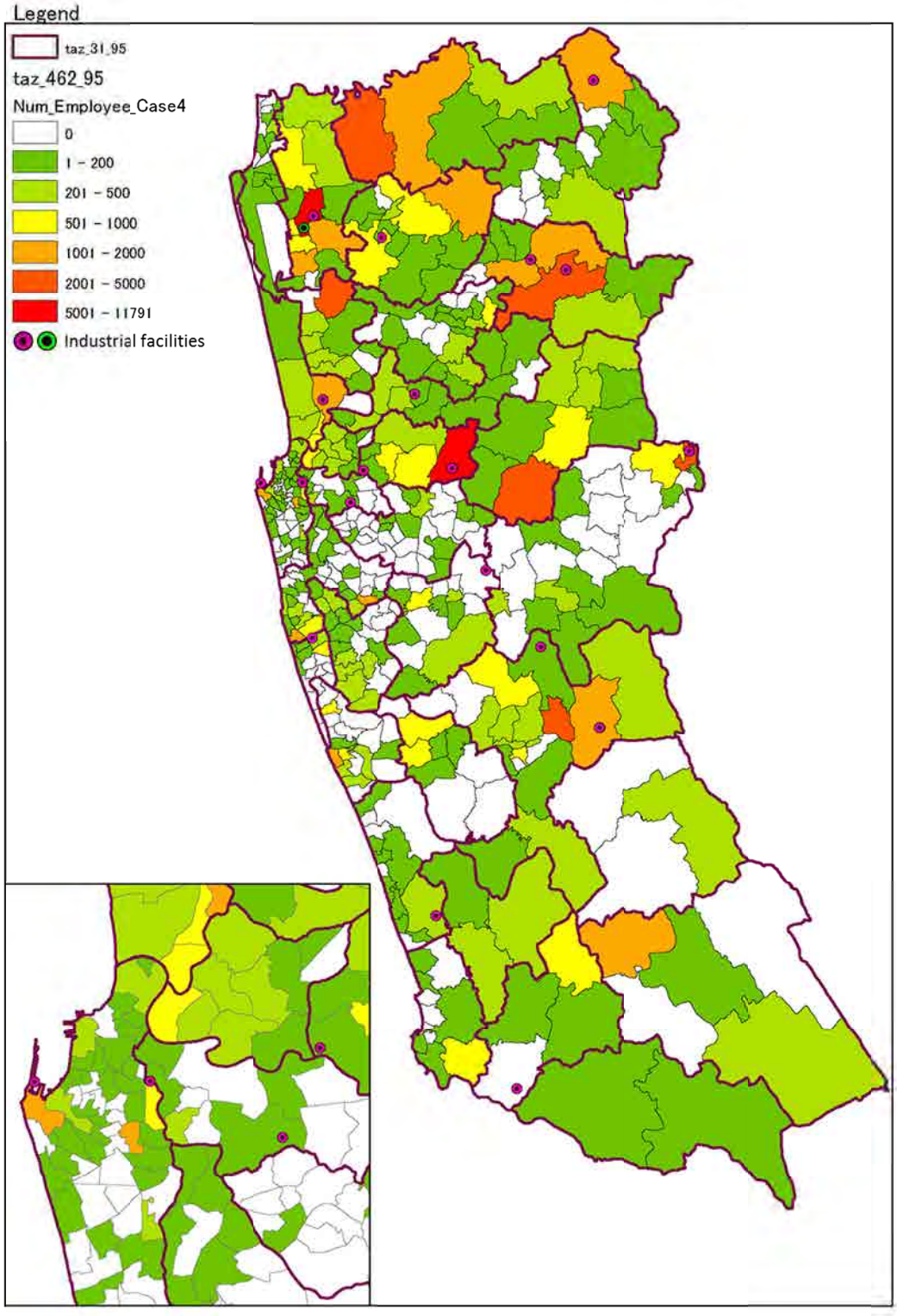
Source: CoMTrans Estimates

(2) Allocation of OD demand from an analysis based on 31 zones to an analysis based on 462 zones

Because the truck OD in 2006 was based on 31 zones, it is required to divide it into 462 zones. While the 462 zones are arrived at by breaking up the 31 zones, it is required to define some rule regarding how to allocate the OD demand in the 31 zones to the 462 zones. Ideally, the allocation should be based on the distribution of industrial establishments, but the data for land use is not available at the moment. Therefore, the OD demand is allocated based on the number of workers in industrial establishments in each of the 462 TAZ. The data for the number of workers is available from the result of the Home Visit Survey. Industrial workers are defined as follows.

- Work place type : Factory, Warehouse, Storage facility, Construction site, Supply, Disposal facility, Shopping mall and Shopping plaza
- Occupation : Labourers, Drivers, Operators of vehicles and machinery, Workers in Construction, Textiles
- Number of employees in work place: More than 100

The structure of the 31 zones, the 462 TAZ and the distribution of workers in industrial establishments is shown in Figure 3.4.1. Dots coloured in purple indicate the location of large industrial plants which are observed in the satellite image. Generally, the number of workers in industrial plants is high in zones where the dots are located. And the workers are concentrated in the north part of Western Province.



Source: CoMTrans Study Team

Figure 3.4.1 Distribution of Workers in Industrial Establishments

The OD demands from zone *i* to *j* in the 462 TAZ are calculated as follows.

$$\text{TAZ462}_{i,j} = \frac{W_i}{\sum_I W_i}\frac{W_j}{\sum_J W_j} TAZ31_{I,J}$$

$\text{TAZ462}_{i,j}$: OD demands from zone i to j in TAZ462
$\text{TAZ31}_{I,J}$: OD demands from zone I to J inTAZ31
W_x: Number of workers in industrial establishments in zone x

While there is no truck type classification in the truck OD in 2006, the ratio of medium trucks, large trucks and container trailers is required. For which, the ratio of truck type observed at Gampaha Screen Line and Kalutara Screen Line in the SLS results is adapted (Medium: 75.7 percent, Large: 11.9 percent, Container Trailer: 12.4 percent).

3.4.2 Truck OD Demand from/to Colombo Port

As explained above, Colombo Port should be treated as an independent zone, because a large number of trucks have their origin or destination there. The OD demand from/to Colombo Port is developed based on the Truck OD Interview Survey (TODIS) and traffic count survey at each gate of Colombo Port. In TODIS, origin and destination of the trucks coming in and going out from Colombo Port is available. While the interview survey was not conducted to all truck drivers, the obtained OD is expanded by the traffic count survey result. The OD from/to Colombo Port is calculated with the equations below, and it is calculated by truck type, by gate, on a daily base. The observed number of incoming and outgoing trucks at Colombo Port was about 5,400 vehicles in 24 hours.

$$v_{p,t,i,j} = TC_{p,t}\frac{TODIS_{i,j}}{\sum_k \sum_l \quad TODIS_{k,l}}$$

$$V_{t,i,j} = \sum_p v_{p,t,i,j}$$

$v_{p,t,i,j}$:	Number of trips of truck type t from *i* to *j* at gate *p*
$V_{t,i,j}$:	Number of trips of truck type t from *i* to *j*
p:	Gate ID,
t:	Truck type (Large, Medium, Container),
i:	Origin zone code,
j:	Destination zone code,
$TC_{p,t}$:	Number of truck type *t* in the Traffic count survey result at gate *p*
$TODIS_{i,j}$:	Number of respondents who trips

3.4.3 Other Intercity Transport

The series of CoMTrans cordon line surveys was conducted at roads and railways at the boundary of the Western Province and the Bandaranayake International Airport. The survey results are summarised in the Technical Report No. 3, Characteristics of Current Transport Demand. Origin destination (OD) tables are estimated by multiplying OD interview survey samples by an expansion factor by location by time duration by direction and by vehicle types. OD tables of

several survey locations were combined by avoiding duplication of the count of trips from an external zone to another external zone. It is also assumed that the volume of intercity traffic is generally proportional to trip generation of the Western Province in the future scenario.

3.5 Traffic Assignment Model

3.5.1 Software

JICA STARDA version 3.5, which contains separate modules prepared for 17 different applications, is used for traffic assignment. Among them, two different modules are used in private and public assignments to assign trips.

3.5.2 Methodology

In traffic assignment, two types of assignment applications are used namely private and public vehicle trips. Trip assignments are done in four steps as follows.

- Private Trip assignment without initial loads (in the 1st stage, assume that there is no traffic on the roads)
- Public Trip assignment with all the passengers.
- Private Trip assignment with initial loads (speed is changed in the network file for the buses which is input from the public trip assignment)
- Public Trip assignments with initial load

For the traffic assignments, several input files are used and the inputs used for both private and public assignments are summarised in Table 3.5.1.

Table 3.5.1 Inputs of Private and Public Assignments

Assignment	STARDA Module	Inputs	Descriptions
Private	User Equilibrium Assignment 3.5	Origin Destination (OD) Trips	Passenger trips made by private vehicles that have to be assigned to the road assignment
		Road Network with Network Parameters	Roads network with parameters relevant to roads and vehicle modes
		Assignment Parameters	Time equivalence settings which need to Equilibrium Assignment
		Initial Load*	Number of buses which can reduce the speed on the roads
Public	Transit Assignment	Origin Destination (OD) Trips	Passenger trips made by public vehicles that have to be assigned to the public transit assignment
		Road Network	Road network which is valid for the transit lines
		Transit Lines	Public transport lines for each operational route by mode
		Assignment Parameters	Speed, frequency, capacity and mode choice parameters
		Initial Load	Output comes from private vehicle trip assignment

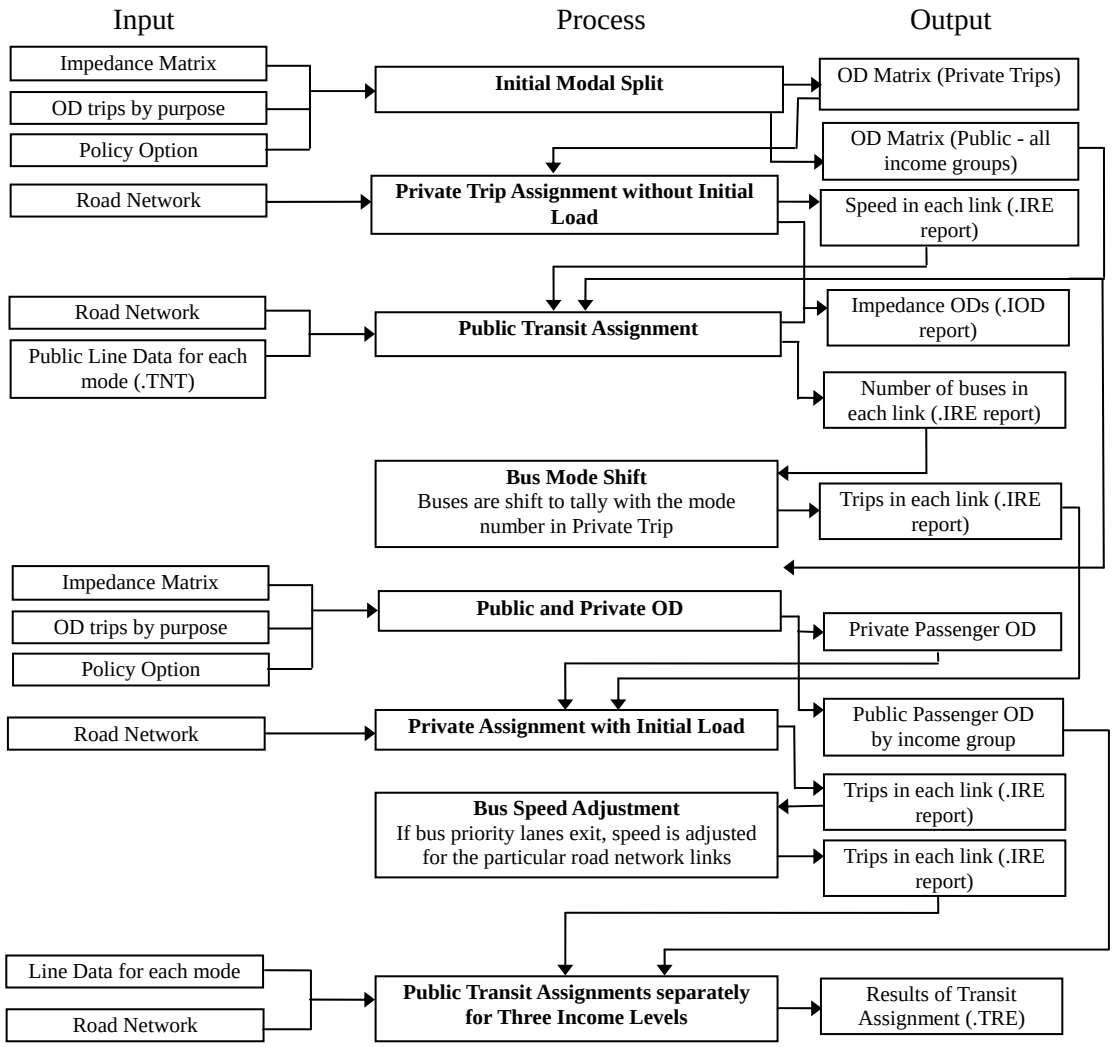
Note: * This is not compulsory input when running the software

(1) OD according to the Income Groups

Population distribution among high, medium and Group C is expected to be significantly different over 2020, 2025 and 2035 with the changes in the economy of the country. Based on the income level changes, the number of trips generated and distribution is also anticipated to change for each year. One of the compulsory inputs for the traffic assignment is Origin - Distribution (OD) matrix which is prepared with the consideration of income levels. The main parameter value that changes with the change of income level distribution is the time value (Rs. /min). In the Public assignment, OD and the parameters are separately prepared according to the specified three income groups. Using all income group trips, combined OD is built for public assignment of all passengers to calculate initial trips.

(2) Traffic Assignment Flow

The traffic Assignment Model has several steps which is referred to as the four step traffic assignment model as shown in Figure 3.5.1.



Source: CoMTrans Study Team

Figure 3.5.1 Traffic Assigning Process Flow

As shown in the Figure 3.5.1 several stages of the assigning processes are undertaken with different objectives. Initial road assignment is compiled with the mode share of private vehicles, which implies different degrees of traffic congestion on the road. It doesn't consider the public mode share, such as bus, railway or any other modern public transport options. As a result of that, initial public transit assignment is carried out to figure out the actual modal share between public modes and private modes. This estimates the actual congestion level between all private and public modes and it reduces the initial speed of private modes.

Impedance of the initial public and private assignment is considered for the second OD preparation. And it will be used for the second private equilibrium assignments, which consider the number of buses utilised in the traffic assigning process. Furthermore, it gives actual road conditions and operating speeds after allowing for all modes. This will be an input for the ultimate public transit assignment conducted for the three income groups separately. During the entire traffic assigning process, the congestion factor and mode share are considered with the assigned capacity level and the speed constraints.

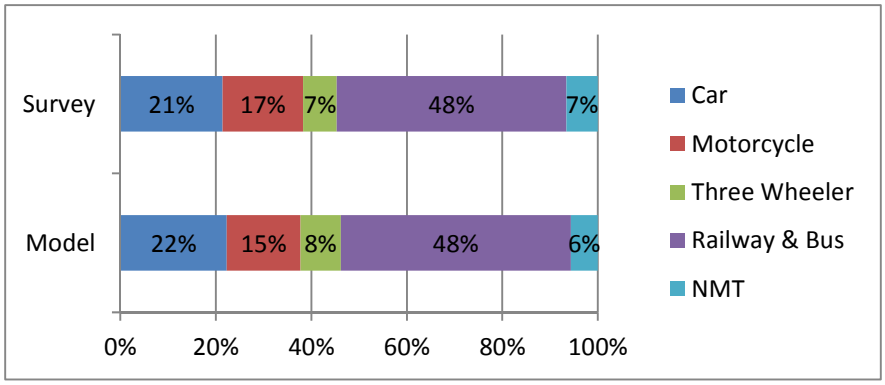
In the traffic assignment model, private passenger trip assignment outputs used as inputs for public trip assignment and vice versa. Vehicle types used in the private passenger trip assignments are cars, motor bikes, 3-wheers, buses and trucks and mode numbers respectively. In public transport assignments, the modes are buses, A/C buses, double track trains, pedestrians, BRT, monorail and single track trains and mode numbers are respectively. There is a mismatch of mode numbers in private and public assignment for buses, so to use the output of the public traffic assignment, buses should be shifted accordingly.

Several traffic demand management techniques are considered to improve the future road transport in the assignments. One of those is Bus Priority Lanes in Horana road (B084) and Low Level road (AB010). In the future network, when this is activated, the speed of the buses is required to be converted to 20km/hr before being fed into the public assignments which receive the output of the private traffic assignments.

3.6 Model Verification

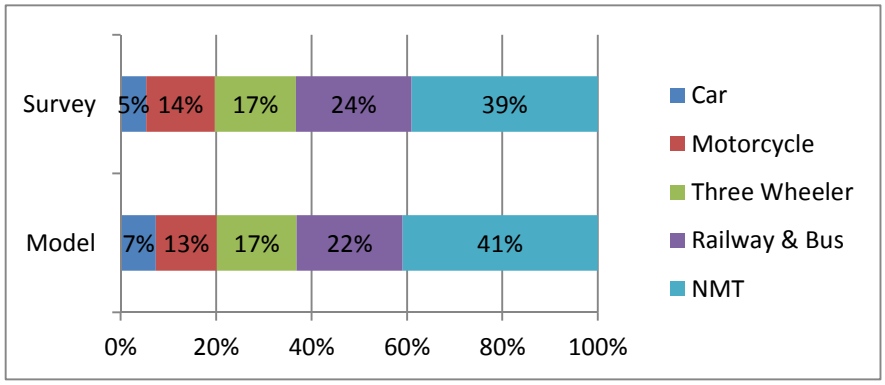
3.6.1 Modal Share

Using the present origin-destination table by purpose by income group and impedance table prepared by the preliminary traffic assignment, modal share was estimated for inter-zonal and intra-zonal trips. Comparison results are summarised in Figure 3.6.1 and Figure 3.6.2. The Home Visit Survey results and the estimated modal share are almost equivalent for both inter-zonal trips and intra-zonal trips.



Source: CoMTrans Study Team; NMT stands for non-motorised transport.

Figure 3.6.1 Verification of Modal Share of Inter-Zonal Trips



Source: CoMTrans Study Team; NMT stands for non-motorised transport.

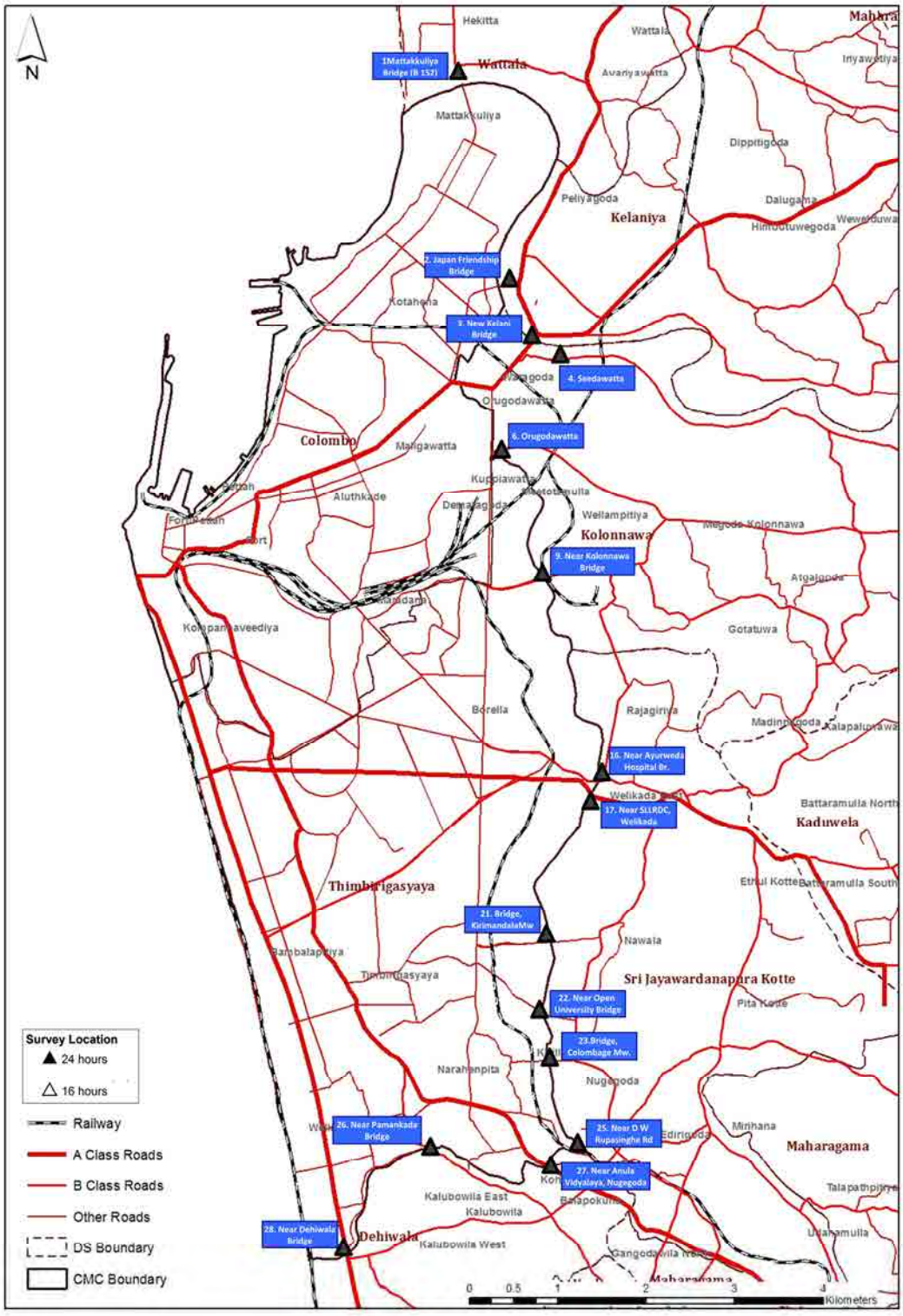
Figure 3.6.2 Verification of Modal Share of Intra-Zonal Trips

3.6.2 Road Assignment

Results of the road assignment (.IRE) were verified with the classified vehicle count results of the screen line survey. The main objective of the screen line survey is observing traffic volume at some of the previous survey locations. The classified vehicle count survey contains the number of vehicles by hour band by mode by direction. The survey locations were selected based on the major roads which are going through the boundary of CMC, Kalutara- Colombo District Boundary and Gampaha-Colombo District Boundary. The survey was conducted in 67 locations in Western Province to analyse the vehicle movements for major corridors.

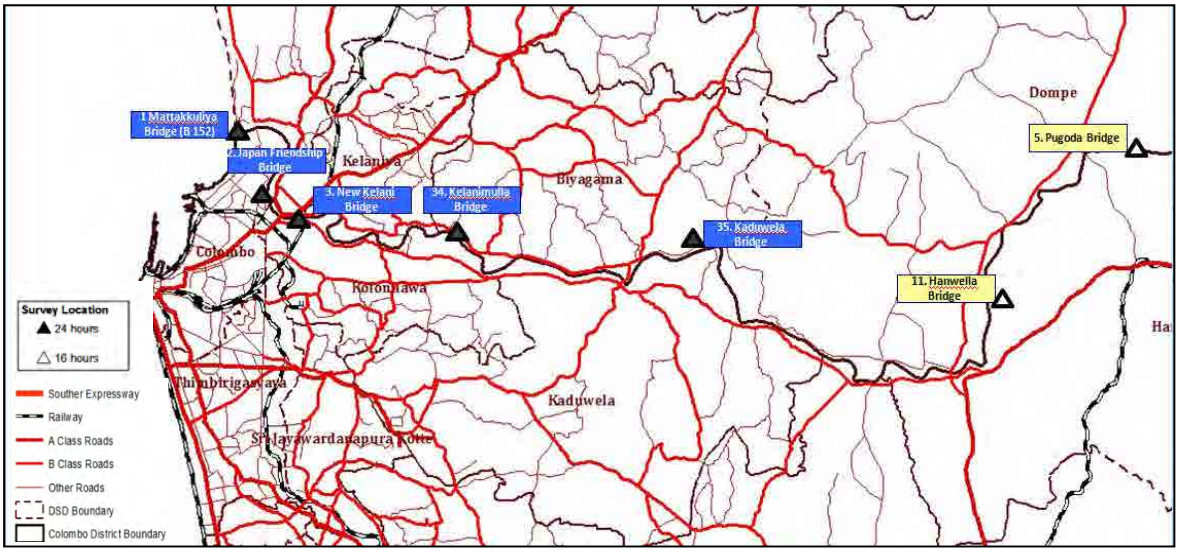
The comparison was conducted at the CMC, Kalutara- Colombo and Gampaha-Colombo boundaries. According to that comparison, the locations for each boundary and the road segments for selected locations were identified (see Figure 3.6.3, Figure 3.6.4 and Figure 3.6.5). The line segment is selected from the JICA STRADA network with the use of Arc GIS.

Comparison was made for the modes of car, motorcycles, three-wheelers and trucks.



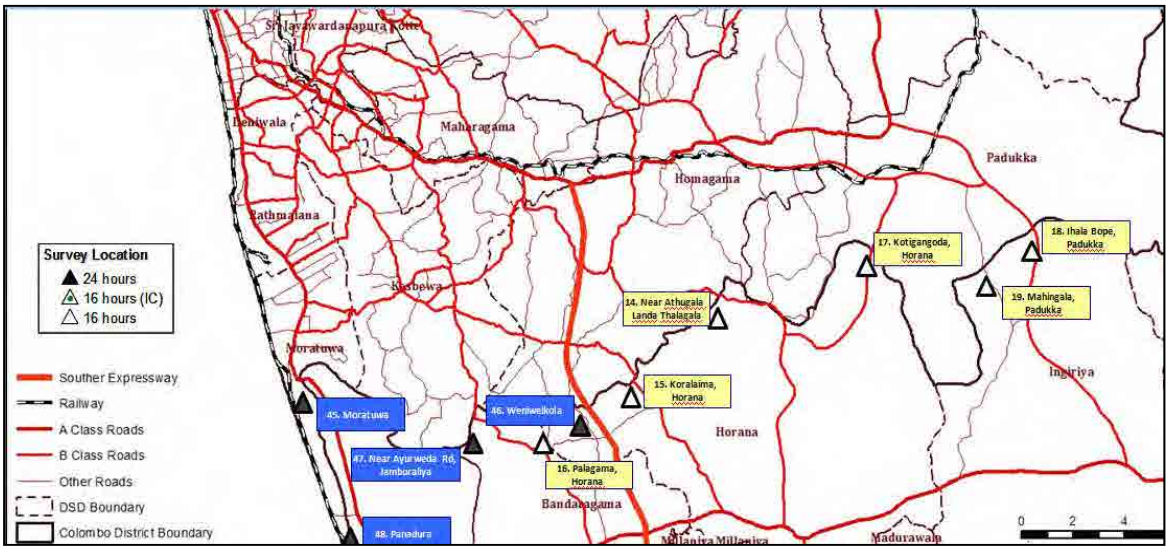
Source: CoMTrans Study Team

Figure 3.6.3 Survey Locations at CMC Boundary



Source: CoMTrans Study Team

Figure 3.6.4 Survey Locations at Gampaha - Colombo Boundary



Source: CoMTrans Study Team

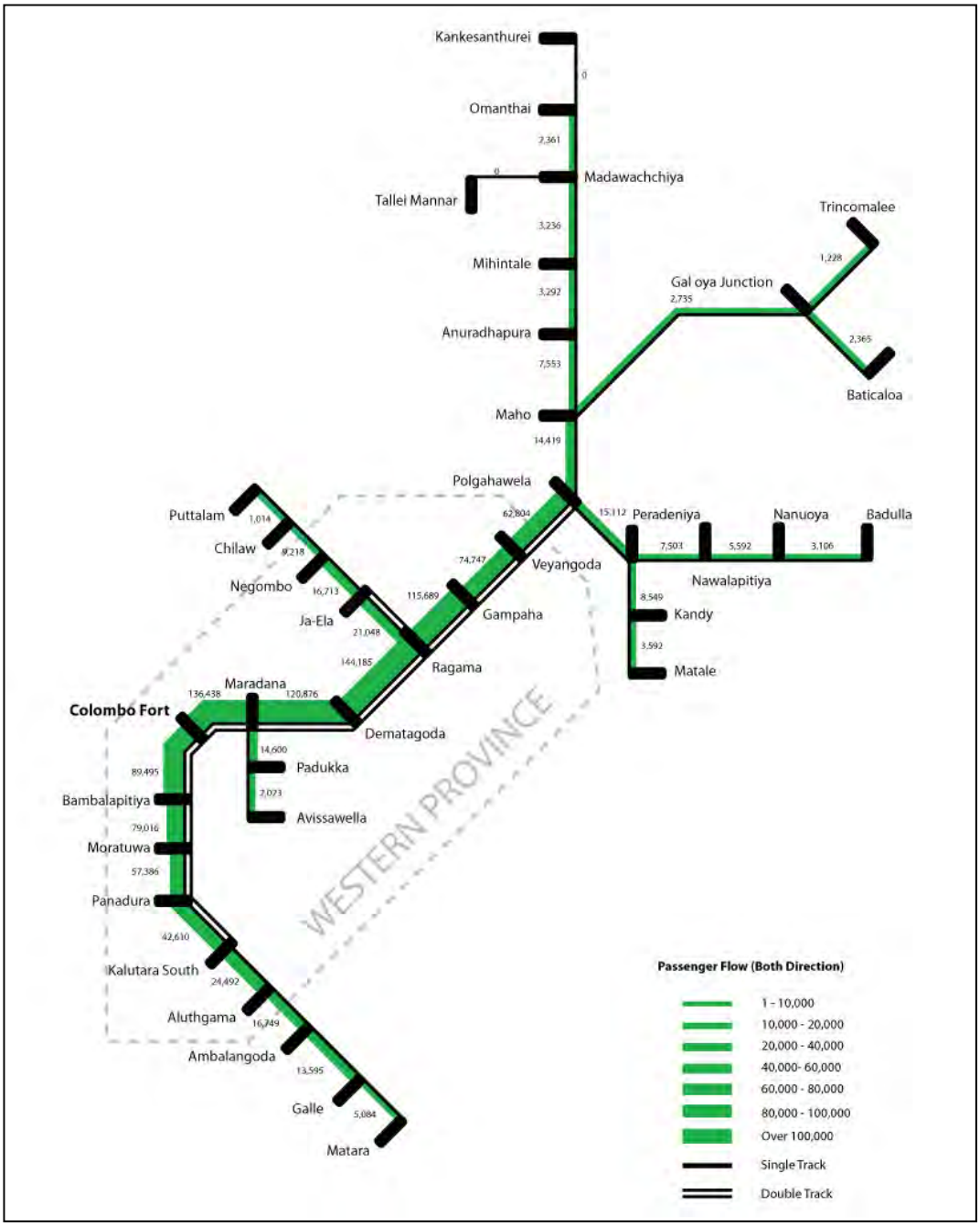
Figure 3.6.5 Survey Locations at Kalutara -Colombo Boundary

3.6.3 Transit Assignment

The transit assignment results (.TRE) were verified with the screen line survey of the bus passenger count. The same survey locations which were surveyed for the road assignment were selected for the analysis. A comparison was made for CMC, Kalutara and Colombo and Gampaha and Colombo boundaries for buses and trains.

In addition to the road segment of survey location, train routes were also selected from the JICA

STRADA network. Train data analysis was made from the Railway Passenger Flow in the Railway Network survey data (see Figure 3.6.6) (University of Moratuwa, 2009). Results of the screen line survey and traffic assignment are shown in Table 3.6.1.



Source- UoM,2009 and Study Team

Figure 3.6.6 Daily Sectional Railway Passenger Volume

Table 3.6.1 Comparison of Screen Line Survey and Traffic Assignment– Private Mode

CMC Boundary (Both Directions)

Item	Car	Motorcycle	3 Wheeler	Sum of 3 Types	Car	Motorcycle	3 Wheeler	Bus	Truck	Sum of 5 Types
Unit	Vehicles/day	Vehicles/day	Vehicles/day	Vehicles/day	PCU/day	PCU/day	PCU/day	PCU/day	PCU/day	PCU/day
Screen Line Survey	246,082	132,584	152,881	531,548	246,082	53,034	122,305	46,572	93,350	561,343
Assigned Traffic	194,589	125,483	83,190	403,262	194,589	50,193	66,552	34,860	87,800	433,994
Asgn/SLS	79%	95%	54%	76%	79%	95%	54%	75%	94%	77%

Boundary of Gampaha and Colombo District (Both Directions)

Item	Car	Motorcycle	3 Wheeler	Sum of 3 Types	Car	Motorcycle	3 Wheeler	Bus	Truck	Sum of 5 Types
Unit	Vehicles/day	Vehicles/day	Vehicles/day	Vehicles/day	PCU/day	PCU/day	PCU/day	PCU/day	PCU/day	PCU/day
Screen Line Survey	82,249	67,863	52,377	202,489	82,249	27,145	41,902	19,966	68,532	239,794
Assigned Traffic	66,051	60,388	35,883	162,321	66,051	24,155	28,706	13,420	53,259	185,591
Asgn/SLS	80%	89%	69%	80%	80%	89%	69%	67%	78%	77%

Boundary of Kalutara and Colombo District (Both Directions)

Item	Car	Motorcycle	3 Wheeler	Sum of 3 Types	Car	Motorcycle	3 Wheeler	Bus	Truck	Sum of 5 Types
Unit	Vehicles/day	Vehicles/day	Vehicles/day	Vehicles/day	PCU/day	PCU/day	PCU/day	PCU/day	PCU/day	PCU/day
Screen Line Survey	31,600	38,710	21,476	91,787	31,600	15,484	17,181	9,662	21,021	94,948
Assigned Traffic	33,468	31,888	28,886	94,242	33,468	12,755	23,109	7,810	17,951	95,093
Asgn/SLS	106%	82%	135%	103%	106%	82%	135%	81%	85%	100%

Table 3.6.2 Comparison of Screen Line Survey and Traffic Assignment– Public Transport

Item		CMC Boundary	Boundary of Gampaha– Colombo Districts	Boundary of Colombo –Kaluatra Districts
Count Survey & Statistics	A	1,206,955	484,965	117,823
Assigned Traffic	B	1,084,138	380,622	220,219
Assignment /Survey	B/A	90%	78%	187%

Unit: passengers / day / both directions

Source: CoMTrans Study Team

While limited difference are observed between the assigned traffic and the count survey results, both data contain certain errors such as observation error of the surveyors, small roads which were not surveyed or simulated in the assignment, daily fluctuation, under reported trips by respondents of the home visit survey and so forth. Taking these into consideration, the simulated model is, in general, valid for metropolitan-scale estimation while further verification and modification are required for a detailed study.