DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF TRANSPORT

URBAN TRANSPORT SYSTEM DEVELOPMENT PROJECT

FOR COLOMBO METROPOLITAN REGION AND SUBURBS

CoMTrans URBAN TRANSPORT MASTER PLAN

FINAL REPORT

MAIN REPORT

AUGUST 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.

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Shaping the Future of Urban Transport in Sri Lanka...
CoMTrans URBAN TRANSPORT MASTER PLAN

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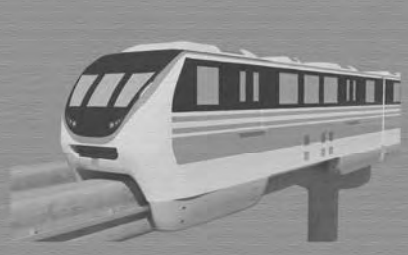

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URBAN TRANSPORT SYSTEM DEVELOPMENT PROJECT FOR COLOMBO METROPOLITAN REGION AND SUBURBS FINAL REPORT

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Abbreviation	Official Name
AAGR	Average Annual Growth Rates
AGT	Automated Guideway Transit
AirMac	Air Resource Management Center
A/L	Advanced Level
ATM	Asynchronous Transfer Mode
BPO	Business Processing Outsourcing
BRT	Bus Rapid Transit
CCPI	Colombo Consumer Price Index
CCTV	Closed Circuit Television
CEA	Central Environmental Authority
CKE	Colombo – Katunayake Expressway
CLS	Cordon Line Survey
CMA	Colombo Metropolitan Area
CMC	Colombo Municipal Council
CoMTrans	Urban Transport System Development Project for Colombo Metropolitan Region and Suburbs
CPI	Consumer Price Index
CTC	Centralised Traffic Control
DMT	Department of Motor Traffic
DMU	Diesel Multiple Units
DSD	Divisional Secretariat Division
EMU	Electric Multiple Units
EPZ	Export Processing Zones
ERP	Electronic Road Pricing
EU	European Union
GCE	General Certificate of Education
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GLK	The Government of the Democratic Socialist Republic of Sri Lanka
GND	Grama Niladhari Division
GPS	Global Positioning System

Abbreviation	Official Name
GRDP	Gross Regional Domestic Products
HC	Hydro Carbon
HVS	Home Visit Survey
IC	Integrated Circuit
IE	Industrial Estate
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPIECA	International Petroleum Industry Environmental Conservation Association
IT	Information Technology
LA	Local Authority
LRT	Light Rail Transit
MC	Municipal Councils
MMC	Multi-Modal Transport Centre
MmTH	Multi-Modal Transport Hub
MODUD	Ministry of Defence and Urban Development
MOFP	Ministry of Finance and Planning
MOHPS	Ministry of Highways, Ports and Shipping
MOPTS	Ministry of Private Transport Services
MOT	Ministry of Transport
NPPD	National Physical Planning Department
NTC	National Transport Commission
O&M	Operation & Maintenance
OCH	Outer Circular Highway
OD	Origin and Destination
ODA	Official Development Assistance
O/L	Ordinary Level
P&R	Park and Ride
PRDD	Provincial Road Development Department
PCUT	Presidential Committee for Urban Transport
PDCA	Plan-Do-Check-Action
PPHPD	Passengers per Hour, per Direction
PPP	Public Private Partnership

Abbreviation	Official Name
PRDA	Provincial Department of Road Development
PS	Pradeshiya Sabha
RDA	Road Development Authority
RFID	Radio Frequency Identifier
RPTA	Road Passenger Transport Authority
SEMA	Strategic Enterprise Management Agency
SEW	Southern Expressway
SLLRDC	Sri Lanka Land Reclamation and Development Corporation
SLR	Sri Lanka Railways
SLTB	Sri Lanka Transport Board
TAZ	Traffic Analysis Zone
TDM	Transport Demand Management
TOD	Transit Oriented Development
TSS	Travel Speed Survey
UC	Urban Council
UDA	Urban Development Authority
UHF	Ultra High Frequency
USA	United States of America
VET	Vehicle Emission Testing
VHF	Very High Frequency
WP	Western Province
WPRDA	Provincial Road Development Authority
WPRPTA	Western Province Road and Passenger Transport Authority

Executive Summary

1. Introduction

The transport demand has increased remarkably over the past few years, especially in the Colombo Metropolitan Area (hereinafter referred to as CMA), which consists of the Colombo Municipal Council (hereinafter referred to as CMC) and the adjacent area, which is shown in Figure 1.1.

Due to the increase in traffic demand, the speed of vehicles on the roads has declined resulting in higher vehicle operating costs for vehicle owners and environmental deterioration on the entire community. These impacts negatively affect not merely the economic development in the CMA, but also that of the country because roughly half of the country's economic activities are concentrated in this area. In addition, the nation's largest international seaport and airport are located within the area. The CMA, therefore, requires improvement and development of the transport system to tackle the increasing transport demand.

Source: CoMTrans Study Team

Figure 1.1 Colombo Metropolitan

As the largest metropolitan area in Sri Lanka, the population of CMA was 3.7 million inhabitants in 2012. It is estimated that the total population of CMA will increase to 5.1 million people in 2035 and economic growth with urban development plans are expected. The total person trip demand would increase 1.75 times and the trip demand made by private modes of transport would increase rapidly due to the anticipated increase of household incomes.

Current traffic congestion becomes serious during the morning and evening peak periods within and around the boundary of CMC and is expanding its area. Furthermore, traffic congestion will worsen due to the anticipated increase of demand if appropriate countermeasures are not taken. Less utilisation of high occupancy vehicles, a lack of facilities for pedestrians and bus passengers, an insufficient capacity of public transport and poor enforcement of traffic rules aggravate the situation.

2. Urban Transport Problems in CMA

The urban transport problems have been explored to identify the urban transport planning issues.

2.1 Traffic Congestion

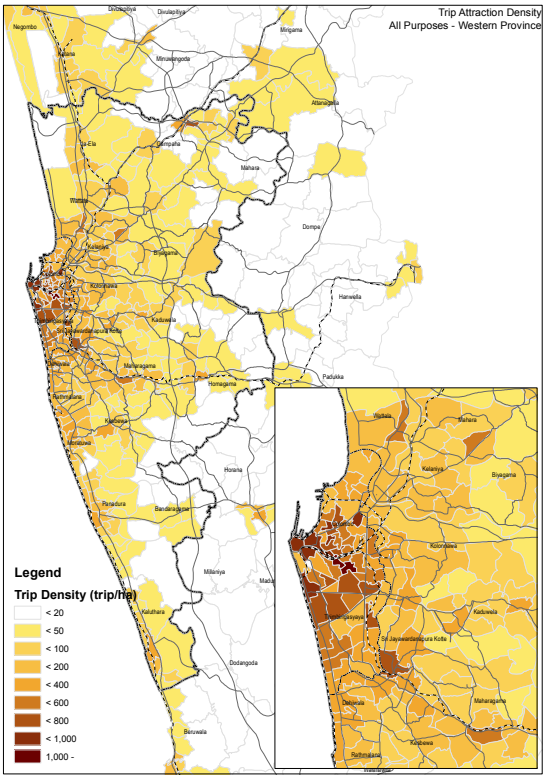
Traffic congestion has been worsening in recent years on the road network in the central area of CMA. Traffic congestion has brought about huge economic loss by increasing vehicle operating cost as well as travel time cost.

(1) Concentration of Trip Attraction

Concentration of trip attraction can be observed inside CMC. This concentration is one of the causes for traffic congestion in CMA as shown in Figure 2.1.

(2) Traffic Congestion in Morning and Evening Peak Hour

Traffic congestion is observed in the morning and evening peak periods at intersections of radial arterial roads, especially around the periphery of CMC and inner cities such as Borella, Maradana, Dematagoda, Town Hall and Nugegoda according to the travel speed survey as illustrated in Figure 2.2.



Source: CoMTrans Study Team

Figure 2.1 Concentration of Trip Attraction in CMC

Source: CoMTrans Study Team

Figure 2.2 Travel Speed in CMC in the Evening Peak Hour

2.2 Urban Transport Problems by Sub Transport Sector

Urban transport problems have been identified by sub transport sector as listed below;

(1) Problems of the Railways

- Insufficient Linkage of the Network
- Lack of Feeder Service for Railways
- Insufficient Integration among Public Transport
- Lack of Railway Access to the International Airport

- Slow Operational Speed of Trains
- Deteriorated Rolling Stock, Track and Signalling Systems
- Insufficient Line Capacity
- Insufficient Revenue of Sri Lanka Railways
- Insufficient Expenditure for Maintenance
- Low Level of Service of Kelani Valley Line

(3) Problems in Bus Transport and Other Road-Based Public Transport

- Low Bus Operation Speed due to Traffic Congestion on Roads
- Pettah-Centred Bus Network
- Lack of Integration with Railways and Other Bus Terminals
- Low Service Level of Bus Operation
- Difficulty in Improvement of SLTB's Bus Service
- Inconvenient Bus Operation for Passengers due to Bus Rental System of Private Bus Operation
- Difficult Coordination between Public and Private Bus Operations
- Insufficient Support for Bus Fare Discount for the Transport Poor
- Insufficient Management on Bus Operation
- Market-Driven Regulatory Scheme of Road-Based Public Transport Modes

(4) Problems on Road Network

- Insufficient Road Network
- Lack of Pedestrian Space
- Lack of Road Network Master Plan for the CMA
- Lack of Road Design Standards for Urban Roads
- Low Accessibility of the Existing Expressway Network
- Need to Enhance Access to Colombo Port for Cargo Transport
- Lack of Linkage of Expressway Network

(5) Problems on Traffic Control and Traffic Management

- Traffic Congestion at Intersections
- Reduction of Traffic Capacity due to On-street Parking
- Traffic Accidents involving Pedestrians and Motorcycles

3. Urban Transport Planning Issues in Colombo Metropolitan Area

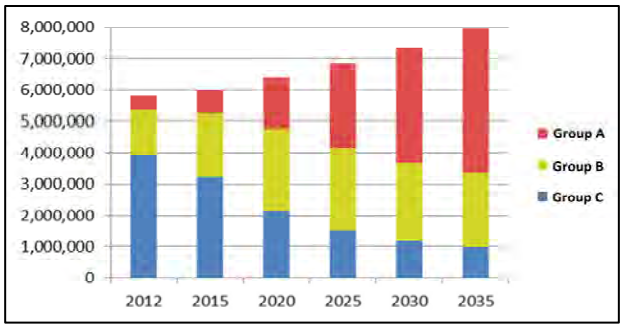
3.1 Perspective of Socio-Economic Aspect and Urban Structure

(1) Urban Development in the City Centre and Suburbanisation

Urban development projects are planned mainly in the city centre and job opportunities will increase in the central area. Since the residential area will disperse and the urban area will be expanded to the suburb, it implies that commuter trips to the city centre will increase and the travel distance of commuters will be longer due to the dispersion of the residences of the population.

(2) Increase in Real Household Income

As high economic growth is expected in the nation, real term household income will increase. In accordance with GRDP growth, real household income would also increase proportionally. It is estimated that the composition of Group C households, of which the monthly income is lower than Rs 40,000, would decrease from 67.8 % in 2012 to 12.5 % in 2035 as shown in Figure 3.1. In contrast the composition of Group A households, of which the monthly income is higher than Rs 80,000 would increase from 7.6% in 2012 to 56.3% in 2035.



Note: 2012 Estimation from CoMTrans Home Visit Survey.
2015-2035 projection, CoMTrans Study Team
It is considered that income 80,000 and over is Group A , income between 40,000 and 79,999 is Group B and, income below 39.999 Rs is Group C.

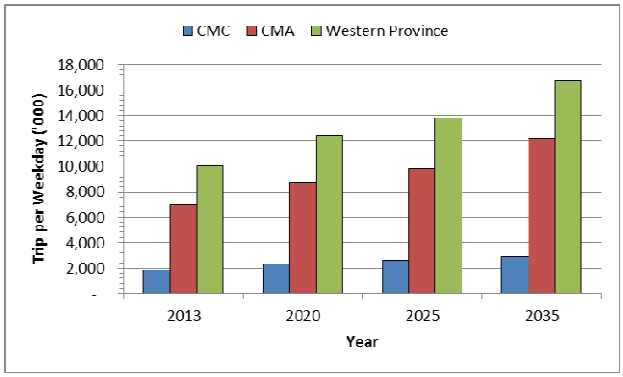
Figure 3.1 Projected Population by Income Level in the Western Province

(3) Increase in Ownership of Private Modes of Transport

The increase of household income would bring about an increase of ownership of private passenger cars and motorcycles. The increase of private modes of transport naturally increases traffic demand on the roads and would cause serious traffic congestion.

(4) Projected Transport Demand

In 2035 the total person trip production in the CMA would increase to almost 12.2 million person trips per day and this is 1.75 times of the present demand of 6.9 million person trips per day as illustrated in Figure 3.2.



Source: CoMTrans Estimate

Figure 3.2 Increase of Person Trip Demand by Region: 2013 – 2035

3.2 Planning Issues for Urban Transport System Development

It is anticipated that traffic congestion will continue getting worse and worse without efforts on the improvement of public

transport systems and the restriction of private modes of transport by the Government. Planning issues in urban transport system development are identified as follows:

(1) Dealing with Peak Transport Demand and Concentration of Traffic in the City Centre

Traffic congestion is brought about by peak traffic demand in time and spatial concentration of vehicular traffic in the city centre. To tackle the traffic congestion problem, one way is to flatten the peak demand. Another countermeasure is to distribute traffic concentration in the city centre to sub centres. This would be achieved by developing urban centres in suburban areas where a sufficient number of job opportunities should be provided. By distributing job opportunities in sub centres, these sub centres would attract the employed population from the surrounding areas and could reduce traffic concentration in the city centre.

(2) Anticipated Shift to Private Modes of Transport

According to the historical trend of modal shift in the last 28 years, the number of passengers crossing CMC boundary by private mode of transport increased approximately 2.5 times while the number of passengers using public transport remained roughly static. The vehicle ownership in recent years also shows a surge in the number of passenger cars, three-wheelers and motorcycles.

Group A households are captive to private modes of transport according to the Home Visit Survey results. Taking into consideration the fact that economic growth is expected in the CMA with huge urban development projects, the modal shift to private modes of transport will be accelerated if no government intervention is taken.

The share of public transport will continuously decrease with economic growth if the government does nothing. While some U.S. cities are recently trying to increase the share of public transport to reduce externalities of private mode of transports, a limited number of cities have succeeded to regain a share of public transport. Once car ownership and a share of private mode of transport increases, it is difficult to reverse it due to the captive characteristics of car users.

With the decrease of travel speeds on the roads due to the abovementioned severe traffic congestion, the speed of buses would decrease. This might accelerate the shift to private modes of transport. It is highly expected to break this vicious circle though provision of convenient, fast and high capacity public transport modes.

(3) Necessity to Develop Extensive Congestion-Free Public Transport Network

To deal with the traffic congestion problem in the city, the reduction of vehicular traffic demand is the main issue to pursue. Since the total travel demand in Colombo Metropolitan Area would increase in the planning period, a shift to public transport from private modes of transport is a challenging task for the Government. As traffic demand increases, traffic congestion on the road network would be worse and travel speed would be reduced in the future. The operation speed of ordinary buses will also be lower due to traffic congestion.

Public transport systems generally provide less convenient and longer travel time compared to private modes of transport, which can provide door-to-door service. Consequently, the public transport network to be introduced should be at a high level of service and congestion free by providing dedicated transport space in order to compete with private modes of transport.

In this regard, a heavy rail system, a medium-sized transit system and a bus rapid transit system

can be regarded as public transport systems with a high level of service in terms of operational speed and punctuality. It is therefore recommended to formulate the public transport systems for the Colombo Metropolitan Area with these congestion free systems and cover the public transport service area as widely as possible.

(4) Transport Facilities for the Physically Handicapped

At present barrier free facilities such as elevators and escalators are not yet provided at railway stations and bus terminals. Thus it is not convenient for physically handicapped people to use public transport. It is required to provide such facilities to support them to travel as normal people in the city.

(5) Transport System to Promote Health

Transport facilities for walking and bicycles have not had attention paid to it for a long time. Walking and bicycling has become popular since these modes are environmentally friendly and good for health. Walking is the most basic means for travel; therefore, the walking environment should be improved and developed in the future. Development of a pedestrian network separated from car traffic is good from the viewpoint of safety and good health overall. Furthermore, improvement in the walking environment would support the promotion of public transport use since when people use buses and the railways, they usually access the railway station and bus stops on foot.

4. Objectives for Urban Transport System Development

The analysis of the present urban transport problems and the planning issues in the Colombo Metropolitan Area have led to the identification of four major objectives which the urban transport system development needs to pursue.

(1) Equity in Transport to All the Members in Society and Affordability of Public Modes of Transport

A minimum level of transport service should be provided to all members of society. In the CMA, the mobility of Group C is limited due to their insufficient income. The role of public transport is thus of great importance in providing affordable means of transport for the Group C people to access urban services. At the same time, it is necessary to develop transport facilities for the physically challenged. Such facilities are seldom seen in the CMA at the present time and the gradual improvement of transport facilities is needed.

A rail-based transport system is better than a bus rapid transit (BRT) and other types of public transport systems since a rail-based transport in general have a larger passenger transport capacity than ordinary bus transport. Usually, rail-based transport has a grade separated structure and is not disturbed by other modes of transport; consequently, it runs faster than BRT since BRT usually must stop at intersections. However, it requires a huge amount of investment as well as having a higher operation cost. This implies that the system needs to charge the passengers a higher transport fare. According to the Home Visit Survey, the Group C with a monthly income less than Rs 40,000 pays about Rs 4,000 for transport. This implies that about 10% of household income is consumed for transport. According to worldwide household expenditure statistics, the average transport expense is usually around 10% of household income and if it exceeds the 10%, households must sacrifice some other expense. Most households therefore, cannot afford to pay

more for transport than at the present level. If the fare of new or improved public transport system is much higher than the presently prevailing fare level, the majority of residents will not be willing to pay for a higher transport fare. Until their household income increases to a certain level, the Government should provide financial support for developing the new transport systems and probably for operation costs in the beginning.

(2) Efficiency in Transport Systems to Support Economic Activities

Traffic congestion has resulted in a considerable amount of economic loss to society because of longer travel times, lack of punctuality and the deterioration of the environment. Efficiency in transport can be achieved by balancing transport demand and transport network capacity. Alleviation of traffic congestion can be dealt with in the following three ways: 1) by increasing road capacity through the development and improvement of the road network; 2) by optimising the utilisation of the existing road capacity by using a traffic control system and providing traffic information; and 3) by decreasing excessive vehicular traffic demand through transport demand management and diverting private mode users to public modes of transport.

At the same time, the promotion of public transport usage would also contribute toward economic efficiency by reducing vehicular traffic demand on the congested urban road network. Mass transit systems have an advantage over private modes of transport in terms of travel costs and lower consumption of space in the context of an urban area. The combination of all the approaches mentioned above will create an efficient transport system.

(3) Environmental Improvement and Health Promotion related to Transport

Air pollution caused by motorised vehicles should be minimised through emission controls for automobiles, promotion of public transport and traffic demand control, especially in the congested areas. Countermeasures to reduce PM10 should be the main focus, particularly in the CMA. In addition, aesthetics should also be considered for developing an urban transport system.

Recently people are more concerned with health and tend to do physical exercises. Walking and bicycling are good for health and transport facilities such as pedestrian paths and cycling roads should be developed for supporting these activities.

(4) Traffic Safety and Security in Transport

Since lives are invaluable and death and injury due to traffic accidents will bring great grief to family members and friends, traffic safety should be enhanced and the number of accident victims should be minimised through the enforcement of laws and regulations, intensive public campaigns, and training and education for drivers as well as the general public.

Improvement of traffic facilities through engineering design would contribute to the reduction of traffic accidents. Furthermore the security of children and women in public transport should be improved and it would partly contribute to increase the use of public transport.

5. Urban Transport Policy

To achieve the four different objectives for transport system development, the following transport policies are essential for the CMA;

1) Promotion of Public Transport Use
2) Alleviation of Traffic Congestion
3) Reduction of Traffic Pollutants/Traffic Noise and Promotion of Health
4) Reduction of Transport Accidents and Improvement of Security

These four transport policies are inter-related. The promotion of public transport is a principal measure to reduce dependence on private modes of transport. Mere improvement of public transport services, however, would not entice people who are accustomed to using private modes of transport to shift to public modes.

6. Urban Transport System Development Scenarios

The following four urban transport system development scenarios were evaluated to find the most appropriate option for long term transport system development for the CMA.

1) Base Case Scenario
2) Intensive public transport system development scenario
3) Mixed public transport and road network development scenario
4) Intensive road network development scenario

In addition, if these cases will not be able to alleviate traffic congestion, a further option can be added. Employment of transport demand management is this option and it includes car traffic restraint schemes such as Electric Road Pricing (ERP). Performance of each transport system development scenario is evaluated from the following aspects.

1) Efficiency: Economic Internal Rate of Return(EIRR) and NPV(Net Present Value)
2) Equity: Service area of quality public transport (railway, monorail and BRT)
3) Environmentally Friendly: Global Warming: Emission of CO_2
4) Traffic Safety: Economic loss due to traffic accidents

Table 6.1 Evaluation of Urban Transport System Development Scenarios

Evaluation Item	A1 Intensive Highway Development	A2 Intensive Highway Development & TDM	B1 Combined Public Transport and Highway Development	B2 Combined Public Transport and Highway Development & TDM	C1 Intensive Public Transport	C2 Intensive Public Transport Development & TDM
Economic Internal Rate of Return (%)	19.7%	21.2%	19.3%	22.7%	19.1%	22.9%
Net Present Value (billion Rs.)	622	765	564	779	541	797
Population in the Public Transport Service Area [1)]	1.26 million people		1.36 million people		1.40 million people	
Reduction of CO_2 Emission (million ton)	4.2	6.4	5.8	7.7	5.8	8.3
Reduction of Loss due to Traffic accident (million Rs.) [2)]	510	724	756	921	710	1066
Overall Evaluation	B-	B+	B-	A-	B-	A

Source: CoMTrans Estimate Note: 1) Public transport service area is defined as the area within 800 meter radius from railway stations and BRT shelters. 2) Loss of traffic accidents are discounted value at 12%.

C2 is recommended as the most appropriate urban transport system development scenario, which include developing the public transport system extensively and at the same time employing Transport Demand Management (TDM) to promote the shift to public transport.

7. Strategies for Urban Transport System Development

The strategies for developing Urban Transport Systems in the Colombo Metropolitan Area can be divided into two stages; one is a strategy at the planning stage and the strategies should be taken into consideration when planning urban transport systems and land use. The other strategies are those related to project implementation.

7.1 Strategies for Integration with Urban Planning

(1) Centre Development for Mass Transit Systems

Urban structure and transport systems should be integrated. For instance, a highway oriented transport network is suitable for low-density land use which can be seen in the suburbs of the United States. In contrast, a mass transit system is appropriate for high-density urban land use.

Sub-centre development is one way to deal with traffic concentration in the city centre. In order to develop the sub centres, strong transport linkage is required between the city centre of Colombo and the sub centres. Mass transit systems should be installed between these centres to support the travel needs of the people and goods. Conceptually, to support the viability of public transport systems, it is preferable that a city grows compactly in a form of poly-centric decentralisation. Guided urban development is essential to develop cities to be consistent with urban transport systems. In this regard, metropolitan-wide urban land use planning is also required.

(2) Development of Public Transport Systems to be Synchronised with Urban Development

The Colombo Metropolitan Area has expanded outward from the city centre. In suburban areas the population density has not been high thus travel demand is not high at present time. In the future, as urbanisation continues, travel demand would increase and then mass transit systems might be required. Mass transit systems should be developed in accordance with urban development. Travel demand along the corridor should be monitored to determine the development timing of the mass transit system. This phased development should be taken into account in particular for the BRT system to be developed along the planned Middle Ring road in the suburban area.

(3) Transit Oriented Development (TOD)

To make mass transit systems viable, high density urban development in the area surrounding rail-based transit system stations is preferable. In the city centre, high-rise office buildings and commercial facilities, such as shopping malls within walking distance from a station are desirable to increase passenger demand on the transit system. In suburban areas, high rise apartments near stations are a preferable form of land use for the mass transit system. To materialise these developments, high floor ratios should be promoted in the urban development plan. On the other hand, outside of the area surrounding the station the floor area ratios should be limited to prevent high density urban development. The urban transport master plan should take into consideration urban development structures. CoMTrans therefore proposes that the integration of urban

development with urban transport systems is of utmost importance. The strategy for the integration includes sub-centre development and Transit Oriented Development.

7.2 Strategies for Transport Planning

(1) Development of Extensive Public Transport Networks

Public transport systems at a higher level of service should be developed in the form of networks so that people can reach their destinations within the system. A higher level of public transport service means a congestion free transport system; namely, railway, medium-size transit systems such as monorail and bus rapid transit(BRT). A public transport network should consist of several trunk lines with feeder services and it should cover as wide an area as possible.

(2) Application of Transport Demand Management (TDM) and Car Traffic Restraint Scheme

Transport demand management (TDM) is necessary to alleviate traffic congestion in the CBD because new road construction, or even road widening is very difficult in the CBD and will be limited due to physical constraints such as the availability of land for the roads. Road pricing is a scheme to alleviate traffic congestion by charging vehicles entering congested areas in the city centre and it also raises funds for developing and improving the urban transport systems. Improvement of public transport is prerequisite for employing TDM.

7.3 Strategies in Project Implementation

(1) Introduction of Private Sector Funding in Transport Infrastructure Development

This system reduces the government investment for transport infrastructure development replaced by private sector funding and encourages the participation of private organisations for operation and maintenance. It is common that urban highways are developed under BOT (Build Operate Transfer) scheme or PPP (Public Private Partnership) scheme in many cities thus when urban expressways are developed, it should encourage participation of the private sector in the form of BOT or PPP. However public transport system development is usually difficult to finance by only the private sector. In most common cases, public transport fares are regulated by the Government at low levels since the government should provide means of transport for low income households. Therefore it seems difficult to make public transport projects financially profitable merely with passenger fare revenue. In many countries a common practice for financing public transport is to provide infrastructure by the public sector and provide operation by the private sector.

(2) Introduction of a Value-Capture System for Public Transport Development

Rail-based transport is not disturbed by ordinary traffic and this mode can provide fast speeds and large passenger capacity transport service. Railway passengers enjoy the fast and convenient railway service for travelling in the urban areas. In addition, railway service can increase the sales of department stores and shopping malls near stations and promote the values of land and housing along the railway corridor. However the railway company is not able to gain all the value added accrued from the railway development.

Since a rail-based transport system requires huge initial investment cost, the methodology of cost recovery should be done through value capture of development. In the case of private railway

companies in Japan, they develop housing areas along the railway corridor. After they provide new railway service, the land values increase and they sell the housing at a higher price and get profits from the real estate business. They are also starting retail businesses as well by building shopping malls at the terminal stations. From this kind of commercial business they can profit in addition to passenger transport service. To support the rail-based transit development project financially it is recommended to take this kind of business model into consideration.

(3) Methodology of Space Preparation for Urban Development

To develop the desirable urban structure, sometimes land acquisition is required but it is no easy to implement; thus, new implementation methods should be introduced. There are two methodologies that can be applied in Sri Lanka.

Land Re-adjustment

This is a typical method of Japan's urban development to create a comfortable residential area. An irregular-shaped plot is re-plotted to a rectangular shape by reducing the site area. The reduced site area is provided for roads and sometimes parks or community facilities, and part of the land is sold to cover expenses for compensation and construction cost for road improvement. Then all lands are re-plotted and roads can be constructed. Although each land owner lost a part of the land, the land owners will gain more value since the land value will be increased as the road condition becomes much better than before.

Urban Renewal Project

This is also a typical method in the Japanese context to create urban centres within a commercial or business district. Land owners can organise an urban renewal association. Often a developer coordinates to organise the association and the Government is also involved. The lands are unified and shared with the owners and the developer. A part of the land is provided for public purposes, mainly roads. Thus, a building is constructed and all the members gain benefits by allocating the floors.

Both are still challenging methods for the Sri Lankan context. However, implementation methods are essential and should be recommended in order to achieve the Master Plan.

8. Urban Transport System Development Programmes

8.1 Urban Transport System Development Programme (1) for Promotion of Public Transport Use

The following policy measures are proposed for promoting public transport use;

1) Monorail Systems

   Multi-Modal Transport Hub and Multi-Modal Centre (MMC)

   Park & Ride and Station Plaza Development

   Provision of Direct Access to Multi-modal Transport Hubs for Inter-city Bus Services
2) Modernisation of Existing Railway System
3) Construction of Airport Connection Line

4) Development of Access Roads to Stations of Railways and New Transit System
5) Introduction of Bus Rapid Transit (BRT)
6) Road Development for Introducing BRT
7) Bus Priority System and Bus Location System for BRT
8) Regulatory Scheme for Road-Based Public Transport Modes

8.2 Urban Transport System Development Programme (2) for Alleviation of Traffic Congestion

The following policy measures are proposed for alleviating traffic congestion;

1) Ring Road Development
2) East - West Arterial Road Development in Eastern Part of Suburban Area
3) Expressway Network Development
4) Flyover Development
5) Port Access Road
6) Traffic Control
   - Traffic Signal Control Improvement
   - Traffic Information System
   - Parking Information System
7) Transport Demand Management (TDM)

8.3 Urban Transport System Development Programme (3) for Reduction of Air Pollutants/Traffic Noise and Promotion of Health

The following policy measures are proposed for reducing air pollutants and traffic noise as well as promoting health;

1) Establishment of Environmental Management Scheme
2) Establishment and Enhancement of Air Pollutant Emission Standards for Newly Manufactured and Imported Vehicles
3) Enhancement of Vehicle Inspection and Maintenance Programmes
4) Low Sulphur Diesel Programme
5) Promotion of Natural Gas Vehicles
6) Promotion of Hybrid Cars and Electric Vehicles
7) Promotion of Walking and Bicycle Use for Energy Saving and to Promote Health
8) Provision of Sidewalk for Urban Roads

8.4 Urban Transport System Development Programme (4) for Reduction of Fatalities and Injuries in Traffic Accidents and Improvement of Security

The following policy measures are proposed for reducing fatalities and injuries in traffic

accidents;

1) Education on Traffic Safety
2) Rehabilitation and Installation of Traffic Signal System
3) Rehabilitation of Railway Signal System
4) Analysis on Causes of Traffic Accidents
5) Provision of Sidewalks and Pedestrian Crossings
6) Establishment of Urban Road Design Standard for Sidewalks

9. Implementation Plan for CoMTrans Master Plan

It is, in principal, necessary to undertake various analytical steps with regard to the "project life cycle" as defined by the Government in order to estimate the impact of the "CoMTrans Master Plan" implementation on the public investment budget.

However, since the CoMTrans Master Plan is a transport network development plan, in which all projects are inherently inter-linked, it suffices to analyse accumulated required investment totals over the three planning horizons (short, medium and long-term), the total planning period (2015-2035) and investigate how these totals compare to the Government's policy targets established for public investments in the transport sector.

9.1 Total Investment Cost Required for CoMTrans Master Plan Implementation

Table 9.1 shows the needed investment volume for CoMTrans realisation without assuming any particular financing model.

- The total investment volume over the planning period from 2015 to 2035 is estimated at Rs 2,780,900 million, of this 59% of the total is for net investments and about 41% for implied O&M cost.
- The distribution of the investment and O&M combined cost components is estimated at 35% over the short-term, 31% over the intermediate term and the balance of 34% over the long-term.
- This total volume may exceed the capacity to finance at a 100% self-financing rate from public budget and envisaged public investment resources.

9.2 Government Budget Requirement to Implement CoMTrans Master Plan

The "reduction in burden" on the public budget could be achieved if the expressways are predominantly financed under a PPP scheme and the O&M burden for the monorail and also the BRT system could be shifted to private sector interests. The main message of the numbers is:

- Total net additions to investment over the whole planning period would be reduced from Rs 2,780,960 million to Rs 2,256,500 million or roughly by 19%
- The major gain would originate from reductions to the public investment budget, and
- Minor gain would also be achieved through reducing the impact on the Government's O&M expenditure.

Table 9.1 Total Investment Requirements for the Entire CoMTrans Master Plan Realisation

unit: million RS

	Short	Intermediate	Long	Total
	2015-2020	2021-2025	2026-2035	
	6 years	5 years	10 years	21 years
Investment				
Monorail	173,800	89,800	144,600	408,200
Railway	67,800	146,400	74,500	288,700
BRT	12,300	9,300	0	21,600
Bus	0	0	0	0
Multi-Modal Transit Facility	21,700	0	0	21,700
Road	462,800	345,000	74,300	882,100
- Expressway	407,100	138,300	0	545,400
- Other Roads	55,700	206,700	74,300	336,700
Traffic Management	2,800	7,500	7,500	17,800
Total	741,200	598,000	300,900	1,640,100
O & M				
Monorail	52,100	65,900	204,100	322,100
Railway	46,100	75,000	187,300	308,400
- Additional Investment	20,300	53,500	144,300	218,100
- Existing Infrastructure	25,800	21,500	43,000	90,300
BRT	10,300	14,100	28,300	52,700
Bus	81,000	67,500	135,000	283,500
Multi-Modal Transit Facility	3,900	3,300	6,500	13,700
Road	43,500	38,100	76,200	157,800
- Additional Investment	0	200	400	600
- Existing Infrastructure	40,700	33,900	67,900	142,500
- Expressway	2,800	4,000	7,900	14,700
Traffic Management	200	500	1,800	2,500
Total	237,100	264,400	639,200	1,140,700
Grand Total	978,300	862,400	940,100	2,780,800
% Composition	35%	31%	34%	100%

Source: CoMTrans Estimate

If it is assumed that the maximum allocation to the urban transport sector is 2% of GRDP in the Western Province, in the short term a shortage of development funds is expected. Consequently to fill the gap between the government budget and amount required for investment, it should consider utilising external financial sources such as ODA.

10. Institutional Setup and Regulatory Framework for Urban Transport

10.1 Transport Administration in Sri Lanka

The National Transport Policy sets the following administrative structure to ensure the adequate provision of transport infrastructure and services. The transport administrative structure is divided into five steps, i.e. policy, planning, implementation and monitoring, regulation, infrastructure provision, and service provision. Although transport policy is made by the MOT assisted by the NTC and other stakeholders and the planning is done by the NTC, the reality is that there are central and provincial governments involved in vertical sphere, and some numbers of institutions involved in horizontal sphere, even if only at the central government level. If including subsidiary institutions, such as the DMT, MOFP and so on, the number of stakeholders increases.

The complexity of the existing urban transport administration makes the urban transport administration in CMA inefficient and this makes it difficult to carry out new transport measures and integrated transport policies, such as inter-modal transfer/connection, a common transport pass system and so on. As stated in the National Transport Policy, the efficiency of transport administration lies in how such complexity can be dealt with in a planned manner. In order to ensure the planning function is strengthened and becomes a responsibility of the assigned agencies, the Government indicated in the National Transport Policy that it would establish a coordination mechanism for urban transport through the Presidential Committee for Urban Transport (PCUT), which is in line with the CoMTrans Team's recommendation as well. An ideal structure for the urban transport administration in CMA would be to establish an agency that is powerful in policy making, planning, monitoring budget allocation, and implementation of public transport service delivery, but lean in institutional structure, i.e. not creating another mega institution to hire many staff members and to fight over vested interests with the existing institutions.

10.2 Towards the Realisation of CoMTrans Master Plan

In line with the National Transport Policy, the CoMTrans suggests the establishment of an Urban Transport Council under the President. The council is expected to be a central high-level body that represents all main political decision makers in urban transport, including the Western Provincial Council. The members consist of appropriate ministers and/or deputy ministers from national government and the chief minister or transport minister of the Western Province Council. The council is to be led by the senior minister in charge for transport in the Administration. The council is set-up for making decisions on urban transport policy and planning in CMA, so it would not replace the existing transport sub-committee under the Cabinet nor the Parliament. The sub-committee for transport under the Cabinet shall be the final resort for the urban transport council, as well, to politically solve transport issues which encompass widespread areas.

(1) Institutional Arrangement

The council must be established as a standing council until its functions are transferred to the envisaged urban transport authority in the future. However, it is not intended to create another institution such as a ministry, department or authority. Therefore, it is suggested to establish a sub-division under the Planning Division of the MOT to support the council as secretariat. The functions of the secretariat are to support all administrative and technical tasks appointed by the council; yet, considering the scarcity of professionals in urban development and transport planning

in the government sector, it is suggested that the academia, e.g. University of Moratuwa, provides technical support to the secretariat. Since the council consists of higher-level members, establishment of a technical committee or technical task force shall be taken into account once the council is formally established. The functions of the technical committee, among others, are to update the transport data collected for the CoMTrans master plan, and to formulate roll-over transport annual action plans, to monitor the progress of the master plan, and to provide technical inputs to the council.

It should be underlined that the council, the secretariat in the MOT and the technical committee must be legally supported as formal bodies, i.e. being established under a presidential decree and announced in a Gazette. It should be also noted that the proposed council is not, apparently, a monolithic bureaucracy which consolidates all present departments and agencies, but it is an efficient strategic policy setting body that coordinates and governs all the components of urban transport. It is also not a funding agency, but one of its duties is to make funding decisions under the framework of given functions of the council to support and recommend budget allocations to MOFP, which allocate budget directly to agencies based on its decisive criteria. The council is envisaged to be responsible for every facet of urban mobility including private modes and public transport and will also have some influential role in city development planning in close cooperation with NPPD, UDA, the Western Provincial Council and local authorities.

(2) Legalising the CoMTrans Master Plan

Unless the CoMTrans master plan becomes a legally binding master plan, there would be no base for the newly established urban transport council to implement the plan, taking into account that respective ministries and local government must already have their own plans to develop roads, public transport service delivery and so on.

Considering that the anticipated members of the council will be almost the same as the members of the steering committee of the CoMTrans master plan study, it is expected that first the CoMTrans master plan would be agreed among the steering committee members and the MOT submit it as a legally binding master plan to the Administration to be endorsed. It is crucial that the short-term projects shall be jointly scrutinised with the National Planning Department of the MOFP, in terms of feasibility of budget allocations for forthcoming project proposals.

(3) Risks for the Realisation of CoMTrans Master Plan

In the past, similar recommendations were made in several studies; yet, no coordination body was established. As stated in previous sections, several issues have hindered the realisation of the recommended measures, i.e. lack of continual political willingness and adverse political interventions, unclear delineation of functional responsibilities among transport related institutions, lack of coordination mechanisms, absence of legal basis for the master plan and absence of legal basis for the implementing institutions.

The biggest issue encountered for the realisation of the master plan is the unpredictable political influence and wandering political directions, which are hard to control or prevent. However, once the master plan becomes a legally binding document, it will be at least a roadmap for urban transport development in CMA. The previous JICA study team failed to make its master plan a legally binding plan, so it had weakness in the implementation stage; so it is strongly suggested that the Steering Committee agrees upon the CoMTrans master plan and make it a legally binding plan within the study period. Once the master plan is endorsed by all stakeholders, the council

can be established and functional responsibilities between the council and related line ministries, agencies and local authorities become crystal clear since the proposed projects and implementing agencies are indicated in the master plan.

11. Conclusions

Economic development has accelerated after the end of the civic conflict and travel demand has also increased rapidly. Colombo is the centre of economic activity in Sri Lanka thus the increase in traffic demand has been remarkable. In the Colombo Metropolitan Area, 6.9 million trips are made each day at present and it is estimated to grow to 12.2 million trips in 2035. It goes without saying that a mass transit system is needed to meet the increasing travel demand. In the CoMTrans master plan it is recommended to develop a monorail system together with a Multi-modal Transport Hub, Multi Modal Centre and Park & Ride systems. It is desirable to develop a rail-based transport system, which is not disturbed by ordinary road traffic. The rail-based transport system, however, requires a considerable amount of investment for development. Consequently, it usually takes a long time to develop the extensive rail-based transport network.

On the other hand, at present buses run at low speeds because buses are caught in the general traffic congestion on the roads, thus punctuality of operation is not ensured. A large number of residents now try to avoid using buses because of the low level of bus services such as over-crowding, lack of punctuality and lack of comfort. Therefore, a higher level of public transport service should be urgently provided to prevent the shift from public to private modes of transport. Furthermore, having merely one route of the rail-based transport system is not sufficient to attract people to public transport use but an extensive network should be formulated like a web to cover the major travel destinations in the metropolitan area. Improvement of transport nodes such as station plazas could make it easy and convenient to use public transport systems.

It should also be noted that the ability to pay for transport of the majority of the residents is low and it is therefore difficult to set public transport fares high enough to enable the private sector to provide a high level of public transport services.

In the short term and intermediate term, the public transport network should be formulated by combining the existing Sri Lanka railway which needs upgrading, a monorail system and BRT system. In the long run, a rail-based transport system is needed to provide a higher level of services as well as a higher passenger capacity. The development of a BRT system ensures the space for future rail-based transport system development with a higher level of services.

Improvement of public transport services alone cannot suppress the deeply rooted preference to use private modes of transport; consequently, traffic restraint schemes should be employed in the central area of CMA where traffic congestion is often observed.

Another important measure is to develop sub-centres in suburban areas and to distribute the urban functions, which are currently concentrated in CMC. By creating an alternative urban structure, traffic congestion problems would be alleviated to some extent.

Although promotion of public transport is the most important policy to alleviate the transport problems in the master plan, the road network has not been well developed and the capacity is significantly low in suburban areas. In particular, the progress of road network development has

not caught up with the expansion of urbanised areas, therefore, road network development is also important in suburban areas.

Transport infrastructure development requires a long period in order to be realised, thus in order to deal with the current transport problems, immediate actions are necessary. The short-term countermeasures include the installation of area-wide traffic signal systems and the improvement of present signal control. Traffic control such as one way systems is also taken into account for the alleviation of traffic congestion in specific areas.

12. Recommended Immediate Actions

(1) Legal Framework for Transport Network Development

The target year of the CoMTrans urban transport master plan is 2035, which is 21 years from now. Developing transport infrastructure needs a long time. Once the urban transport master plan is agreed among the relevant stakeholders, it should be authorised and have legal binding for future development. This implies that the Right of Way (ROW) should be reserved for future development of transport facilities - railway and road networks. If urban development such as commercial building and residential complex developments are allowed in the areas set aside for the planned transport network, it would become difficult to develop the transport network in a desirable form. It is therefore proposed to establish a legal framework for setting aside a space for future transport system development.

(2) Enhancement of Urban Land Use Regulations

CoMTrans emphasises the importance of integration between land use and the transport systems, thus Transit Oriented Development (TOD) is recommended in this regard. It needs high density urban development in the areas surrounding railway stations and important public transport hubs. Urban land use regulations which designate a type of land use and floor area ratio is needed for guiding land use to a desired pattern. In Sri Lanka, however, the floor area ratio has not been determined for every plot and no limitation on floor area is given to a block exceeding a certain size of plot area. Without limitation of the floor area ratio it is difficult to guide land use in the area surrounding the railway stations into high density, for instance high rise office buildings and apartments. Urban land use plans with guidance for the floor are ratio should be prepared for materialising TOD, otherwise it will be difficult to promote. If such regulations cannot be established, it would lead to failure in TOD and also it would worsen the traffic congestion.

(3) Post Evaluation of Projects in the Urban Transport Master Plan

It is definitely important to conduct a post evaluation to understand the performance of the relevant agencies. If some projects are delayed in implementation, it requires exploring the reasons why the projects have not been executed as scheduled. If the projects have been implemented, the impacts of the projects on transport as well as economic activities should be examined carefully. It should be then fed back to the next stage and the plan should be modified and improved into a more efficient and convenient system. The circumstances surrounding the urban transport will change over time and the initial plan would not be suitable for a new situation. The urban transport master plan, which is prepared for the long period of 20 years, should be regarded as a rolling plan. It should be reviewed regularly and updated to fit in the new circumstances. A Plan-Do-Check-Action (PDCA) cycle should be applied for master plan implementation and monitoring.

(4) Development of Urban Transport Database System

The CoMTrans conducted the first large-scale Person Trip Survey in Sri Lanka including Home Visit Survey and other relevant transport surveys. The data collected gives base data not only for transport planning but also for urban planning. In line with the master plan review and updating mentioned above, this database is useful for post evaluation of the master plan. The database should be updated and modified periodically for review and updating the master plan. Since the database covers a broad range of fields; demography, land use, economic activities, industry, and transport, the establishment of an urban transport database centre is desirable for maintenance of the database. The database centre could be established in the Ministry of Transport or a University. In addition, it is necessary to build the capacity of the transport planning experts who can undertake a transport analysis and plan using this database.

(5) Further Investigation on Traffic Safety

Thanks to the accident data provided by the police, an extensive traffic accident database is available and it was analysed in the Study. Further detailed analysis on Black Spots is proposed to identify the places where traffic accidents frequently occur. The analysis will lead to the identification of causes of accidents and required countermeasures.

(6) Promotion of Health in the Transport Sector

Developing of a pedestrian path network and bicycle road network, which connects major parks in the urbanised areas is proposed in the master plan. Construction of these facilities encourages walking, jogging and cycling by the citizens in the metropolitan area. These kinds of facilities contribute to green transport which aims at healthy and environmentally friendly transport.

(7) Bus Operation Reform

Bus operation can be made more efficient and systematic without a huge investment. Currently real-time monitoring of bus operation can be achieved with a GPS device. Fare collection with an IC card through a communication device is also available now. The technical solutions are available for the difficulties in monitoring and management of bus operation. Now is a good opportunity to reform bus operation to provide better service for passengers. Installation of a GPS device on the buses enables bus fleet tracking on a real time basis, and then the management of bus companies can control their buses on the roads. Moreover, the introduction of the IC ticket system makes it possible to provide a subsidy for private bus companies, if the government would like to provide subsidy for private companies, since the exact number of discount tickets can be counted.

(8) Feasibility Study for Project Implementation

A number of transport infrastructure development projects as well as soft measures have been proposed in the CoMTrans master plan. Although the feasibility study on Monorail and MmTH project has been conducted, the feasibility studies on the other projects are also important for alleviation of traffic congestion and the promotion of public transport. This includes BRT system development for developing an extensive quality public transport network integrated with the monorail and employment of ERP for demand management. It is recommended to conduct these feasibility studies at the earliest possible time.

Main Report

CHAPTER 1 Introduction

1.1 Background

The transport demand has increased remarkably over the past few years, especially in the Colombo Metropolitan Area (hereinafter referred to as CMA)[1], which consists of the Colombo Municipal Council (hereinafter referred to as CMC) and the adjacent area which heavily depend on urban transport.

Due to the increase in traffic demand the speed of vehicles on the roads has declined resulting in higher vehicle operating costs for vehicle owners and environmental deterioration on the entire community. These impacts negatively affect not only the economic development in the Colombo Metropolitan Area, but also that of the country because roughly half of the country's economic activities are concentrated in this area. In addition, the nation's largest international seaport and airport are located within the area. The Colombo Metropolitan Area, therefore, requires improvement and development of the transport system to tackle the increasing transport demand.

As the largest metropolitan area in Sri Lanka, the population of CMA was 3.7 million inhabitants in 2012. It is estimated that the total population of CMA will increase to 5.1 million people in 2035 and economic growth with urban development plans are expected. The total person trip demand would increase 1.75 times and the trip demand made by private modes of transport would increase rapidly due to the anticipated increase of household incomes.

Current traffic congestion becomes serious during the morning and evening peak periods within and around the boundary of CMC and is expanding its area. Furthermore, traffic congestion will worsen due to the anticipated increased demand if appropriate countermeasures are not taken. Less utilisation of high occupancy vehicles, a lack of facilities for pedestrians and bus passengers, an insufficient capacity of public transport and poor enforcement of traffic rules aggravate the situation.

It seems difficult for the government to invest for all of the transport infrastructure projects since a huge amount of investment is required for development. Appropriate allocation of funds should be examined not merely for one sector but for all sub sectors relevant to urban transport. It is also of great importance to promote private sector participation in transport system development and reduce the burden on the government in transport infrastructure development and transport service provision.

1.2 Study Objective

In order to develop an efficient urban transport network and the promotion of a reliable and safe transport system, the objectives of the Urban Transport System Development Project for Colombo Metropolitan Region and Suburbs (herein under referred to as the Project) are:

[1] Section 4.1 explains how to define the Colombo Metropolitan Area

- To prepare reliable transport data that can be utilised to evaluate and formulate transport development plans/projects in a scientific manner by conducting an area-wide transport survey.
- To formulate a comprehensive Urban Transport Master Plan for the Colombo Metropolitan Area including the six transport corridors prioritised by the Ministry of Transport with the justification of selected priority/leading projects for short-term, mid-term, and long-term implementation.
- To conduct a feasibility study on the prioritised project under the comprehensive urban transport master plan.

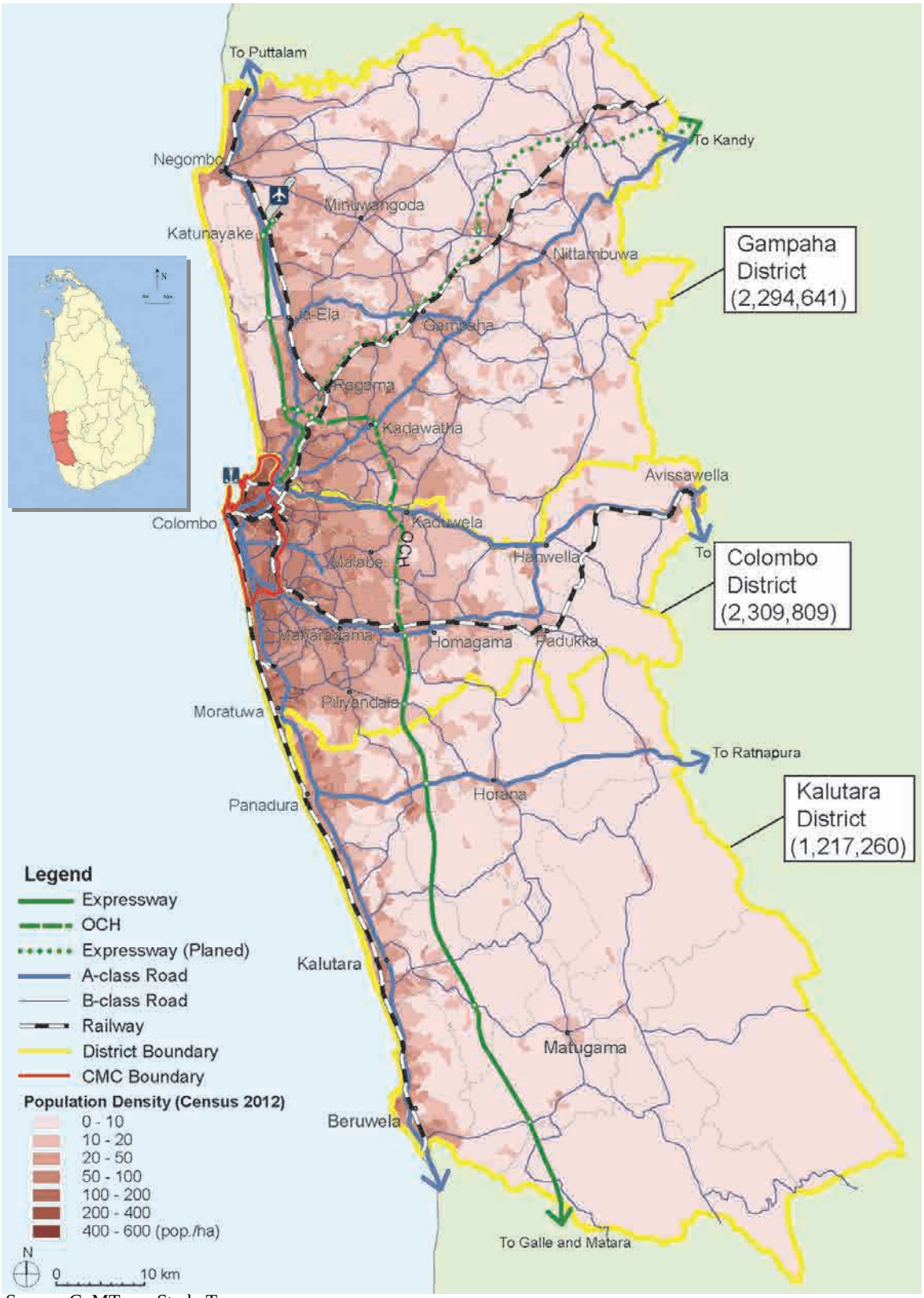
The target year for the Urban Transport Master Plan is 2035. The master plan includes an immediate implementation plan (2015), short-term (2020), intermediate-term (2025) and long-term (2035) transport system development plans.

1.3 Study Area and Planning Area

The Study area covers the entire Western Province where the transport surveys were conducted as shown in Figure 1.4.1. The Western Province is comprised of the Gampaha, Colombo and Kalutara Districts. Seven municipal councils (MC) among 23 municipal councils in Sri Lanka are located in the Western Province including the Colombo municipal council, the largest municipality in Sri Lanka, and the Sri Jayawardenapura Kotte municipal council, an administrative capital. The planning area is the area for the Urban Transport Master Plan and it should cover the urbanised area in the planning horizon of Year 2035. The planning area including the Colombo Metropolitan Area (CMA) identified in the Study is described in Chapter 4.

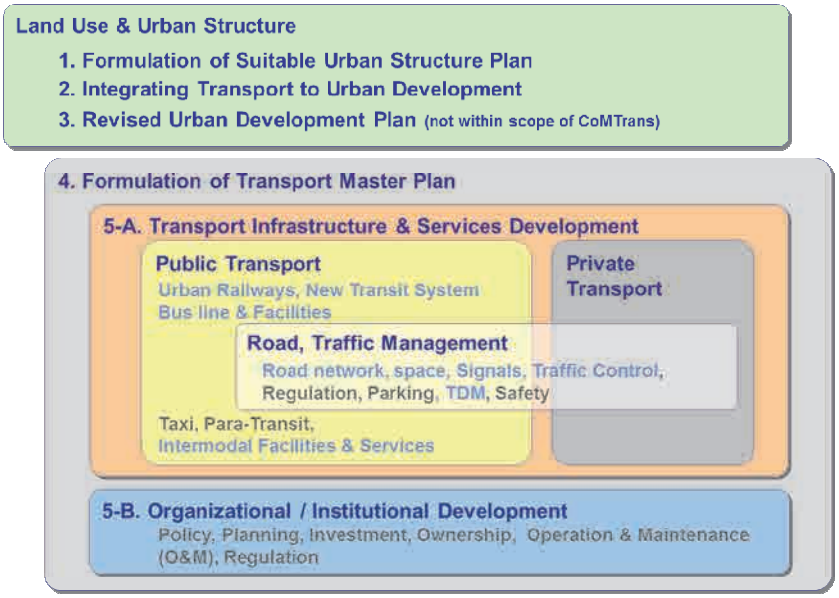
1.4 Scope of the Study

The scope of the urban transport master plan formulation includes an urban structure and land use plan though detailed urban planning was not conducted in the Study. The urban transport master plan is formulated in a well organised manner which integrates various types of public transport systems and road networks. Furthermore it should be incorporated with traffic control and transport management as well. To materialise the projects proposed in the master plan, institutional setups and financial arrangements are also taken into consideration. Figure 1.4.2 shows the overall scope for the urban transport master plan.



Source: CoMTrans Study Team

Figure 1.4.1 Study Area



Source: CoMTrans Study Team

Figure 1.4.2 Scope of Urban Transport Master Plan

1.5 Structure of Final Report

The Final Report consists of the following reports:

- Main Report (this report)
- Summary Report
- Technical Reports

Technical reports deal with the technical aspects of the contents of the main report which include transport surveys conducted in the Study, urban structure and land use, identified present urban transport problems of transport sub sectors and the proposed development plans, transport models and demand forecasting, institutional aspects for master plan implementation, and the strategic environmental assessment.

1.6 Structure of Main Report

The Main Report of the Final Report consists of the following Chapters:

- Chapter 2 presents the basic feature of the Colombo Metropolitan Area from three aspects; population, urban structure and economic activities. The population part describes changes in the population between 2001 and 2012 referring to the Population Census 2012 and discusses the socio-economic characteristics based on the Home Visit Survey. The urban structure part reviews current land use and urban structure, mentioning urban development characteristics and its problems. The economic indicators part presents the growth of and Gross Regional Domestic Products (GRDP) as well as household income distribution in CMA.

- Chapter 3 describes the current person travel demand to understand the features of the present transport situation. Person trip demand by trip purpose and by mode of transport is examined. In the latter part of the chapter, the situation of the current urban transport system is presented, including railway and bus transport as well as private vehicles. Both demand and service level is examined, from the view point of the network and demand.
- Chapter 4 discusses the perspective of a socio-economic framework and urban structure in the Colombo Metropolitan Area. Integration between an urban transport system and land use is discussed. The future population is estimated by income level and occupation for the future years of 2020, 2025 and 2035.
- Chapter 5 presents the Integrated Urban Transport Master Plan. In the beginning of this chapter, the future perspectives of the urban transport including future demand forecast are described. Objectives of the urban transport system development are identified based on the problems which are mentioned in the previous chapter. To achieve the objectives, an urban transport policy and policy measures are listed. A corridor analysis was conducted and the most suitable mode of transport is selected. Based on the corridor analysis, three urban transport system development scenarios have been prepared. The base case is based on the corridor analysis which has identified the mode for each corridor. Another three types of urban transport system development scenarios (Intensive Highway Development, Public Transport Intensive and Combined Public Transport and Highway Development) have also been prepared for comparison. Urban transport development scenarios are evaluated from various aspects and the most suitable option is selected. Strategies are then explained to materialise urban transport system developments. In addition, the outline of the intercity transport system is described for the integration of an intercity transport system with urban transport systems at interchange points such as a Multi-modal Transport Hub and a Multi Modal Centre. In line with urban transport policy, urban transport system development programs are established and major components of the program are described. Finally CoMTrans urban transport master plan is established and a phased development plan is also prepared which consists of a short-term development plan, an intermediate development plan and a long-term development plan.
- Chapter 6 discusses institutional aspects and financial arrangement. After formulating the urban transport master plan for the Colombo Metropolitan Area, it is of great importance to consider a way how to make it happen. To implement the projects included in the master plan, institutional setup is required and relevant regulations shall be established. Furthermore financial arrangement is also important for implementing the projects since the government has a limited budget for infrastructure.
- Chapter 7 presents the conclusion of the Study. An urban transport master plan should integrate relevant sectors in transport and it should also be integrated with urban structure and land use. In the master plan the variety of transport infrastructure development projects such as road network and public transport system development are proposed. Comparing the different transport system development scenarios, CoMTrans recommends the intensive public transport system development for the Colombo Metropolitan Area which focuses on public transport projects. In addition, it is also recommended that regulatory reform and financial arrangement are important for materialising the proposed projects.

CHAPTER 2 Socio-economic Conditions and Urban Structure

2.1 Population

2.1.1 The Census Details

(1) Historical Growth

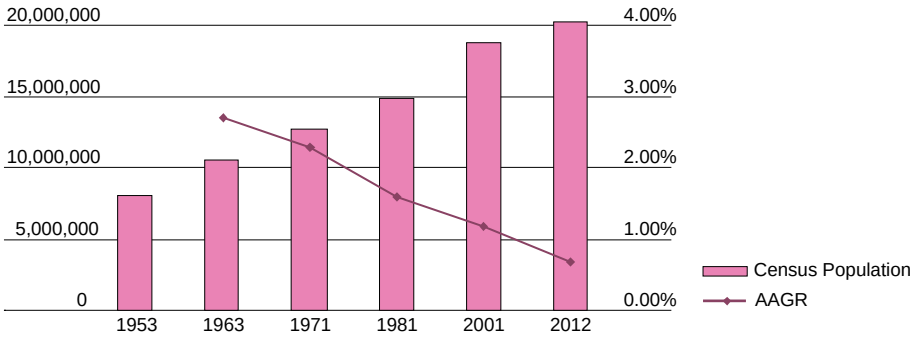
After 1950, the Department of Census and Statistics undertook a census in Sri Lanka in the years of 1953, 1963, 1971, 1981, 2001, and 2012. Population and Average Annual Growth Rates (AAGR) of Sri Lanka, the Colombo District, the Gampaha District, the Kalutara District, and the Western Province of the census years are shown in Table 2.1.1 and Figure 2.1.1, and Figure 2.1.2.

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 the Western Province was 5,821,710 in 2012 and the AAGR was 0.72%. The AAGR of the Western Province has kept pace with that of the country. Within the Western Province, the AAGR of Colombo District is 0.23%, which is much lower than in other areas.

Table 2.1.1 Population and Average Annual Growth Rate (1953-2012)

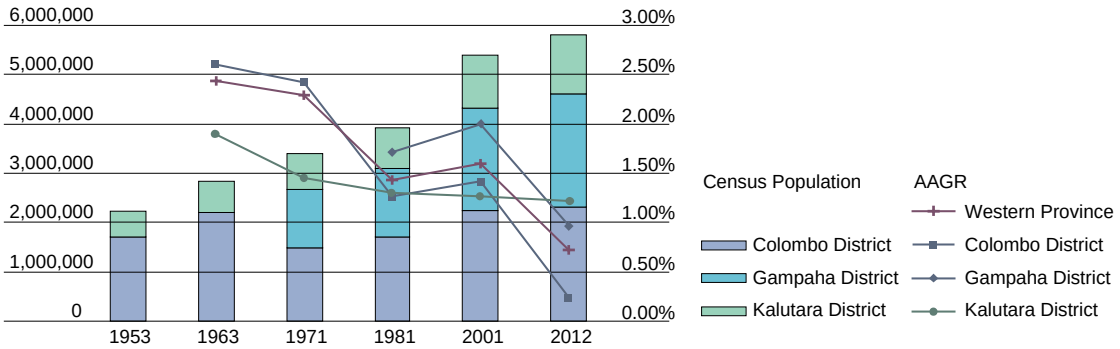
Census Population	1953	1963	1971	1981	2001	2012
Sri Lanka	**8,097,800**	**10,582,100**	**12,689,897**	**14,846,750**	**18,797,257**	**20,263,723**
Western Province	**2,232,276**	**2,838,877**	**3,401,779**	**3,919,807**	**5,381,197**	**5,821,710**
Colombo District	1,708,726	2,207,420	1,498,393	1,699,241	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 2.1.1 Census Population of Sri Lanka



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

Figure 2.1.2 Census Population in the Western Province

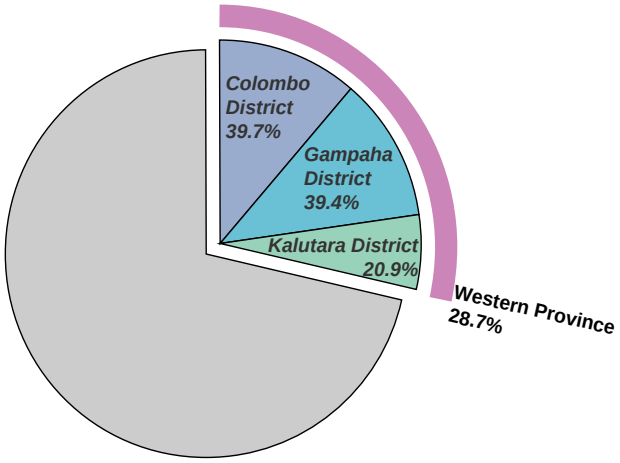
(2) Population Share

The 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 the Western Province, 40% of the population is in the Colombo District and another 40 % is in the Gampaha District, while the Kalutara District has only 20%. The population share of the Gampaha district is rising gradually, and now it is reaching the same population as the Colombo District. The population share is shown in Table 2.1.2 and Figure 2.1.3.

Table 2.1.2 Population Share in Sri Lanka and the 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 the Western Province

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

Figure 2.1.3 Population Share of the Western Province (2012)

(3) Population by Age Group and by Gender

Population by age group was published in the 2001 Census on a detailed level. However, only preliminarily results are available from the census of 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 2.1.3. The population was aging from 2001 to 2012 in Sri Lanka as well as in the Western Province. In the 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 is over 60 years old. In comparison to the rest of Sri Lanka, the 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-old population by GND are mapped in Figure 2.1.4. In rural areas and the central area of CMC, the percentage of over the 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 the Western Province's population was male. The male population is equally distributed.

Table 2.1.3 Population by Age in Sri Lanka and the 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, NuwaraEliya, 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 2001 Census, 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 2.1.4 Share of Aged Population Over 60 years (2012)

(4) Estimation of 5-year Age Group Population

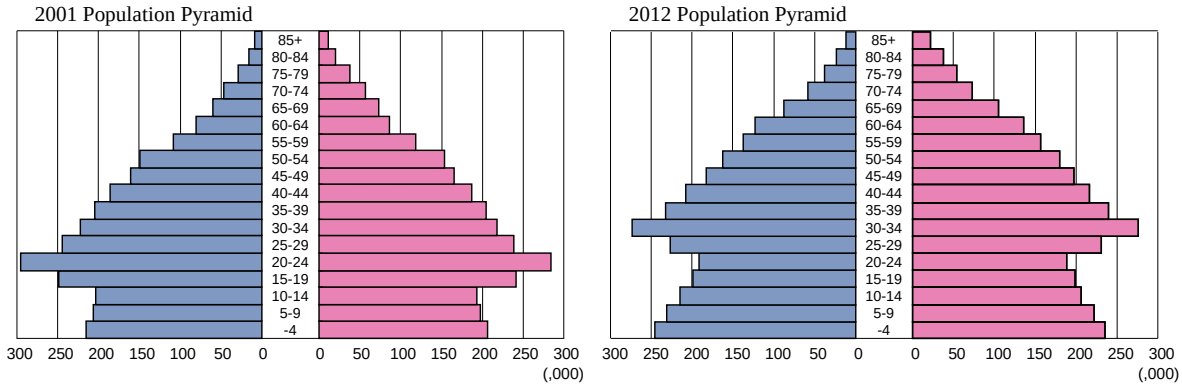
The 2001 Census gives the population by each age and sex in 2001. As for the population in 2012, although the detailed results of the 2012 Census are not available yet, population by age and sex can be estimated from crude birth rates and crude death rates. The Registrar General's Department published 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 2.1.4, and the Population Pyramids in 2001 and 2012 are shown in Figure 2.1.5.

Table 2.1.4 Population by Sex and 5-year Age Group of the 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 the 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 the CoMTrans Study Team
Source: Census of Population and Housing 2001 and 2012, Department of Census and Statistics

Figure 2.1.5 Population Pyramids of Western Province (2001 and 2012)

2.1.2 Migration

(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 2.1.5.

Table 2.1.5 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 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 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.

(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 2.1.6. Although it is outdated, it shows out-flow migration from the Colombo District and the Kalutara District. Annually, almost 10,000 people left the Colombo District.

Table 2.1.6 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 of 2012 indicates the estimated migration population.

Table 2.1.7 summarises the population differences.

Table 2.1.7 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 the Colombo District. Approximately 19,000 people left annually.

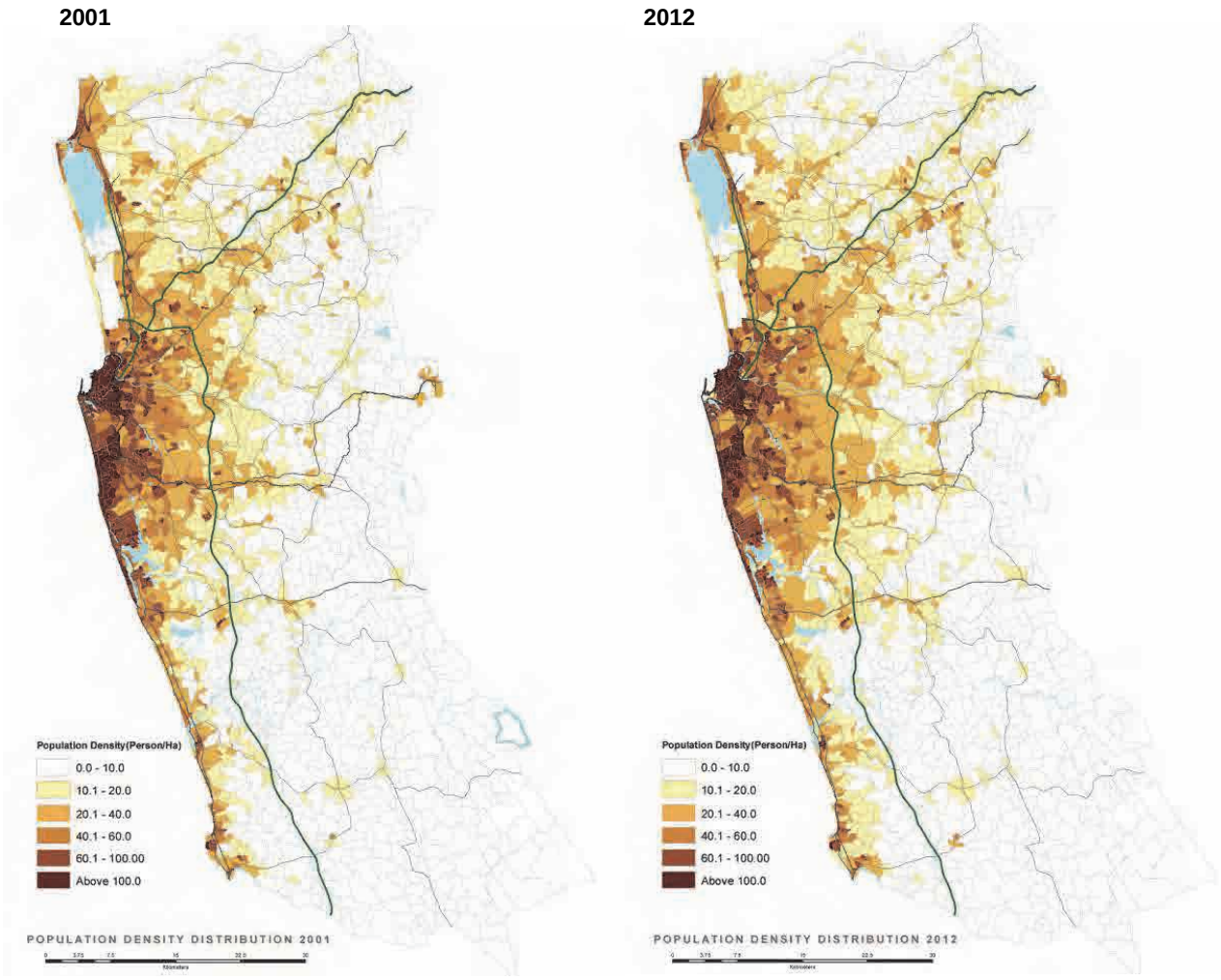
2.1.3 Spatial Distribution and Growth Trend

(1) Spatial Distribution

Population Densities in Residential Areas were calculated by the CoMTrans Study Team based on the population by GND in the Census in the years 2001 and 2012 and are shown in Figure. 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. The 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 2.1.6 Population Density in Residential Areas in the Western Province (2001 and 2012)

The population density of the Colombo Municipal Council is 13,779 persons per sq. kilometres. This density is comparable with the other central areas of major cities. The population density of the Colombo Metropolitan Area (CMA) is 3,699 persons per sq. kilometres. It is lower than the central areas of Sao Paulo and Bangkok in the same scale of area. When compared to those of Ho Chi Minh City and Taipei metropolitan areas, the density is almost in the same range. It can be said that the population of CMA is standard as an urban area.

Table 2.1.8 Population Density in Metropolitan Area and Central Area, 2010

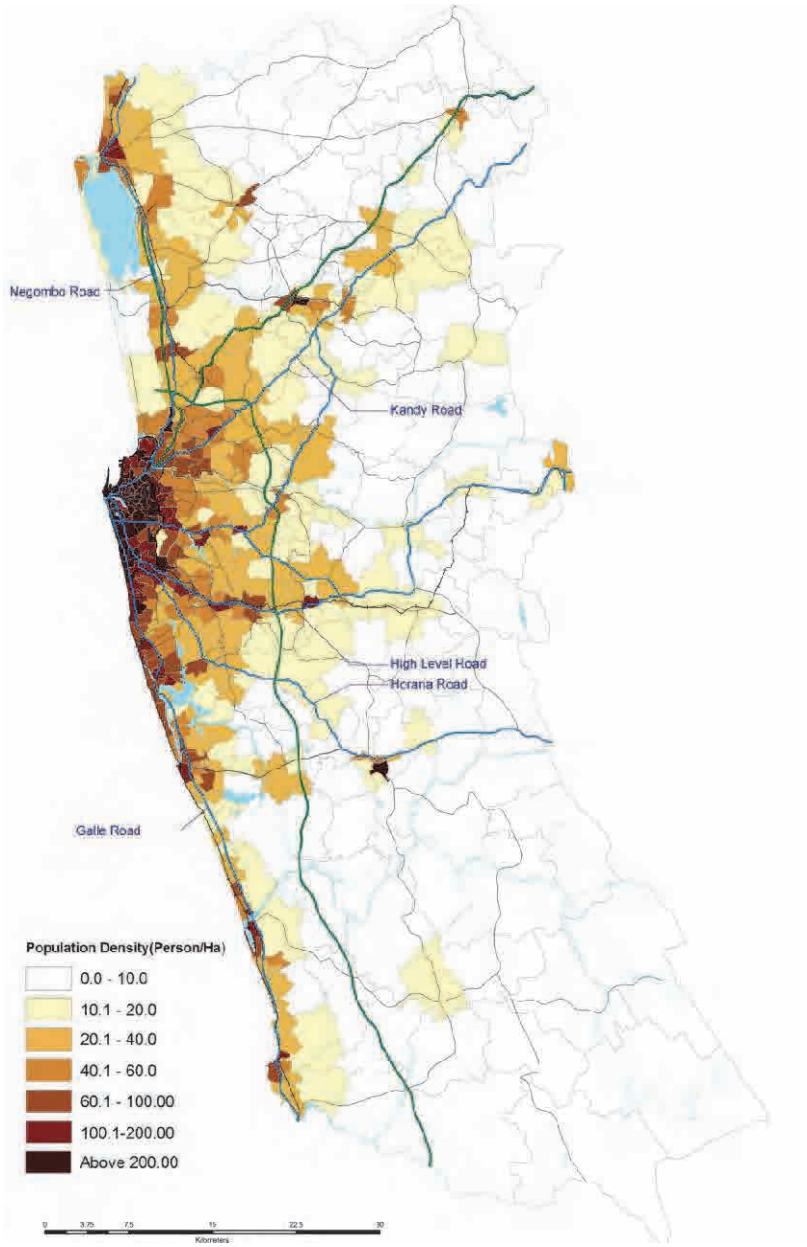
Country	Metropolitan Area	Metropolitan Area (sq. km)	Population Density of Metropolitan area (persons/sq. km)		Country	City	Central Area (sq. km)	Population Density of Central Area (persons/sq. km)
UK	London	1,596	4,811		**Chile**	Santiago	22	8,964
Vietnam	HCMC	2,095	3,419		**France**	Paris	105	20,807
Taiwan	Taipei	2,457	2,748		**Argentina**	Buenos Aires	203	14,520
Sri Lanka	Colombo (CMA)	996	**3,699**		**Taiwan**	Taipei	376	6,968
Argentina	Buenos Aires	4,758	691		**Vietnam**	HCMC	494	11,905
Philippines	M. Manila	4,863	4,405		**UK**	London	589	7,838
Chile	Santiago	5,947	1,211		**Korea**	Seoul	605	17,489
China	Shanghai	6,341	3,030		**Japan**	Tokyo	621	13,934
Japan	Tokyo	6,467	4,799		**Philippines**	M. Manila	639	21,131
Thailand	Bangkok	7,762	1,542		**Indonesia**	Jakarta	664	15,211
Brazil	Sao Paulo	7,944	2,469		**China**	Shanghai	822	13,038
Korea	Seoul	11,771	1,880		**USA**	NYC	834	9,808
France	Paris	12,012	912		**Sri Lanka**	Colombo (CMC)	40	13,779
Indonesia	Jakarta	13,601	1,772		**Brazil**	Sao Paulo	1,523	7,216
USA	NYC	18,443	1,051		**Thailand**	Bangkok	1,569	5,800

Source: Transport Development in Asian Megacities

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

Employed Population Densities at Work Places in 2013 are also estimated based on the data from the Department of Census and Statistics, and HVS, and it is shown in Figure 2.1.7.

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

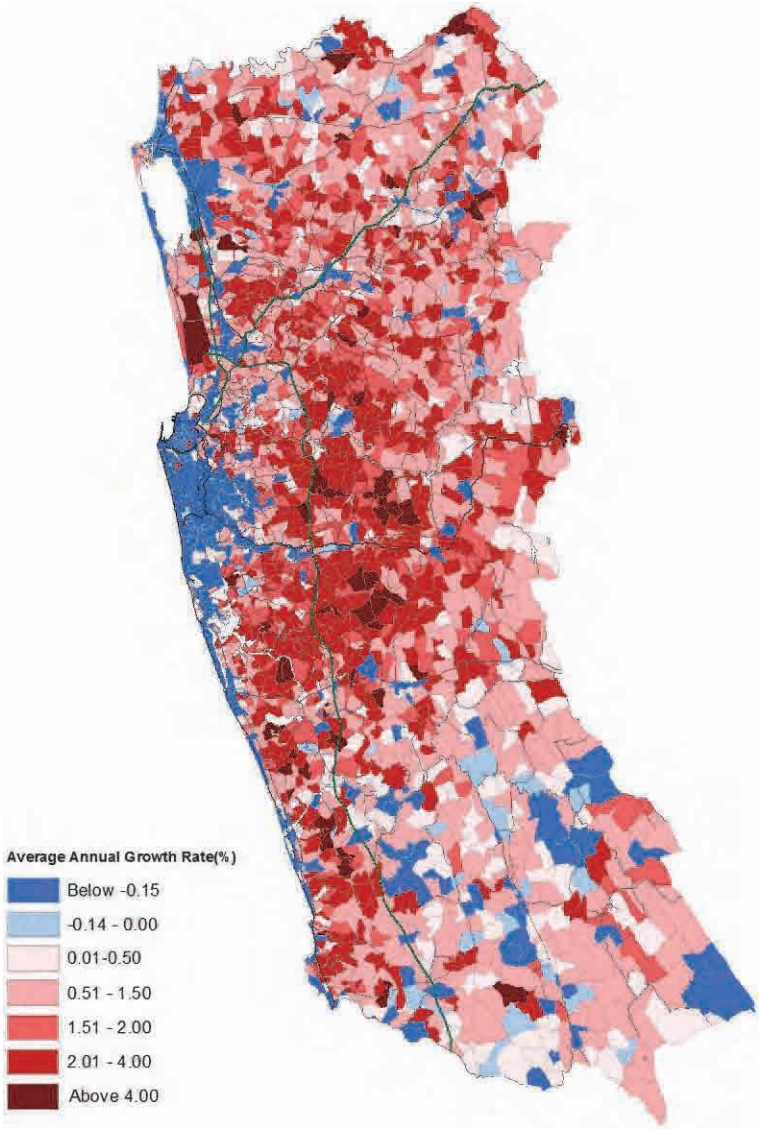


Note: Calculated by the Traffic Analysis Zone (TAZ). TAZ is described in Chapter 3.
Expressways/Highways are shown on the map as reference.
Source: CoMTrans Home Visit Survey 2013

Figure 2.1.7 Employed Population Density at Working Places in Western Province (2013)

(2) Growth Trend

Population changes from 2001 to 2012 are shown in Figure 2.1.8. This more clearly gives an idea of how urbanisation has been progressing in the Western Province. It shows that the population in the centre of Colombo is decreasing, and is increasing in the suburban areas.



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

Figure 2.1.8 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 the 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 the Western Province, such as Avissawela, the west of Negombo, and the inner costal area of the Kalutara district show population increases as well. Especially, major population growth was seen around and outside of the planned OCH area.

2.1.4 Social Status

As for the Social Status, a comparison between Population Census 2001 and HVS 2012 is shown in Table 2.1.9 and Figure 2.1.9. In the Population Census in Sri Lanka, social statuses are based on the population who are ten years old and over. In the Western Province, 43% of the population are employed and 15% are students. While the employed population of the Western Province has increased slightly in number, the share to the total population aged ten years and over has decreased. The student population by HVS shows a larger number than in the 2001 Census. More details of Employed and Student population are described in the following sections.

Table 2.1.9 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 years 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, NuwaraEliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle, where the detailed data of the 2001 Census is 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.

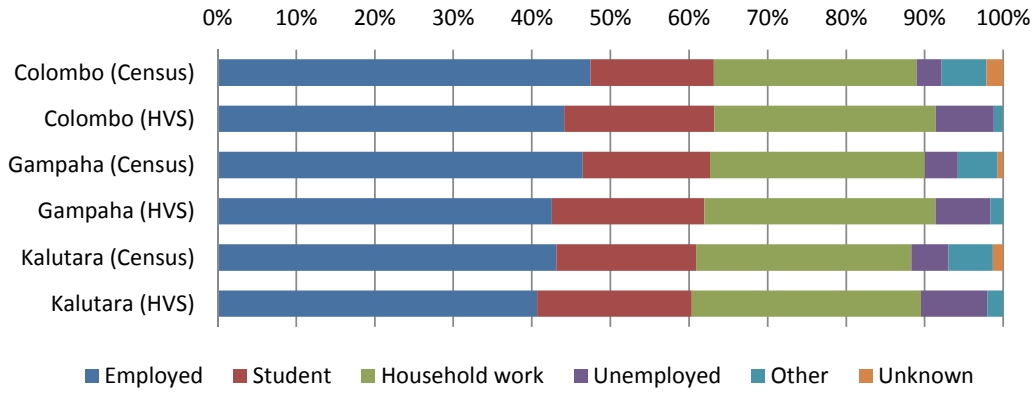


Figure 2.1.9 Population by Social Status based on Population Census 2001 and CoMTrans Home Visit Survey 2013

2.1.5 Employed Population

(1) Current Status of the Employed Population

The data of the employed population is available in the 2001 Census, however, the details of the employed population in the latest 2012 Census have not been published yet. Therefore the CoMTrans Study Team has estimated the employed population according to the trends of the 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 2.1.10.

According to the 2001 Census, approximately 2.0 million people are employed in the 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 the 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 the CoMTrans Home Visit Survey are also available and it is calculated that there are 2.0 million people in the employed population.

Table 2.1.10 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, NuwaraEliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle, where the detailed data of Census of Population and Housing 2001 is available.

2012 Estimation based on the trend by the CoMTrans Study Team. Total population: Census of Population and Housing 2012, ten 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

(2) Current Status of the Employed Population by Industrial Sector

Figure 2.1.10 shows the locations of EPZ (export processing zones) and other IE (industrial estates). In the suburbs of Colombo, there is a major EPZ located at Biyagama and other IEs such as Katuwana IE located to the south of Homagama and Templeberg IE located nearby Athurugiriya. In the Gampaha District, fairly many industrial areas are found at Mirigama,

Katunayake, Minuwangoda, Mawawatta, and Mathupitiwala. On the other hand, the Kalutara District has less industrial areas. They affect the number in the secondary sector population.

Source: CoMTrans Study Team

Figure 2.1.10 Locations of Export Processing Zones and Industrial Estates

According to the 2001 Census and the CoMTrans Home Visit Survey 2013, populations by industrial sector are shown in the following Table 2.1.11and Figure 2.1.11.

In 2001, there were clear differences between the three districts. In the Colombo District, 69% of the working population were engaged in the tertiary sector and the primary sector was only at 2%. In the Gampaha District, more secondary industries were active; approx. 41% were working for that group. In the 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 primary industry of the Western Province was much less than 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 the Kalutara District. On the other hand, more than 60% are engaged in the tertiary sector.

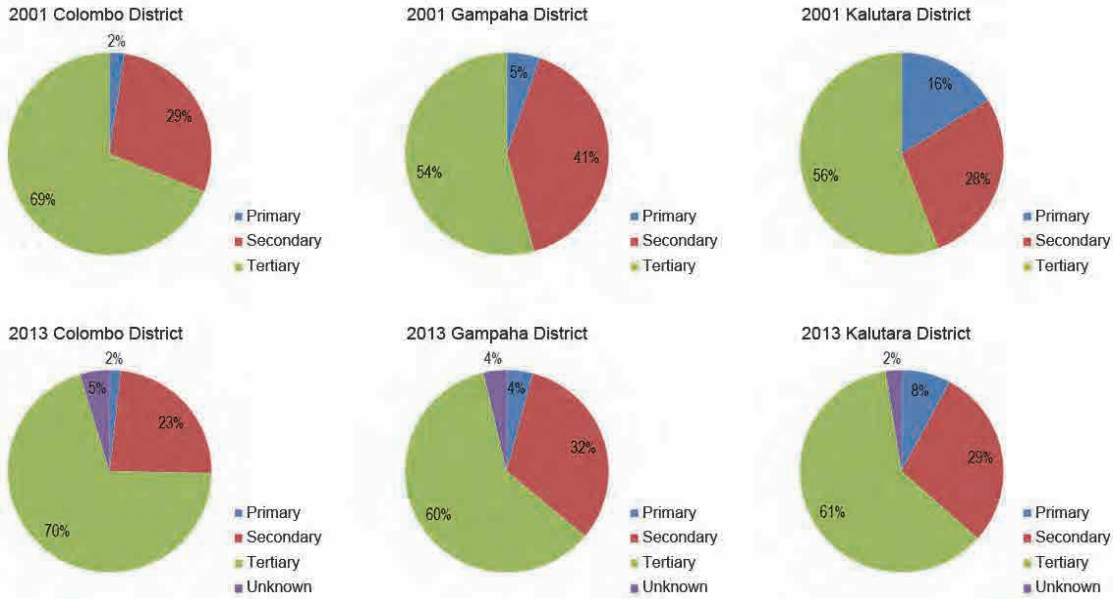
Table 2.1.11 Employed Population by Major Industry Sector in Western Province (2001 and 2013)

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, NuwaraEliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle, where the detailed data of the 2001Census is available.

2001 – Census of Population and Housing 2001, Department of Census and Statistics
2013 – Estimation based on the 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 2.1.11 Employed Population by Major Industry Sector in the Western Province (2001 and 2012)

2.1.6 Student Population

In the 2001 Census, the following details of the student population are available, but the detailed results of the 2012 Census are not published yet. In the Western Province in 2001, 1,187,674 people were students, which was 22% of the total population. School students of Grade 1 to GCE Advanced Level made up 17.7% of the total population. As for university students, only 0.6 % of the total population were attending a university. 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 the Western Province are shown in the Table 2.1.12.

On the other hand, the estimated student population is calculated from HVS and it is shown in Table 2.1.13.

Table 2.1.12 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, NuwaraEliya, Galle, Matara, Hambantota, Ampara, Kurunegala, Puttalam, Anuradhapura, Polonnaruwa, Badulla, Moneragala, Ratnapura, and Kegalle, where the detailed data of the 2001 Census is 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 2.1.13 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

2.1.7 Population by Household Income

The population by household income group is only available from the HVS conducted by the 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 used. The share of private car users is very high for Group A and extremely low for Group C. On the other hand, a high percentage of Group C walk or use a bicycle for their trips.

The income status is summarised in the following Table 2.1.14.

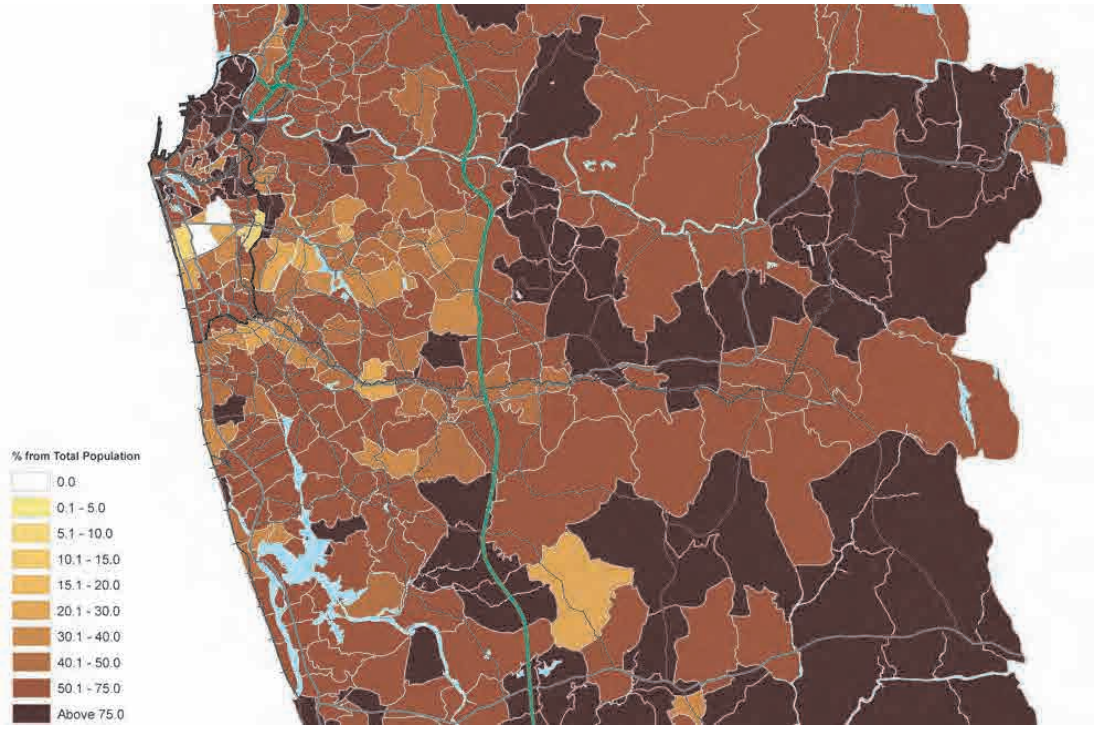
In 2012, more than 60% of the population earned less than 40,000 Rs per month. On the other hand, there are very few in the Group A population, less than 10 %.

Table 2.1.14 Population by Household Income Level in the 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 Income (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%*

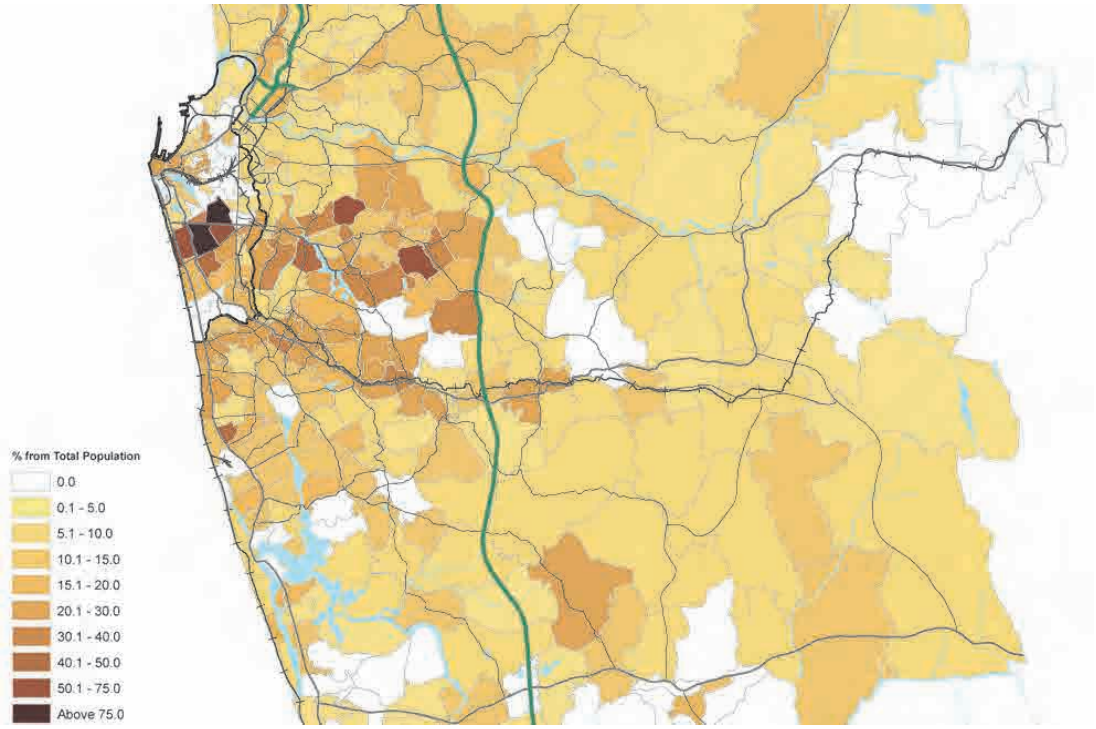
Note: Range is co-related with the HVS
Source: CoMTrans Home Visit Survey

Figure 2.1.12 and Figure 2.1.13 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 rural area. On the other hand, the middle of CMC has high percentage of the Group A population. TAZs along Malabe Corridor have a relatively large Group A population.



Source: CoMTrans Home Visit Survey

Figure 2.1.12 Percentage of Group C Population (2013)



Source: CoMTrans Home Visit Survey

Figure 2.1.13 Percentage of Group A Population (2013)

2.2 Land Use Patterns and Urban Structure

2.2.1 Land Use Patterns

(1) Expanding Urbanised Areas

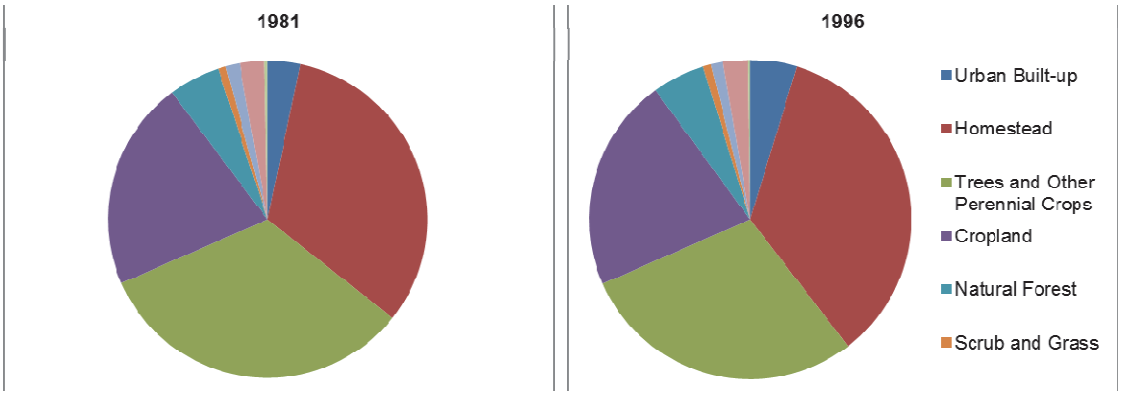
In the "Colombo Metropolitan Regional Structure Plan" of 1998, there are data regarding general land use patterns in 1981 and 1996 as shown in Table 2.2.1 and Figure 2.2.1. Land Use of urban areas is only classified as Urban Built-up areas and Homesteads. In the Western Province, Urban Built-up Land 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 of the land use 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 2.2.1 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 2.2.1 General Land Use Patterns of the Western Province 1981 and 1996

(2) Land Use Pattern and Maps in the Survey Area

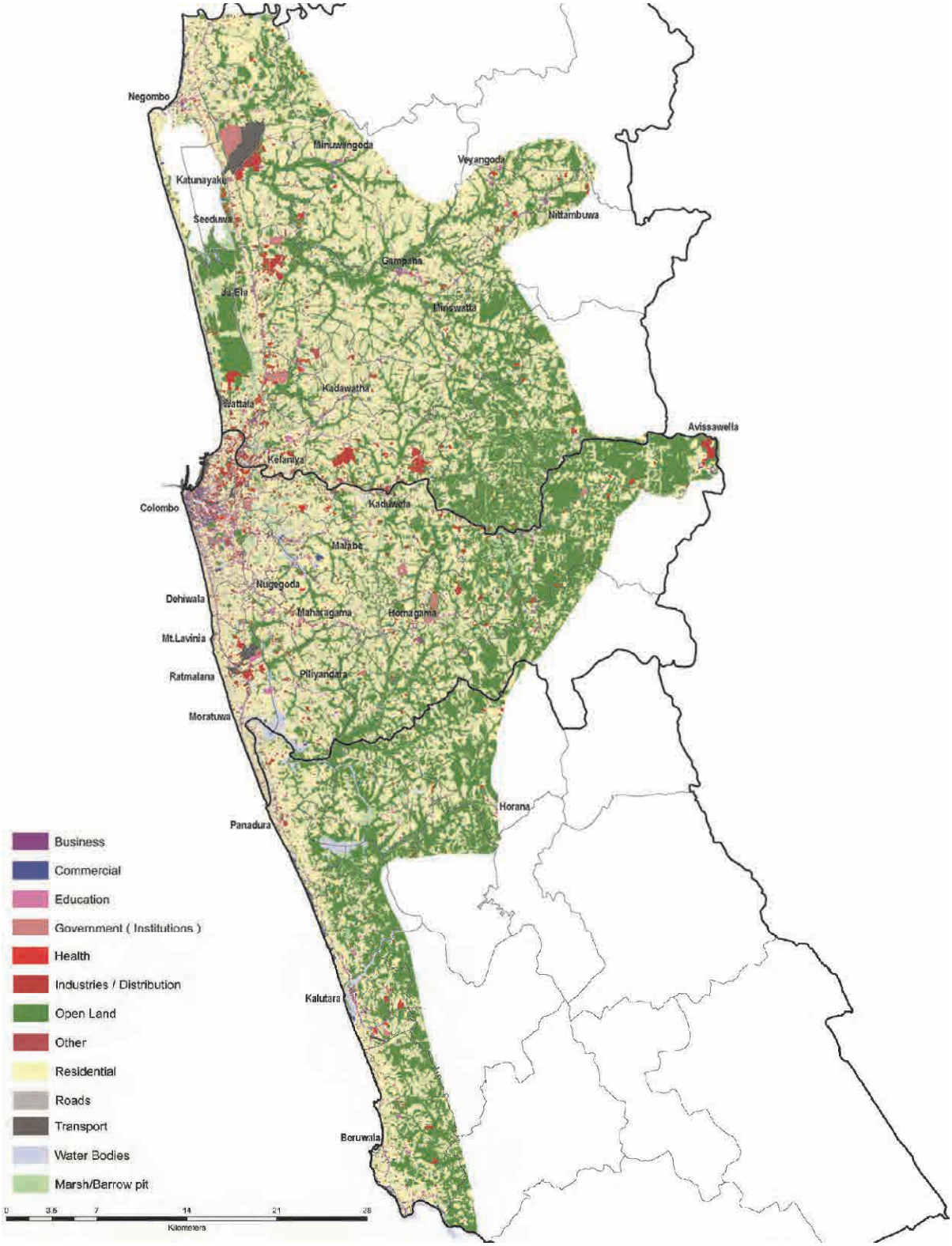
The Land Use Survey was conducted by the CoMTrans Study Team in 2013 in order to determine the current land use pattern. Areas that are already urbanised and those presumed to be urbanised by the target year of 2035 were considered as the land use survey area. It has approximately 1,700 km^2, which is 45% of the Western Province. The results of the Land Use Survey in the Western Province are shown in Figure 2.2.2 and Table 2.2.2. The details of the survey are mentioned in the Technical Report No.4.

The built-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, 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 use, such as business and commercial, are concentrated around the 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 7 km^2 are used for commercial purposes. The urban land use, except for the residential use, is 108 km^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.

In addition, the results of the land use survey, as well as the other transport surveys, would be criteria to define the Colombo Metropolitan Area (CMA), which is described in Chapter 4.



Source: CoMTrans Study Team

Figure 2.2.2 Land Use Map for Land Use Survey Area (2013)

Table 2.2.2 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	-

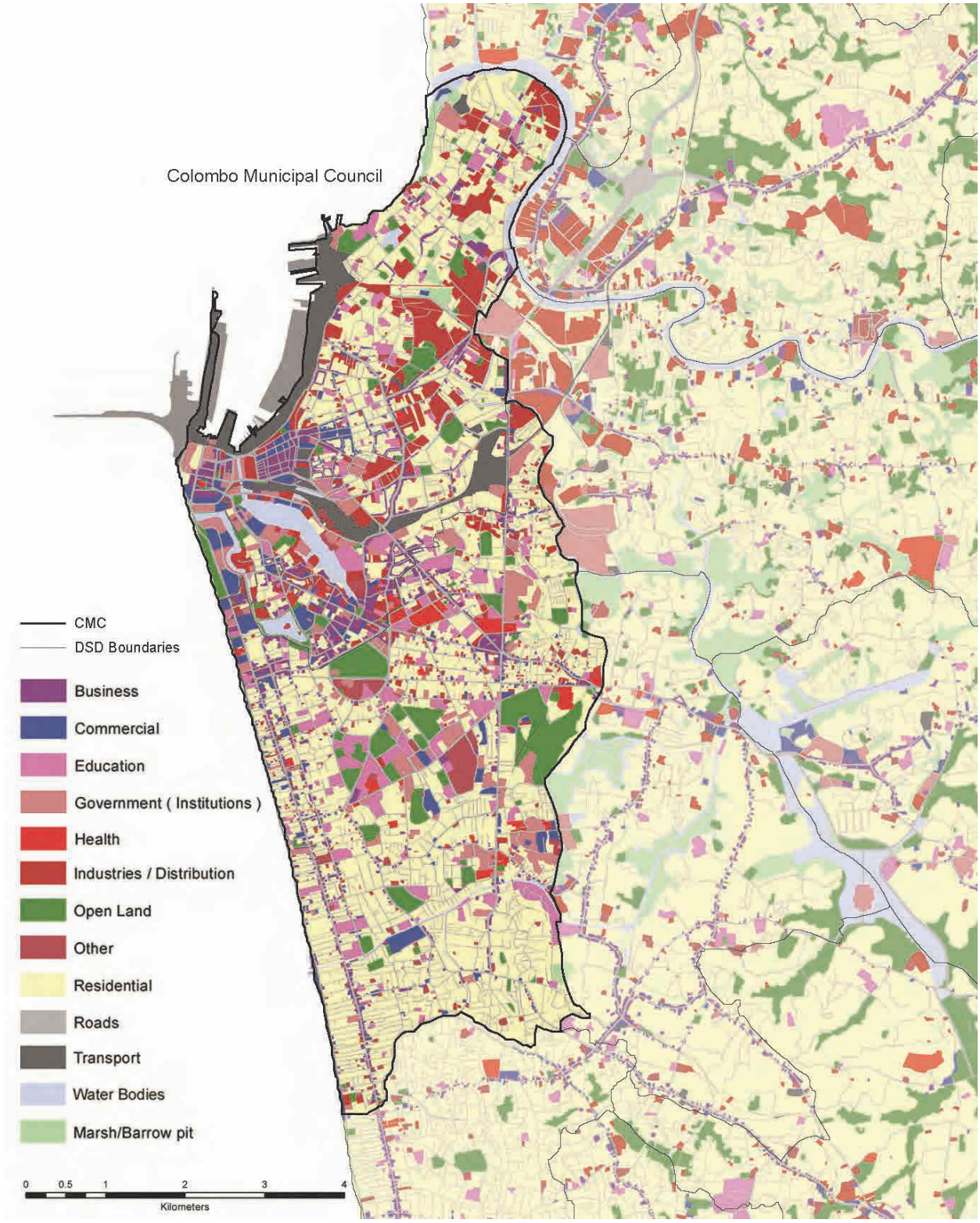
Note: Land Use Patterns by DSD are shown in the Technical Report No.4
Source: CoMTrans Study Team

(3) Land Use Pattern and Map in the Colombo Municipal Council

Land use in Colombo Municipal Council (CMC) is enlarged in Figure 2.2.3 and the extent of each land use is summarised in Table 2.2.3.

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 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 2.2.3 Land Use of Colombo Municipal Council (2013)

Table 2.2.3 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

2.2.2 Current Urban Centres and Urbanised Area

Urban structure and characteristics can be understood from the existing structure plan, 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 endorses the urban structure pattern more precisely.

(1) Urban Centres

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 2.2.4 which is a map updated by the CoMTrans Study Team based on the Colombo Metropolitan Regional Structure Plan 1998.

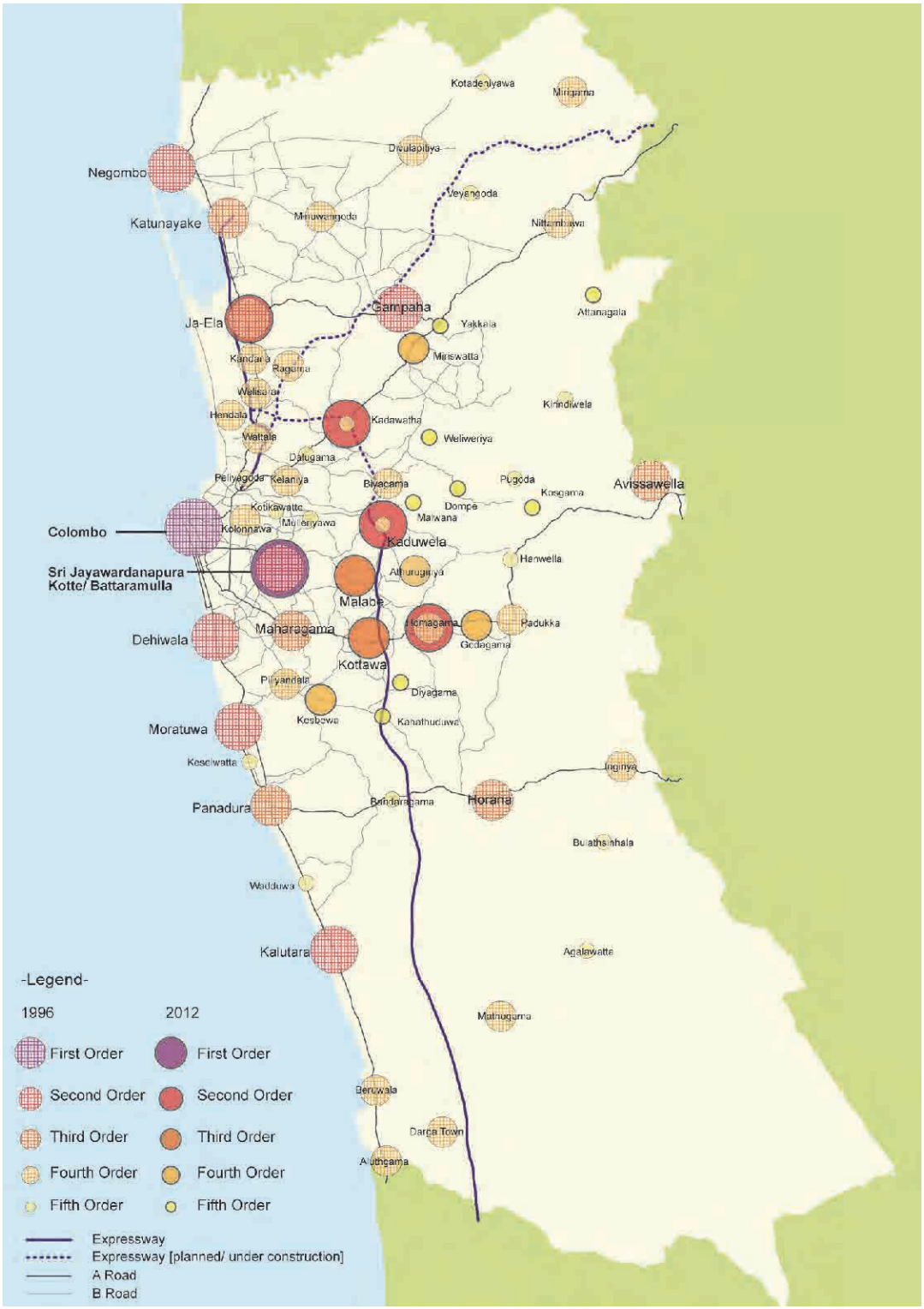
The National Physical Plan 2006 described a clear hierarchy in a structured manner. Urban centres are classified in the following five categories. Each category indicates its extent of the area providing services and ideal population range. At the same time, specific urban facilities are identified. They are shown in Table 2.2.4.

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 2.2.4 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 (Farmar's/ 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)

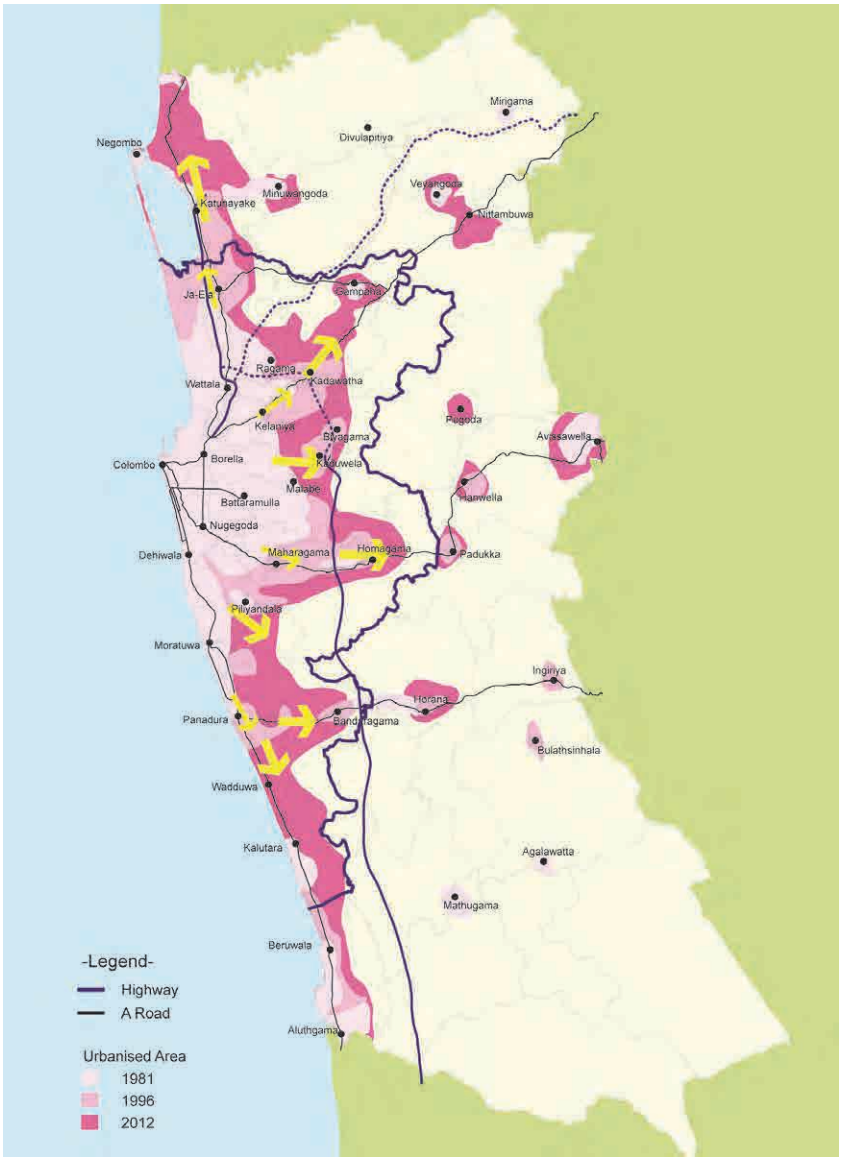


Note: Updated by CoMTrans Study Team based on the map 2.14 "Existing Functional hierarchy of Urban Centres 1996", Colombo Metropolitan Regional Structure Plan 1998

Figure 2.2.4 Functional Hierarchy of Urban Centres

(2) Urbanised Areas

The study of Colombo Metropolitan Regional Structure Plan1998 shows the urbanised areas in 1981and 1996. In addition, present urbanised areas can be found from the current population density and the land use pattern. Figure 2.2.5 shows urbanised areas in 1981, 1996, and 2012.



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

Figure 2.2.5 Urbanised Areas in 1981, 1996 and 2012

The urban area in 1981 was concentrated in the western part of the Western Province around CMC and surroundings, and some local urban centres such as Katunayake, Gampaha, Mirigama, Avissawella, Homagama, Horana, Kalutara, and Beruwala. By 1996, expansion of the urbanised

area 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.

2.2.3 Urban Development Characteristics

The following are the major urban characteristics. At present, urban development is becoming notable in the 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 2.2.6.

(1) Low Density Urban Sprawl and Scattered Residential Development

The current urban settlement pattern, especially in 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 the 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

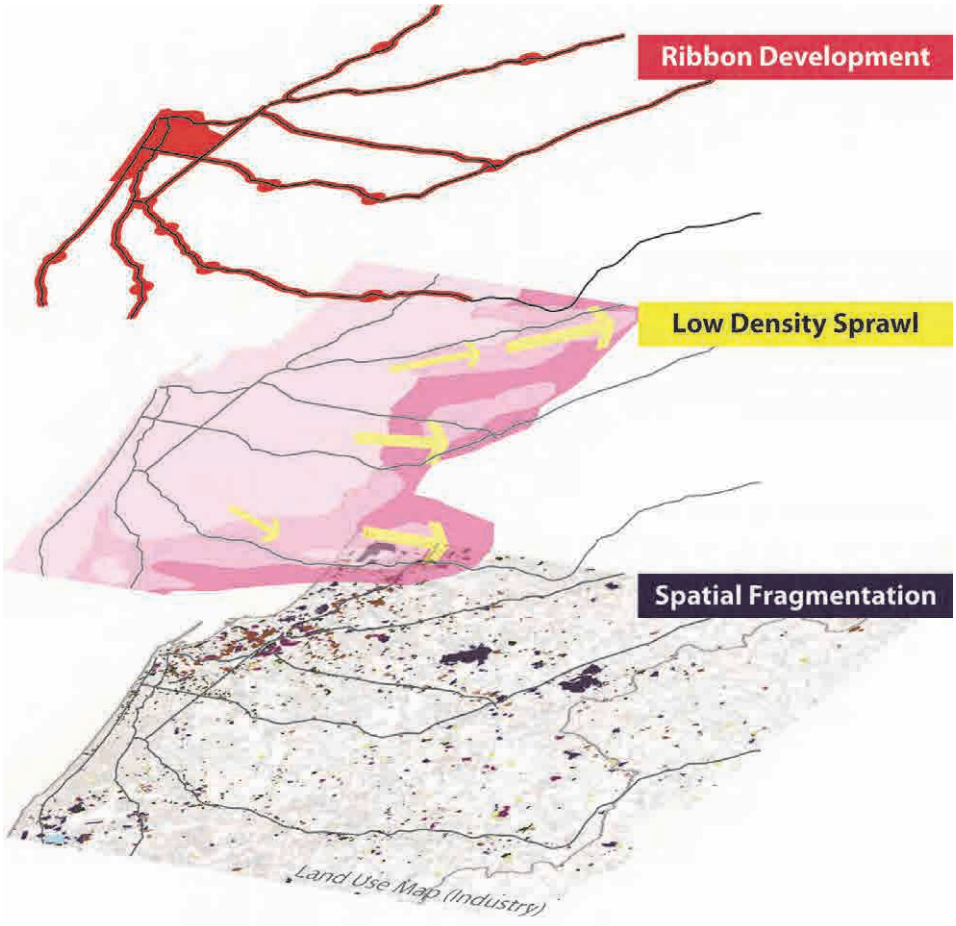
Whilst new residents are seeking a better quality of life, bad neighbouring uses such as industrial, logistics and mining uses are also proliferating within the peri-urban residential and agricultural areas. Due to the lack of planning regulations for land use zoning, it is possible that a residential area could be 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 driving 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 the 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 the schematic indication of commercial land use, Low Density Sprawl shows the schematic indication of urbanised area, and Spatial Fragmentation shows industrial land use according to the Land Use Survey.

Figure 2.2.6 Urban Development Characteristics

2.3 Economic Activity

2.3.1 GDP and Foundation of Economic Growth

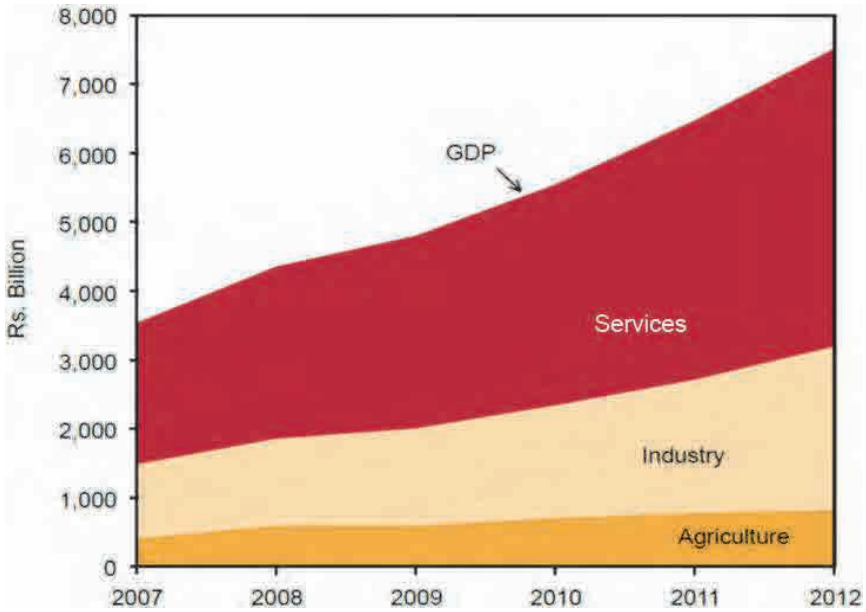
(1) National GDP and Growth

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 down 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 2.3.1 summarises the National GDP, and Figure 2.3.1 shows the changes in the GDP.

Table 2.3.1 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 2.3.1 GDP in Sri Lanka

Table 2.3.2 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 at 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.

The 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 2.3.2 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

Growth Forecast by the Sri Lankan Government

The forecast by the Sri Lankan Government is that the economy will continue its trend with high growth and GDP will increase by 8% continuously to 2015. Table 2.3.3 shows the GDP growth forecast by the Central Bank of Sri Lanka.

Table 2.3.3 GDP Forecast to 2015 by the 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.

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 2.3.4. At least till 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 2.3.4 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) GRDP of the Western Province

The Western Province is the most developed and urbanised region in Sri Lanka and its Gross Regional Domestic product (GRDP) accounts for nearly 45% of the national GDP in the past five years. The "City Cluster Economic Development – Sri Lanka Case Study" 2010 by the Asian Development Bank, identified the 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 2.3.5 summarises GRDP of the Western Province.

Table 2.3.5 GRDP at Current Market Prices of the 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 the 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 the 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, the 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% growth in real income is targeted over the next five years. This in turn requires raising investment to around 35% 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 middle-income country status within the next ten years".

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

2.3.2 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 has increased by around 7% in recent years. It 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 2.3.6 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 moderating in the recent years.

As for the sub-indices, except for the communication prices, the index of which was 109.4 in 2012, many indices indicate almost200.

It is noted that the index of Transport prices was 313.4 in 2012compared to a base of 100 in 2002. It 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 2.3.6 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 at 2011 and 2012 are calculated by the 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 ten years, the wage almost tripled. Table 2.3.7 summarises the wage rate indices.

Table 2.3.7 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

2.3.3 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 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 approximately 10% increase annually. The incomes and expenditures are summarised in Table 2.3.8.

Table 2.3.8 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 are shown in Table 2.3.9. 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 higher Gini coefficients indicate 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 the Western Province is almost the same as the National level.

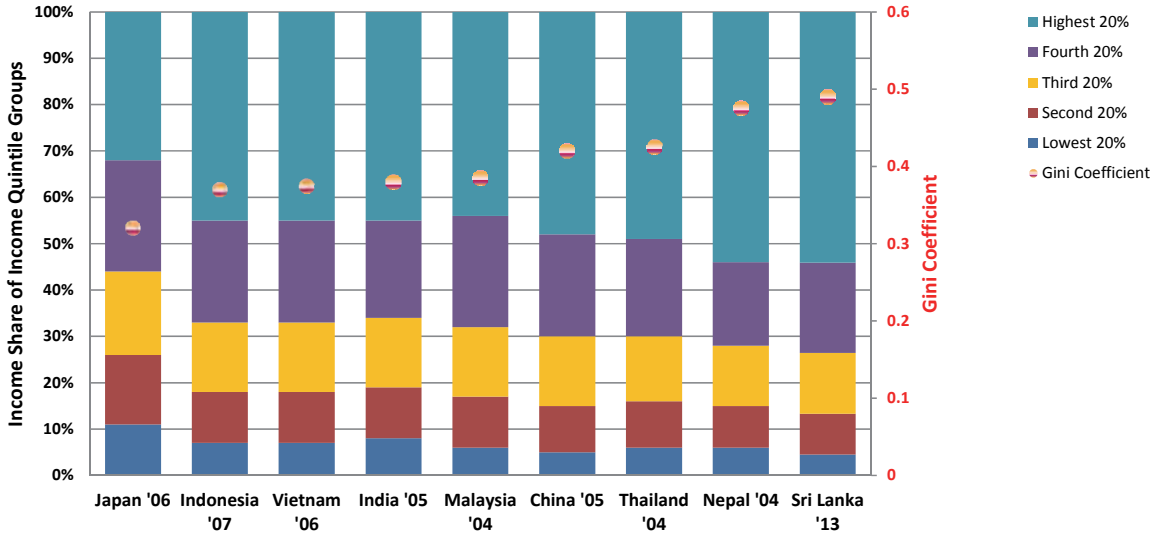
Table 2.3.9 Income Share and Gini Coefficients (2006/07 and 2009/10)

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

Income distribution of Sri Lanka and other countries are shown in Figure 2.3.2. In Sri Lanka the highest 20 % of households earn 54% of income and the Gini Coefficient is the highest at 49% in the selected countries.



Source: Transport Development in Asian Megacities

Central Bank of Sri Lanka

Figure 2.3.2 Income Distribution and Gini Coefficients in Selected Countries

2.3.4 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 was15.4% in 2011.

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

The unemployment rates from 2002 to 2011 are shown in Table 2.3.10.

Table 2.3.10 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 the Eastern Province but excluding the Northern Province / (b) Excluding the Mullaitivu and Kilinochchi districts / (c) All districts included / (d) Excluding the Northern and Eastern Provinces. / Source: Department of Census and Statistics

2.4 Public Finance

Government Finance is summarised in the following Table 2.4.1 and Figure 2.4.1.

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, the 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. Government total debt as percentage of 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 2.4.1 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
Privatization 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

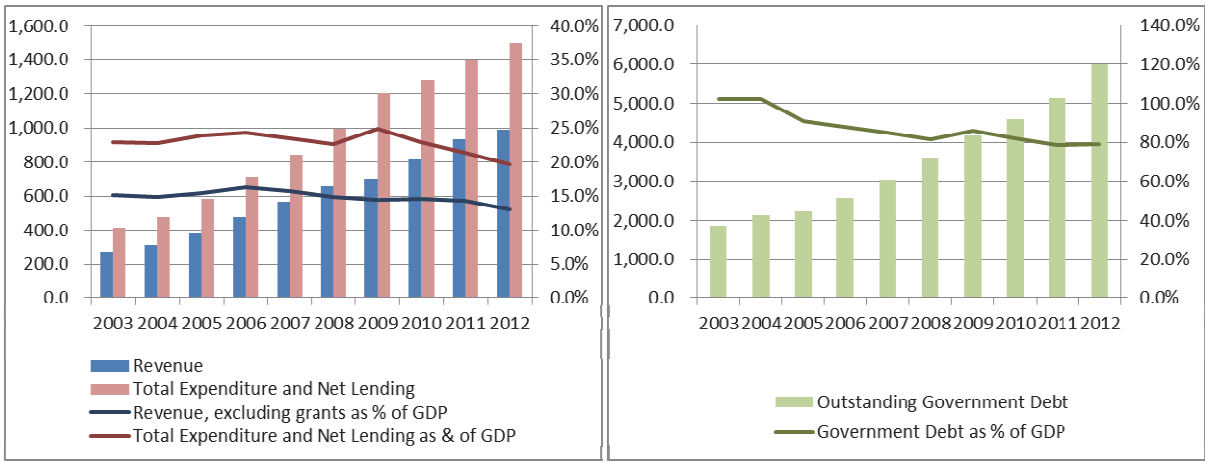


Figure 2.4.1 Revenue and Expenditure in Sri Lanka (2003-2012)

Expenditure on Transport Sector

Based on the Annual Report by the Ministry of Finance and Planning, expenditures on the transport and communication sector are shown in Table 2.4.2. In this data, the figures of the transport and communication sectors are added up.

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

Table 2.4.2 Government Expenditure on 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 2.4.3.

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 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 the capital expenditure. The expenditure of the Department of Motor Traffic has stayed the same in the 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 four times larger than the capital expenditure of Ministry of Transport.

Table 2.4.3 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 revised budget allocation, 2013 is estimated budget allocation, and 2014 is not available.

*** Name of the Ministry changed from "Ministry of Highways and Ports" in 2013.

Source:National Budget Department

2.5 Motor Vehicle Registrations and Ownership

2.5.1 Vehicle Population based on Revenue Licences

The total number of vehicles based on the revenue licences in the 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 issued ten years ago. Annually, it increased 8.5% on average. Compared 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 2.5.1 and Figure 2.5.1.

Table 2.5.1 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 Licence	**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

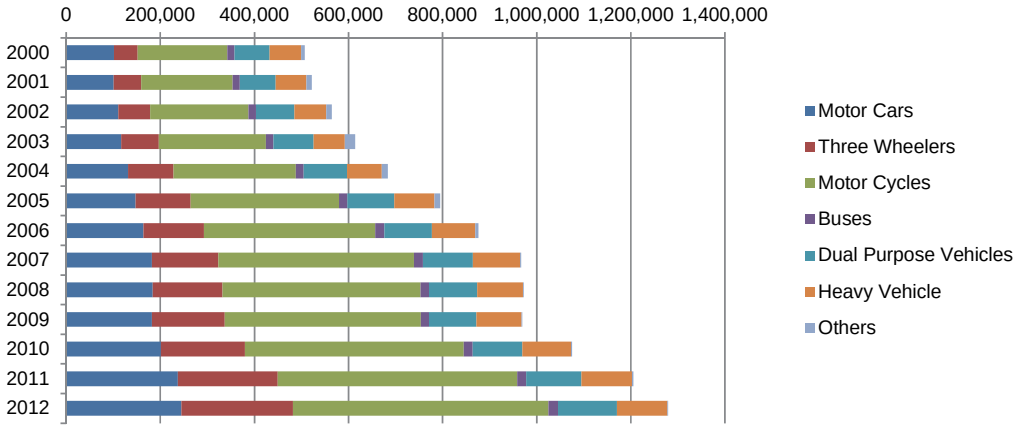
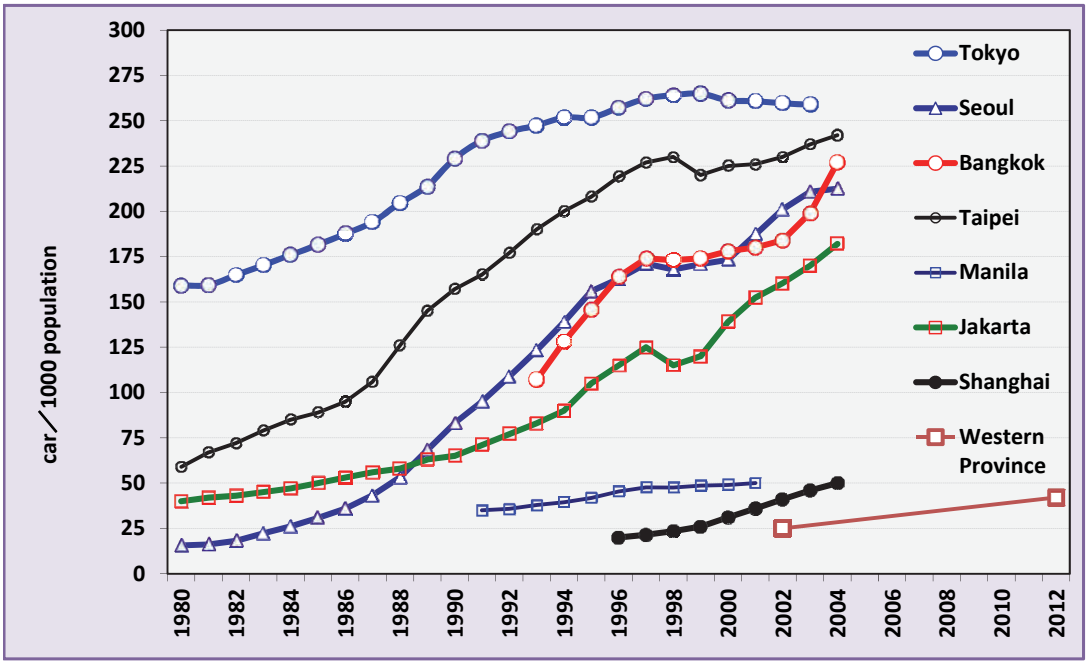


Figure 2.5.1 Vehicle Population in the Western Province

Many large Asian cities have experienced the rapid motorisation as depicted in Figure 2.5.2. Car ownership in the Western Province was 20 cars per 1000 people and it increased to 42 cars per 1000 people in 2012. However the car ownership in the Western Province is still low compared the other large cities. It might increase as GRDP per capita increases in the future.



Source: Transport Development in Asian Megacities

Economic and Social Statistics of Sri Lanka 2013, Central Bank of Sri Lanka

Figure 2.5.2 Past Trend of Car Ownership in Selected Cities

2.5.2 Vehicle Registration in Sri Lanka and Western Province

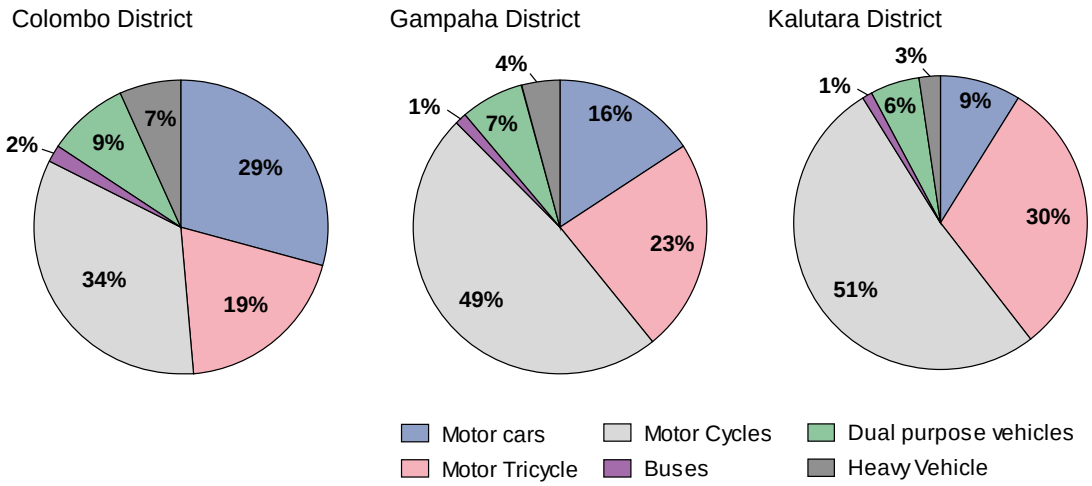
Vehicle registration depends largely on the government tax policy. Although the number of registered vehicles is increasing generally, there were low numbers registered in 2009, and the numbers significantly increased to 525,421 in 2011. Again, it dropped to 397,295 in 2012. More specifically, diesel vehicles were increasing but petrol vehicles were decreasing in this year. Around 30% of the total number of vehicles were registered in the Western Province, and of these, around half were in the Colombo District. The registered numbers of vehicles are listed in Table 2.5.2.

Approximately 29% of motor cars are in the Colombo District, but fewer motor cycles are registered. On the contrary, almost 50% of registered vehicles in Gampaha and Kalutara District are motor cycles and in these districts there are more tricycles than motor cars. The shares of registered vehicles in the Districts in the Western Province are shown in Figure 2.5.3.

Table 2.5.2 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
Motor Cycles	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	

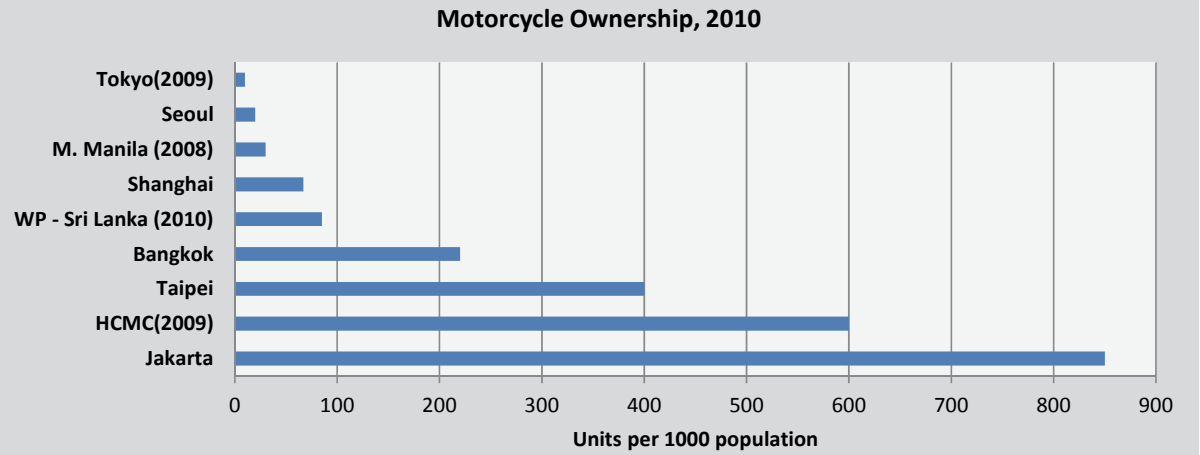
Source: Department of Motor Traffic



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

Figure 2.5.3 Share of Registered Vehicles in 2011

It is widely known that motorcycle ownership in Jakarta has been increasing remarkably. During the period from 2000 to 2010, the total number of motorcycles has grown by five times. At present the average number of motorcycles is 0.85 motorcycles per person in Jakarta as shown in Figure 2.5.3. Motorcycle ownership in the Western Province is still low at 0.8 but the growth rate of motorcycle ownership is high in the Western Province. It implies that the motorcycle ownership would continue to increase over the short-term.

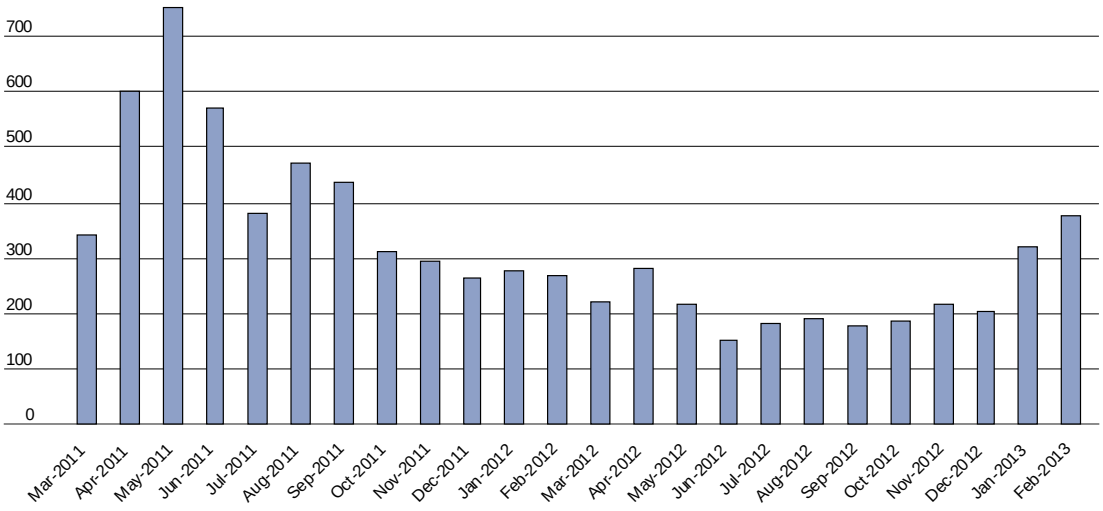


Source: Transport Development in Asian Megacities
Economic and Social Statistics of Sri Lanka 2013, Central Bank of Sri Lanka
Census of Population and Housing 2012, Department of Census and Statistics

Figure 2.5.4 Motorcycle Ownership in Selected Cities

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 government tax policy. The registration numbers of Hybrid Cars are shown in Figure 2.5.5.



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

Figure 2.5.5 New Registration of Hybrid Cars

2.5.3 Vehicle Ownership in the Western Province

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

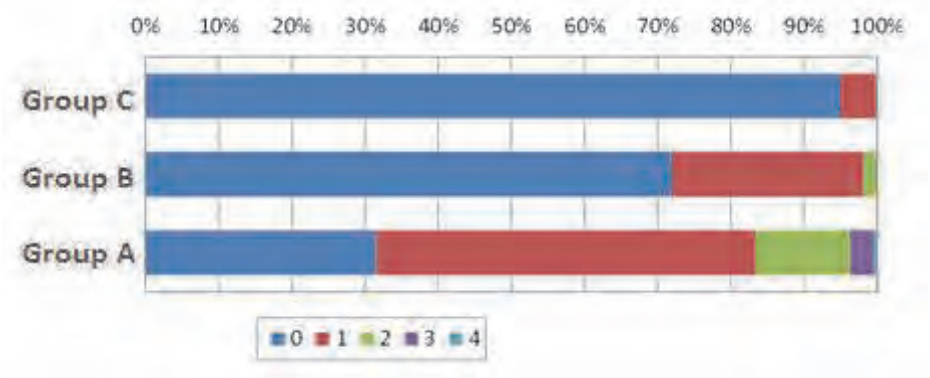
(1) Passenger Car Ownership

Table 2.5.3 and Figure 2.5.6 show the distribution of passenger car ownership by income levels. Clearly, the passenger car ownership grows as income level goes up. The average number of passenger cars owned per household of Group C is 0.05. Meanwhile that of Group A is 0.89.

Table 2.5.3 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 or 4 Cars	137	156	3,786	4,078
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 Household 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

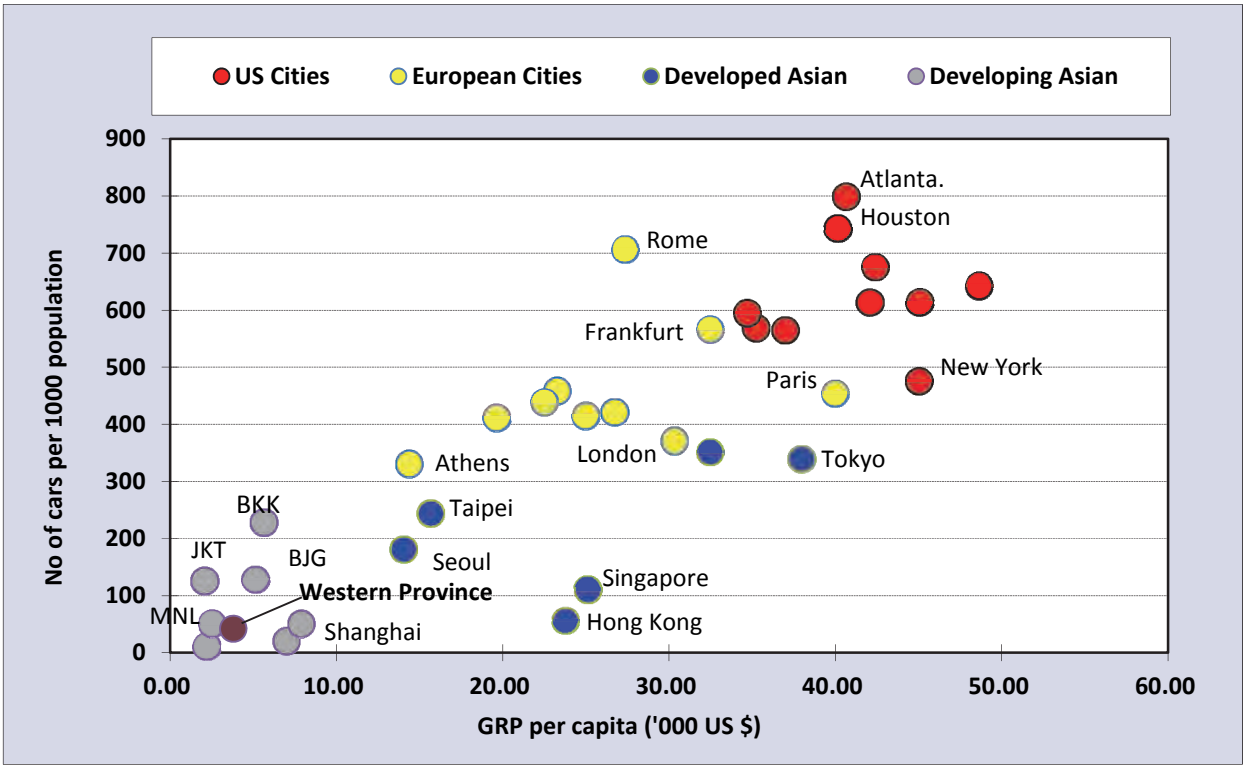


Source: CoMTrans Study Team

Figure 2.5.6 Passenger Car Ownership by Household Income Level

Metropolitan areas in USA and those in EU countries have different characteristics. Many US metropolitan areas indicate high car ownership while European metropolitan areas show lower car ownership than the USA. Compared to the US metropolitan areas and EU metropolitan areas,

Asian metropolitan areas have lower car ownership. The car ownership in the Western Province is still low which is similar to that in Metro Manila. The future car ownership in the Western Province depends on urban transport policies such as the promotion of a public transport network and the restriction of private car use and so forth.



Source: Transport Development in Asian Megacities
Economic and Social Statistics of Sri Lanka 2013, Central Bank of Sri Lanka
Census of Population and Housing 2012, Department of Census and Statistics

Figure 2.5.7 Car Ownership and GRDP per Capita for Selected Metropolitan Area

(2) Motorcycle Ownership

Table 2.5.4 and Figure 2.5.8 show the distribution of motorcycle ownership by income levels. Motorcycle ownership grows as income level goes up from Group C to Group B. However, if monthly household income goes up from the Group B to the Group A, motorcycle ownership conversely decreases. This is because if they become rich enough to allow them to purchase a car, they shift to that instead of a motorcycle.

Table 2.5.4 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 Household 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

Source: CoMTrans Study Team

Figure 2.5.8 Motorcycle Ownership by Household Income Level

(3) Three Wheeler Ownership

Table 2.5.5 and Figure 2.5.9 show the distribution of three wheeler ownership by income levels. Three wheeler ownership decreases as income level goes up.

Table 2.5.5 Three Wheeler Ownership by Household Income Level

Three Wheeler Ownership	Group C	Group B	Group A	All
Number of Households Not Owning 3-wheelers	910,992	281,669	98,567	1,291,228
Number of Households Owning 1 3-wheeler	116,277	37,487	4,975	158,738
Number of Households Owning 2 3-wheelers	1,127	950	225	2,303
Number of Households Owning 3 3-wheelers	30	198	0	228
Total Households	1,028,426	320,304	103,767	1,452,497
Total Number of 3-wheelers	118,622	39,982	5,425	164,028
Average Number of 3-wheelers per Household	0.12	0.12	0.05	0.11
Average Number of 3-wheelers per Total Number of Household Owning 3-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 A: Rs. 80,000 and above
Source:CoMTrans Home Visit Survey 2013

Source: CoMTrans Study Team

Figure 2.5.9 Three Wheeler Ownership by Household Income Level

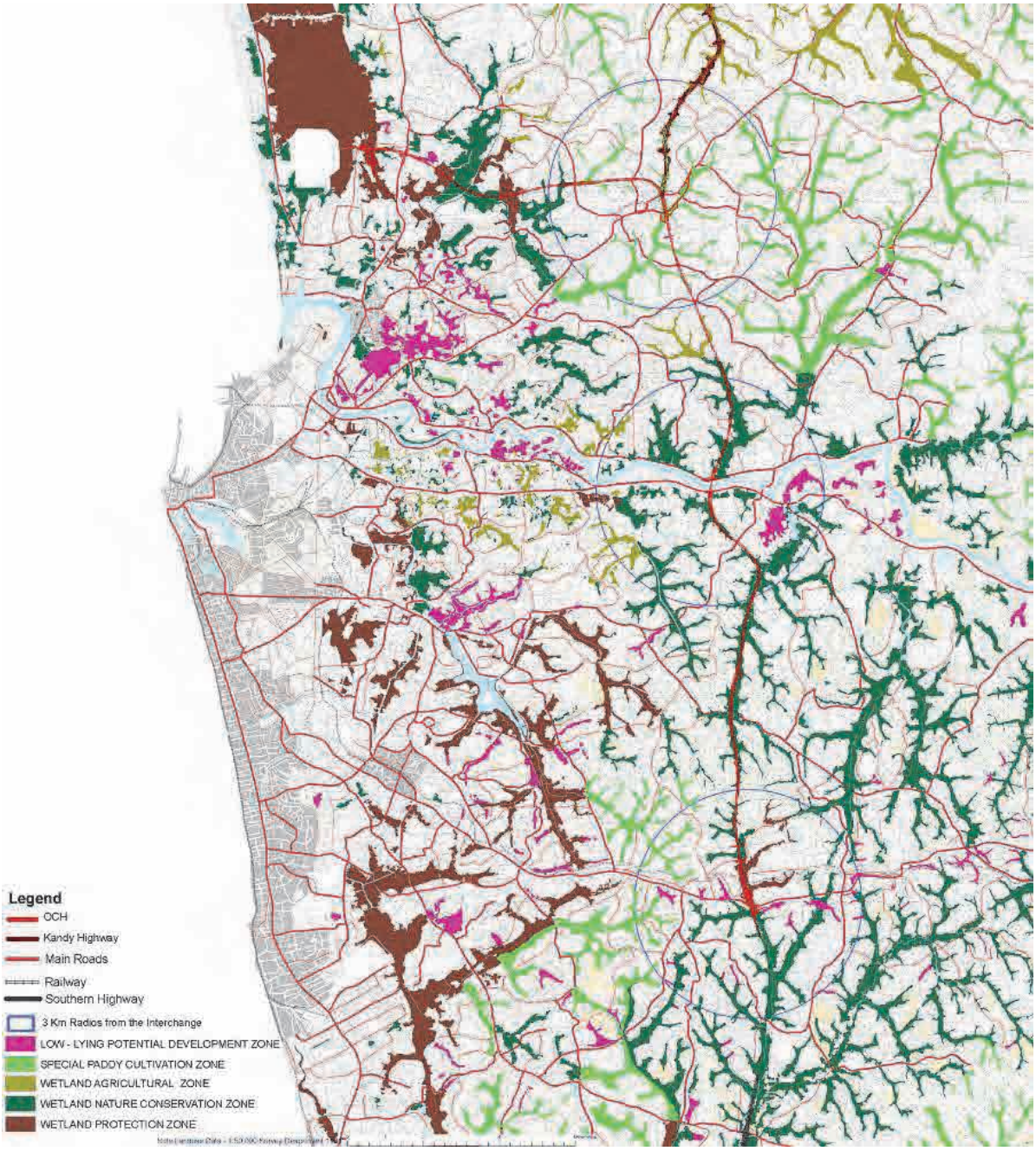
2.6 Environmental Issues

(1) Characteristics of Natural Land

One of the geographical characteristics of the 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 the Western Province, except around Colombo's 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 to maintain biodiversity and water retention function for flood control.

These wetland areas in the 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 the 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 suburb is shown in Figure 2.6.1. 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 2.6.1 Wetland Zoning in Colombo Suburbs

2.6.1 Major Contributors for Air Pollution

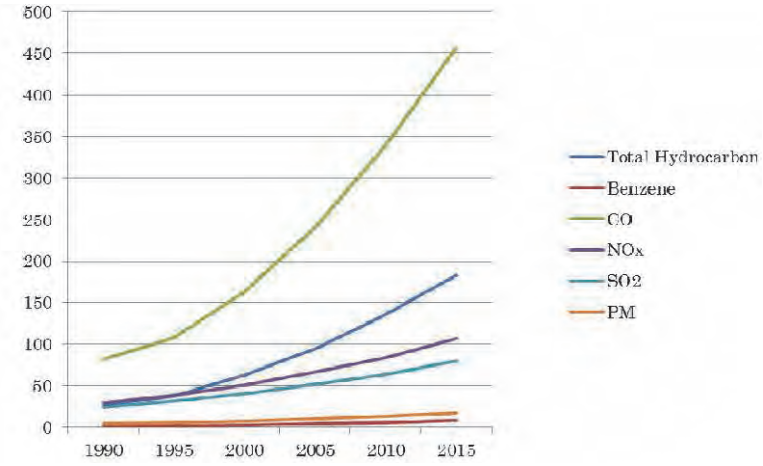
Rapid urbanisation and industrial development are the main factors responsible for air pollution; the major contributors for this pollution are the industries and vehicle fleets. The emission from the motor vehicles is one of the most air polluting sources in Sri Lanka. Ever increasing use of vehicles 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, and especially in the main urban areas of Colombo, this has resulted in adverse health conditions.

(1) Air Polluting Emissions from Transport Sector

It is estimated that around 60% of the vehicle fleet is concentrated in the Western Province. The atmospheric environments in Colombo and its suburbs are 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.

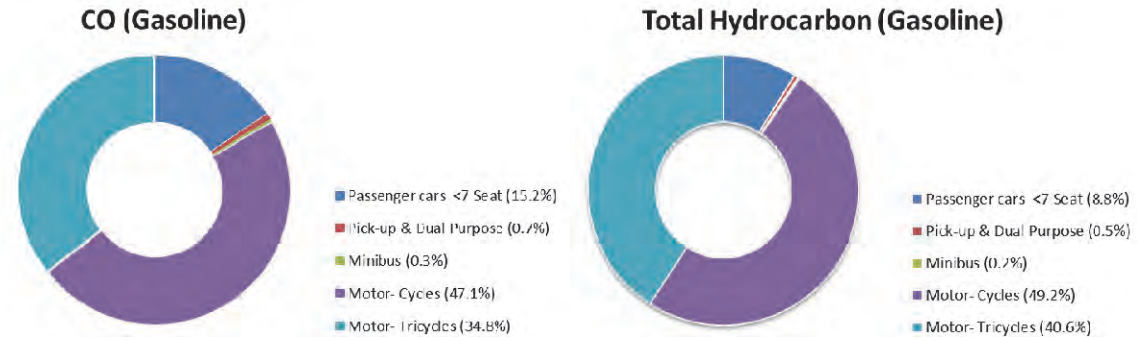
The Air Resource Management Center (AirMac) has calculated the base case emissions from the transport sector, the "Do Nothing Scenario", for the period between 1990 and 2015 as shown in Figure 2.6.2. The emissions are calculated using an emission inventory model. This model, originally developed for 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 (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 2.6.3) and diesel engine vehicles (Figure 2.6.4). Among these, gasoline engines are bigger emitters of CO and Hydrocarbon, while NOx and PM are mostly emitted from diesel engines.



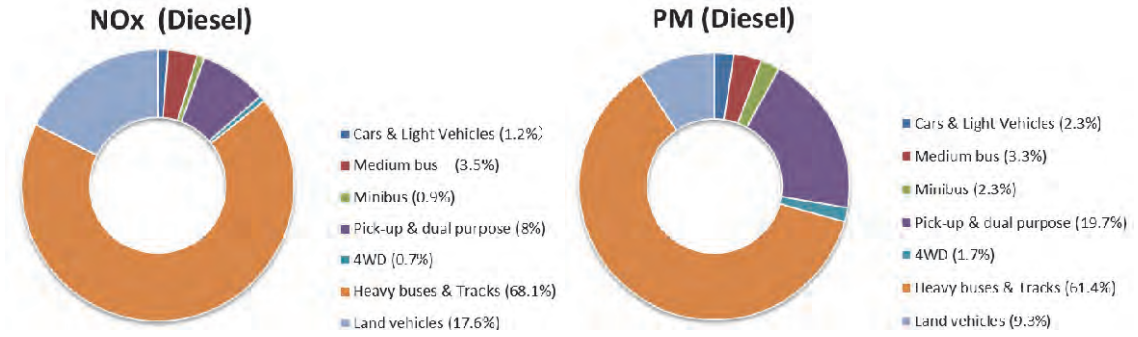
Source: Urban Air Quality Management in Sri Lanka

Figure 2.6.2 Estimated Air Emissions from Transport Sector in Sri Lanka (kt/year)



Source: Urban Air Quality Management in Sri Lanka

Figure 2.6.3 Percentage of Emission by Type of Gasoline Vehicles



Source: Urban Air Quality Management in Sri Lanka

Figure 2.6.4 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 motortricycles 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.

(2) Ambient Air Quality

Continuous Air Quality Monitoring is currently in operation at the Colombo Fort Station of the 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 2.6.1 shows the maximum concentration observed in the measured data in 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 Gampaha area which eventually aggravate the pollution levels of the surrounding environment.

Table 2.6.1 Result of 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

Source: CoMTrans Study Team

There is a lack of data availability for PM2.5 in the 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 discussed 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.

2.6.2 Climatic Factors

(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 2,000 mm – 3,000 mm. According to monthly average rainfall records for Colombo for 50 years from 1961 to 2010 (Department of Meteorology), May, October and November are observed to be rainy months with around 330 – 350 mm 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 ℃.

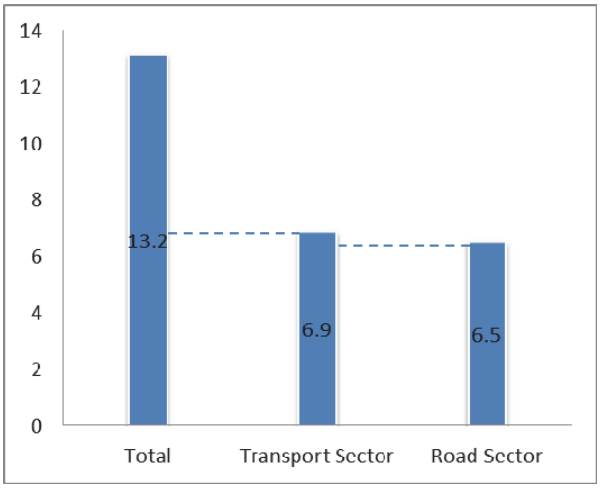
(2) Climate Change

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 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 discussed that the increase in temperature is caused by enhanced greenhouse effect as well as rapid urbanisation generating a heat island effect.

(3) Green House Gas (GHG)

GHG are the main contributors to Global Warming. Emissions from transport represented 22% of global CO_2 emissions in 2010 (including emissions from non-fuel combustion) and almost three-quarters of the emissions from transport is from the road sector. According to the International Energy Agency (IEA) report[1], total $CO2_2$ emission from fuel combustion in Sri Lanka in 2010 was 13.2million tonnes and a little higher than half of total CO_2 emission (6.9 million tonnes), was from the transport system, of which the road sector contributes the most (approximately 94%) of CO_2 emission of 6.5 million tonnes (Figure 2.6.5). Although Sri Lanka`s contribution of GHG is very minor at the global level, the portion of CO_2 emission from the road sector in the western part of Sri Lanka is very high, especially in the Western Province where 28% of the total population lives.

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



Source: CoMTrans Study Team

Figure 2.6.5 CO_2 Emission from Fuel Combustion (million ton)

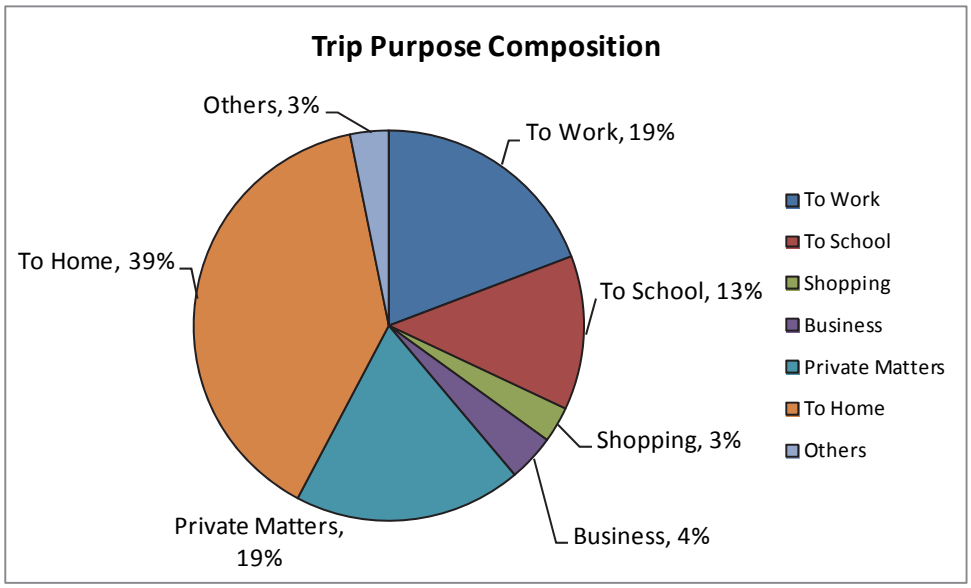
CHAPTER 3 Current Urban Transport System and Transport Demand

3.1 Person Travel Demand and Characteristics

3.1.1 Trip Purpose Composition

A trip is defined as the movement of a person from an origin to a destination with a purpose. Detailed explanations of trips, including special cases and exceptions, are given in Technical Report No. 3.

Trip purpose composition of the residents in the Western province is shown in Figure 3.1.1. Aside from "To Home" trips, the "To Work", "Private Matters" and "To School" trips are the three major trip purposes and the share of these three trips are 19%, 19% and 13% percent respectively. Compared to the three major trip purposes, "Business", "Shopping", and "Others" trips represent 4%, 3% and 3%.



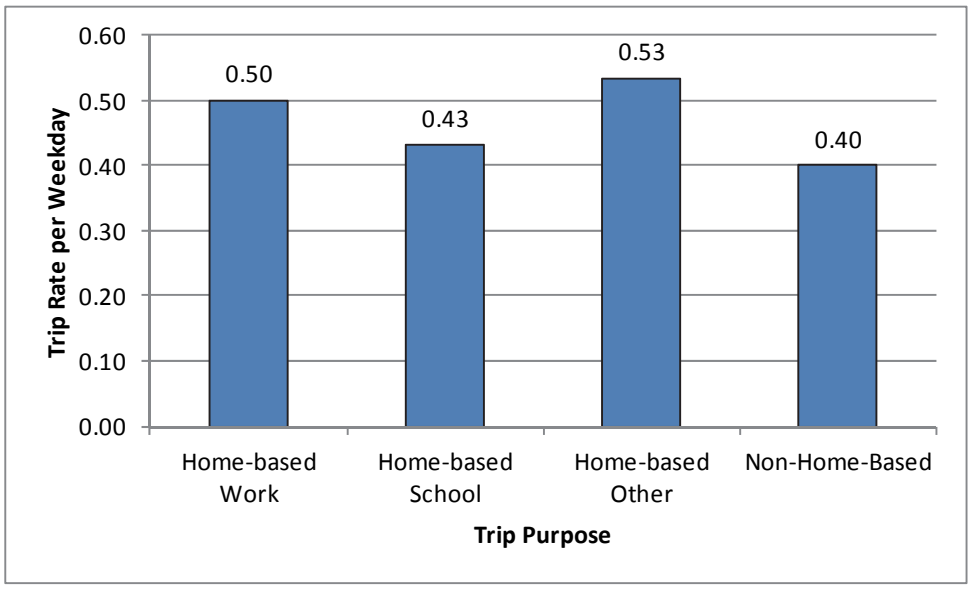
Source: CoMTrans Home Visit Survey 2013

Figure 3.1.1 Trip Purpose Composition

3.1.2 Trip Production Rate

Trip production rate is an important indicator to understand trip making behaviour of the residents. An average trip per person per weekday, calculated by dividing the total number of trips by the population aged five years and above, is referred to as gross trip rate.

The overall gross trip production rate in the province is 1.87. Based on the breakdown of this trip rate by purpose is shown in Figure 3.1.2 "Home-based Other" purpose has the highest trip rate. The next one is "Home-based Work", which is followed by "Home-based School" and "Non-Home-Based".



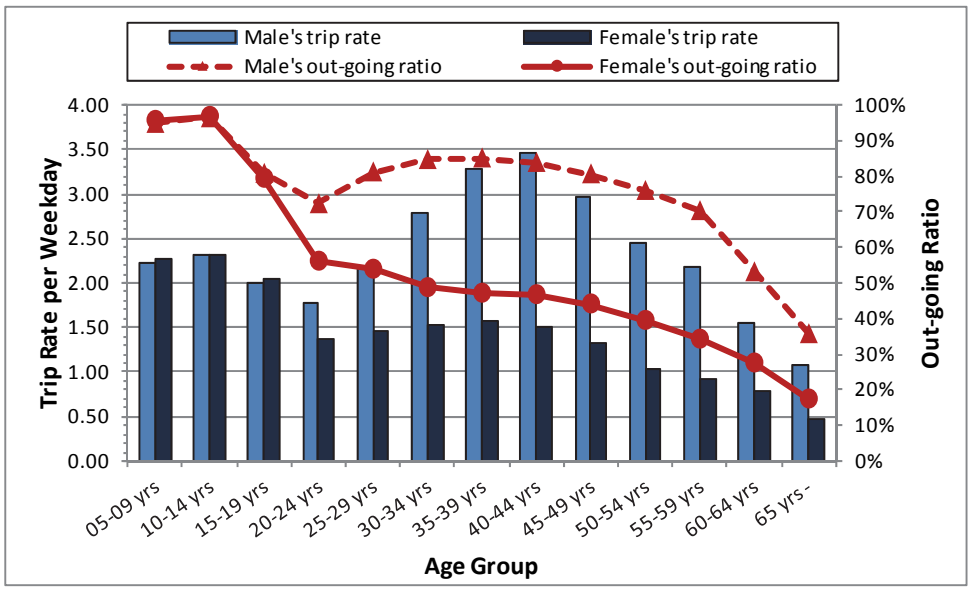
Source: CoMTrans Home Visit Survey 2013

Figure 3.1.2 Trip Rate by Trip Purpose

3.1.3 Trip Patterns by Socio-economic Group

Trip rate is one of the most important indicators to understand trip making patterns and it is also used for measuring future trip generation.

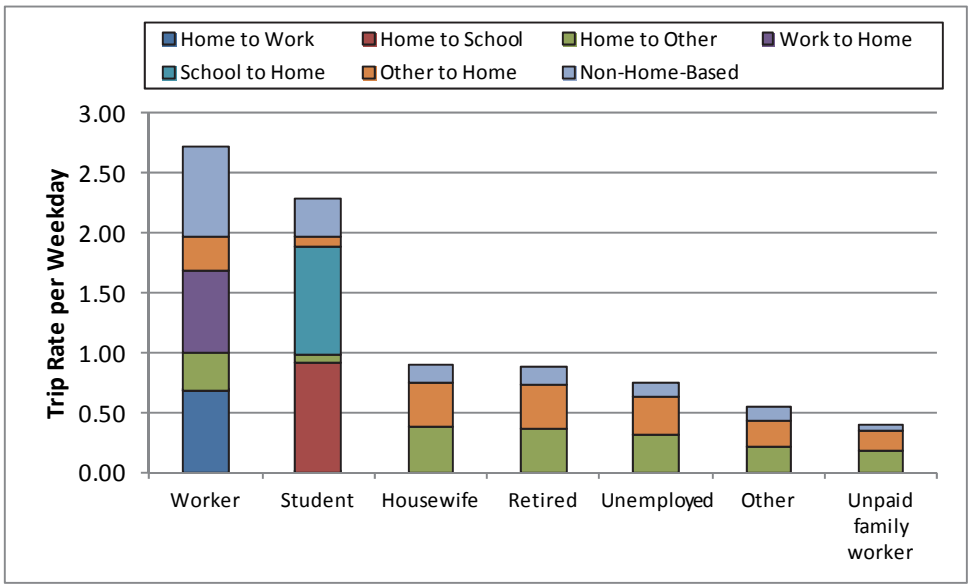
Trip making behaviour of males and females in the Western Province differ significantly. On average, out-going ratio and trip rate per weekday of males are 77% and 2.35, while that of females are 53% and 1.43 respectively. The following figure reveals the decline of out-going ratio and trip rate of females as age increases. It is interesting to note that both males and females have equally high out-going ratios and trip rates when the age is below 20 years, the school-attending age.



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.3 Trip Rate and Out-going Ratio by Gender and Age Group

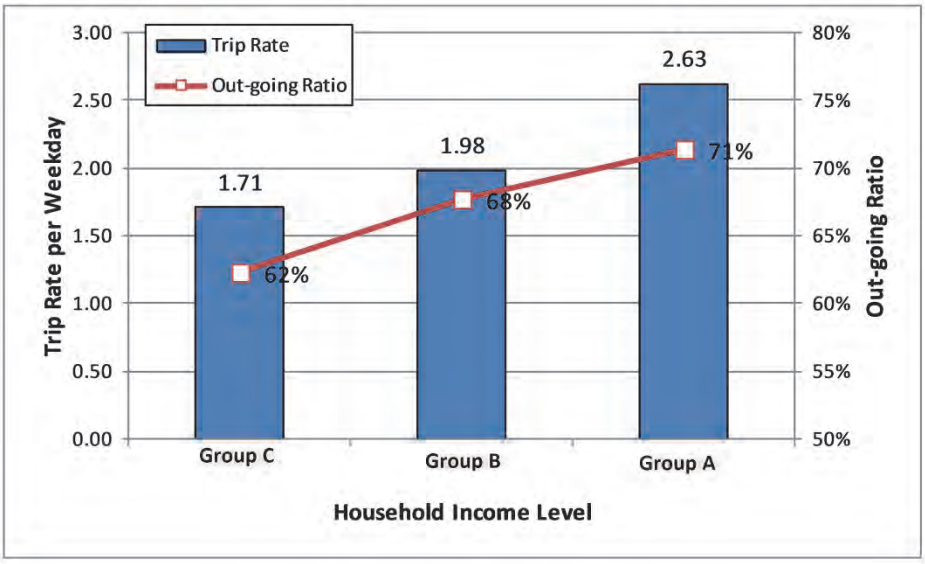
The trip rate varies according to social group and trip purpose as shown in Figure 3.2.4. For workers, higher trip rates are for "Home to Work", "Work to Home" and "Non-Home-Based", while for students, higher trip rates are "Home to School" and "School to Home". For the remaining social groups, trip rate consists mainly of "Home to Other", "Other to Home", and "Non-Home-Based" purposes.



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.4 Trip Rate by Social Group by Trip Purpose

It is estimated that around 10 million trips are generated every day from 1.46 million households in the Western Province in which 71%, 22% and 7% belong to Group C, Group B and Group A households respectively. Trip making behaviours, which are characterised by trip production rate and choice of transport mode, are significantly influenced by levels of income. From Figure 3.1.5, it is observed that trip rate and out-going ratio increase proportionately with the household income level.



Note: 1) Classification of income - Group C: <40,000Rs./HH/Month; Group B: 40,000-79,999Rs./HH/Month; Group A: 80,000 Rs/HH/Month and over

Source: CoMTrans Home Visit Survey 2013

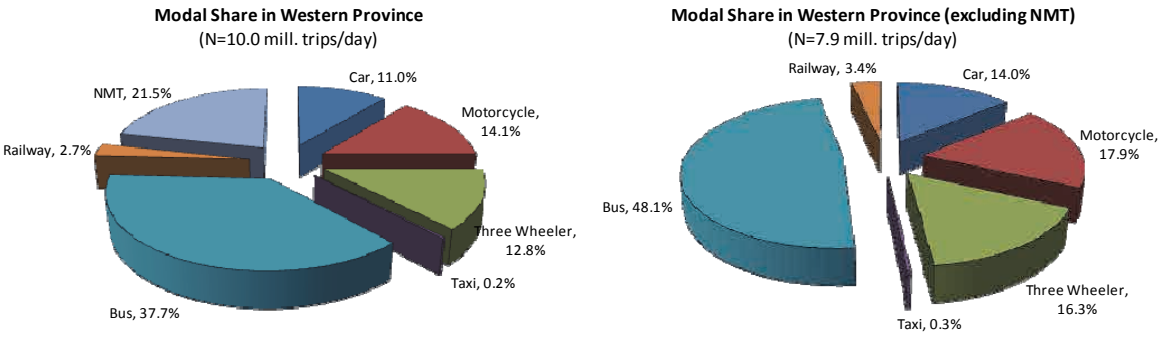
Figure 3.1.5 Trip Rate and Outgoing Rate by Income Group in the Western Province

3.1.4 Modal Share

Figure 3.1.6 shows the modal share with and without non-motorised transport. Around 38% of trips are made by private modes of transport, including cars, taxis, three wheelers and motorcycles while approximately 40% are made by buses and railway. The remaining 21.6 percent of the trips are made by non-motorised modes of transport including walk, bicycle, and others.

In general, transfers reduce ridership of public transport. Figure 3.1.10 shows that while 74% of bus trips do not require any transfer between transport modes, only 26% of railway trips have this pattern. On average, bus users make 0.31 transfers per trip whereas railway users make 1.06 transfers per trip, more than three times higher. Furthermore, bus service is highly accessible by foot as walking accounts for more than 90% of access and egress modes of bus trips. Accessibility of railway, however, relies not only on walking but also on other modes, particularly bus. Figure 3.1.11 reveals that walking and taking the bus constitutes 49% and 38% of access mode and 51% and 40% of egress mode respectively.

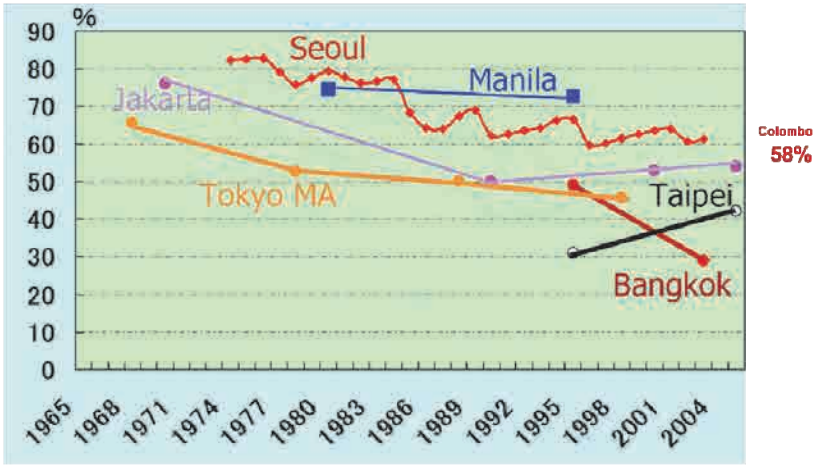
This analysis gives an implication that buses not only widely cover the study area, but also operate as trunk lines. Moreover, as long as connections between bus and railway are not well organised, the issue of transferring remains strong impedance for travelling by train.



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.6 Modal Share of Person Trips made by Residents in the Western Province

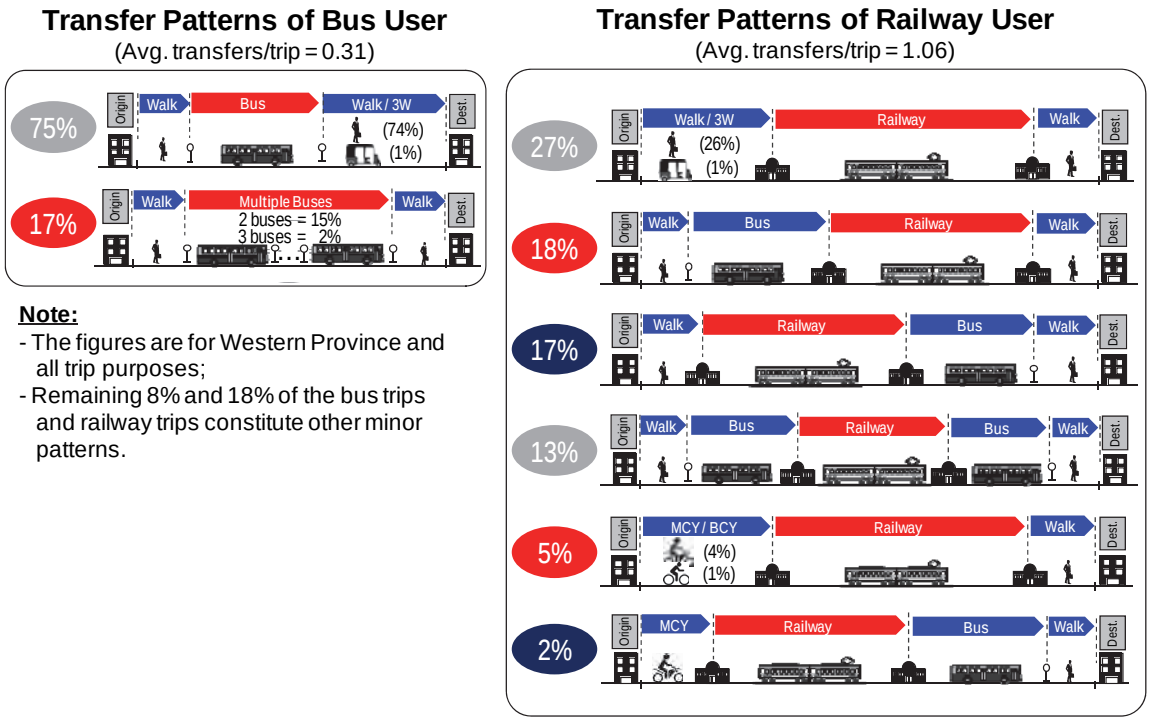
Figure 3.1.7 depicts the trends of public transport mode share. In general, the share of public mode of transport in the metropolitan areas tends to be declining due to several reasons such as rapid motorisation and insufficient public transport service. It should be noted that the change of modal share cannot be explained by one factor but may be attributable to various factors. Tendency of a decreasing share of public transport is a lesson from international experiences.



Note: Walking and bicycles are not included.

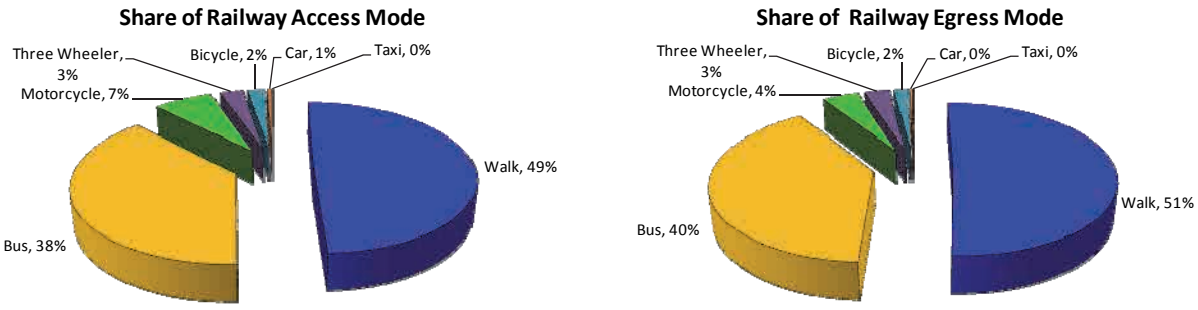
Source: Presentation prepared by Prof. Dr. Shigeru Morichi (2003), GRIPS

Figure 3.1.7 Trend of Public Transport Mode Share



Source: CoMTrans Home Visit Survey 2013

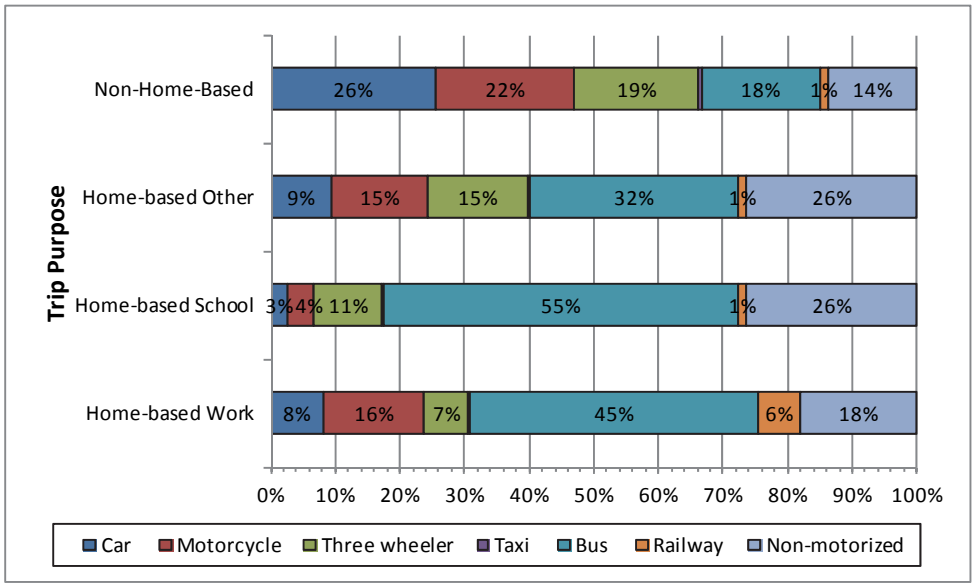
Figure 3.1.8 Major Patterns of Mode Transfer for Bus Users and Railway Users



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.9 Access and Egress Modal Share for Railway

Modal share also varies according to trip purpose. Figure 3.1.10 indicates that for almost all trip purposes, bus is always the dominant mode. More than half of the home-based school trips and almost half of home-based work trips are made by bus. Modal share of three-wheelers and motorcycles is about the same for home-based other trips. For non-home-based trips, private modes, including cars and motorcycles, are the leading modes of transportation.

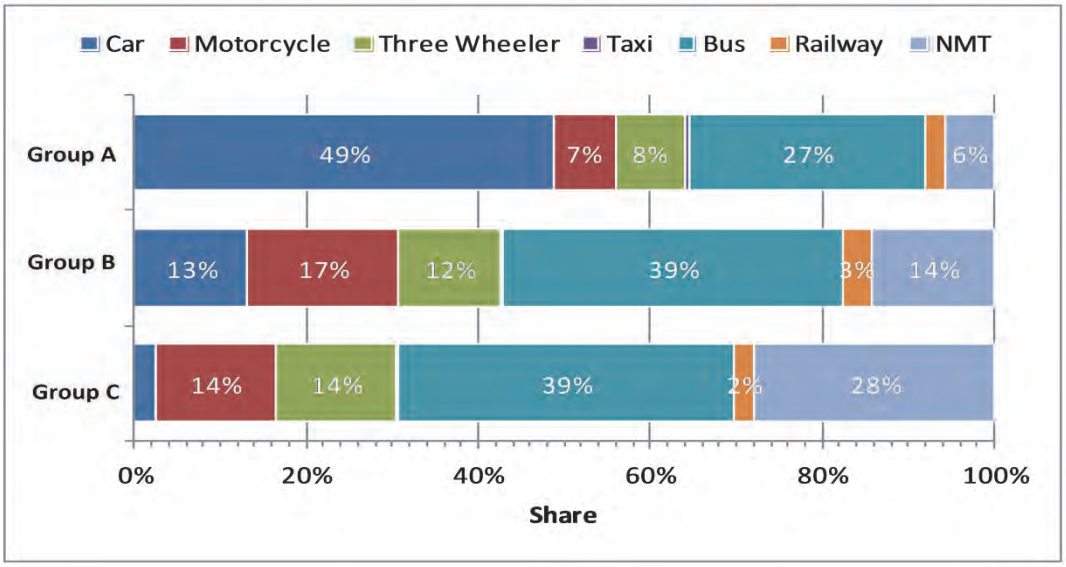


Source: CoMTrans Home Visit Survey 2013

Figure 3.1.10 Modal Share by Trip Purpose in the Western Province

Residents of Group A are more car dependent as the modal share accounts for 47.6% as shown in Figure 3.1.11. Only a few of them use non-motorised transport (6.3%) as compared to Group C. On the other hand, it is noteworthy that the modal shares of bus transport are considerably high in all income groups, while that of railways is extremely low. One of the reasons is that the area covered by the railway network is limited compared to the bus network, or in other words, the accessibility to railways is low.

Given the limited coverage of the railway network, railways users make more transfers than bus users.



Note: 1) Classification of income - Group C: <40,000Rs./HH/Month; Group B: 40,000-79,999Rs./HH/Month; Group A: 80,000 Rs/HH/Month and over

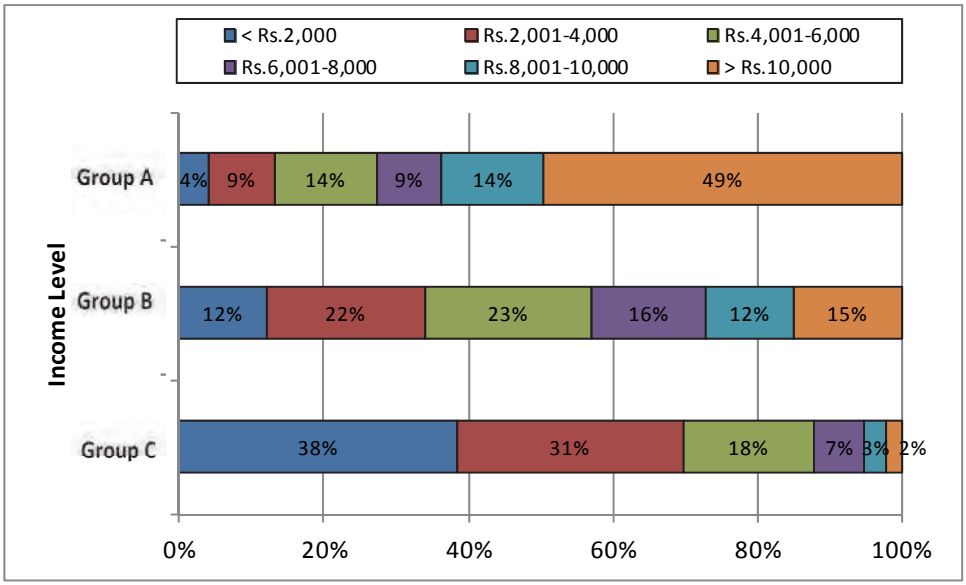
2) NMT includes walk, bicycle, and others.

Source: CoMTrans Home Visit Survey 2013

Figure 3.1.11 Modal Share by Household Income in the Western Province

3.1.5 Transport Expenditure

Figure 3.1.12 depicts the composition of monthly household transport expenditure by income group. As expected, the general trend is that Group C households spend less and Group A households spend more on monthly transport. As much as 69% of Group C households (i.e. households with income less than Rs. 40,000) spend no more than Rs. 4,000 on transport, while only 34% and 13% of Group B (Rs. 40,000 – Rs. 79,999) and Group A households (Rs. 80,000 and above), respectively, spend Rs 4,000 or less on transport. It is interesting to note that for Group C, 27% of the households spend more than Rs. 8,000 which is more than 10% of their household income. For the Group A, almost 50% spend over Rs. 10,000 for transport.



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.12 Distribution of Household Monthly Transport Cost by Income Group

As given in Table 3.1.1, the average monthly transport cost of Group C, Group B and Group A are Rs. 3,584, Rs. 6,998 and Rs. 14,929 respectively. The transport cost of the Group B households is almost double that of Group C; transport cost of Group A households is as high as 4 times that of the Group C. On average, 14%, 16%, and 17% of the total household expenditure of Group C, B, and A income respectively are spent on the transport cost.

Table 3.1.1 Average Household Transport Cost and its Ratio to Total Expenditure

Household Income Group	Average Household Monthly Expenditures (Rs./month)	Average Household Monthly Transport Cost (Rs./month)	Ratio of Transport Cost to Total Expenditures
Group C	26,307	3,584	14%
Group B	43,303	6,998	16%
Group A	88,432	14,929	17%

Source: CoMTrans Home Visit Survey 2013

3.1.6 Trip Generation and Trip Distribution

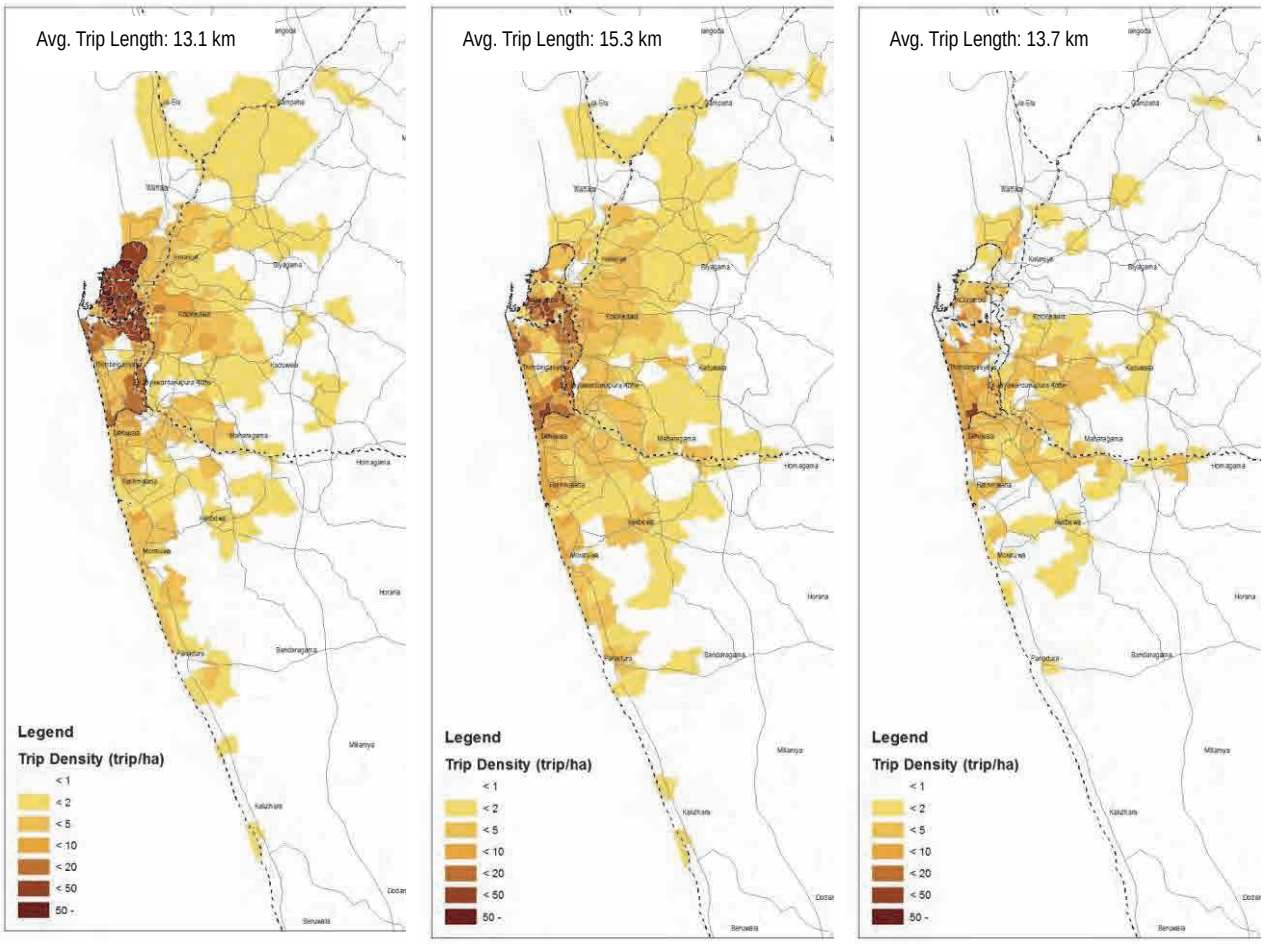
Generated and attracted trips are observed in terms of trip density. Trip density is calculated by dividing the number of trips by the area of each Traffic Analysis Zone (TAZ)[1] where the trips are produced or attracted.

[1] Traffic Analysis Zone (TAZ): a unit of geography which varies in size and is commonly used in conventional transport planning models. In this study, the Western Province is divided into 462TAZs, in which 59 TAZs are in CMC and 403TAZs are in the rest of the province based on the boundary of GN Division.

(1) Generated and Attracted Trips by Purpose

To Work Trip

The number of trips for commuting to work in CMC is around 400 thousand trips per day, in which more than 70% come from outside of CMC. Trip origin distribution of workers commuting to work in CMC depicted in Figure 3.1.2 indicates that most of the Group C workers commute at relatively shorter distances, that is, they live relatively closer to their workplace, particularly in the Northern part of CMC. Despite their short commuting trip distance, almost 15% of their household expenditure is spent on the transport cost alone.



a) Group C b) Group B c) Group A

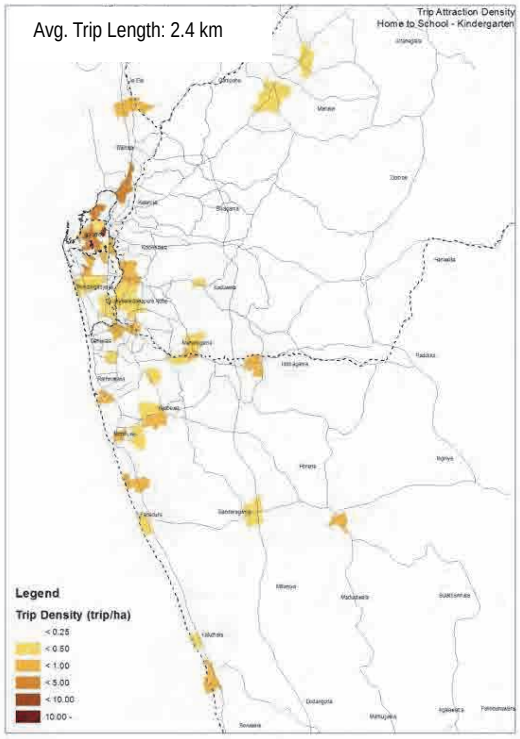
Source: CoMTrans Home Visit Survey 2013

Figure 3.1.13 Trip Generation Density of Workers Commuting to CMC

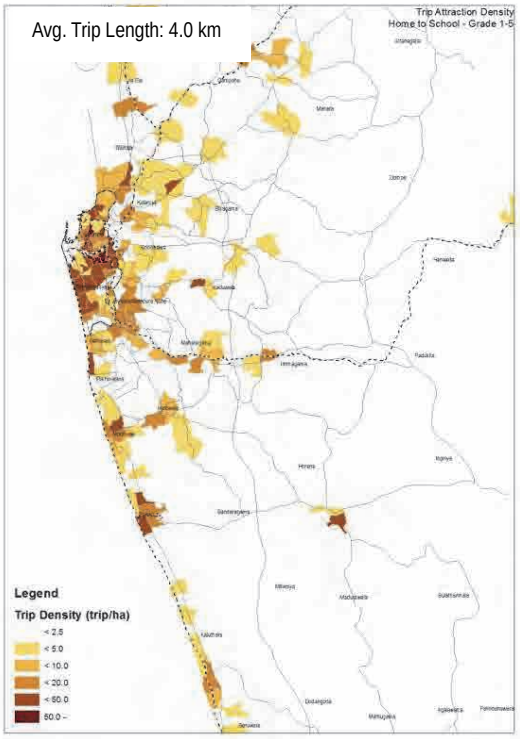
Educational Trips

In general, high trip attraction for educational trips is observed in CMC where education facilities are concentrated (see Figure 3.1.16). For students who attend G.C.E A-Level or lower grades,

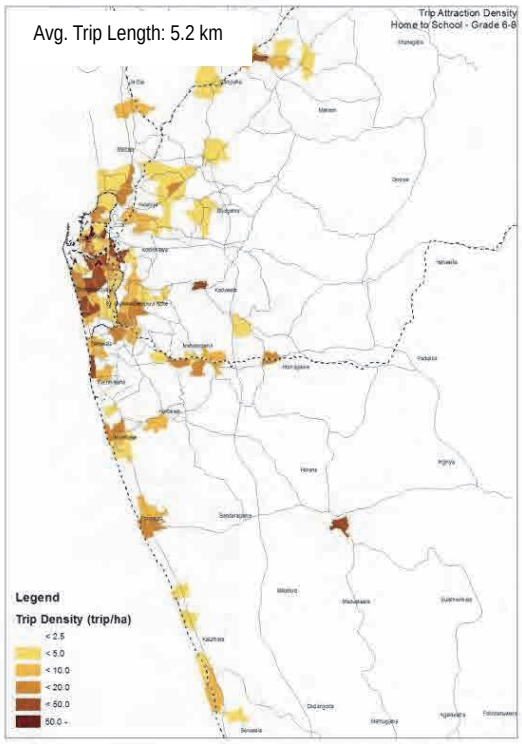
their average trip length below 7.0 km suggests that they go to school close to their residential location. Once admitted to universities, their average travel distance significantly increases to as much as 17 km since many tertiary educational institutions (including state and private universities or institutions) are located within CMC and its surrounding urbanised areas such as Kelaniya, Malabe, Nugegoda and Moratuwa. Those who attend non-university tertiary education also have to travel 14.7 km for educational purpose.



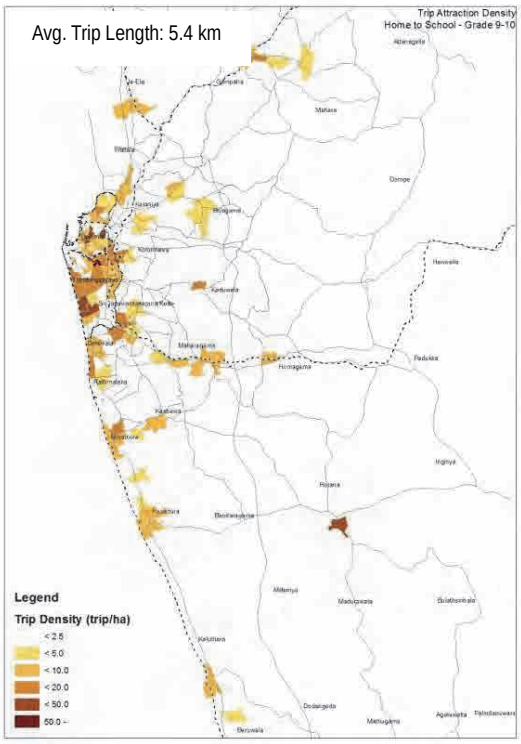
a) Kindergarten



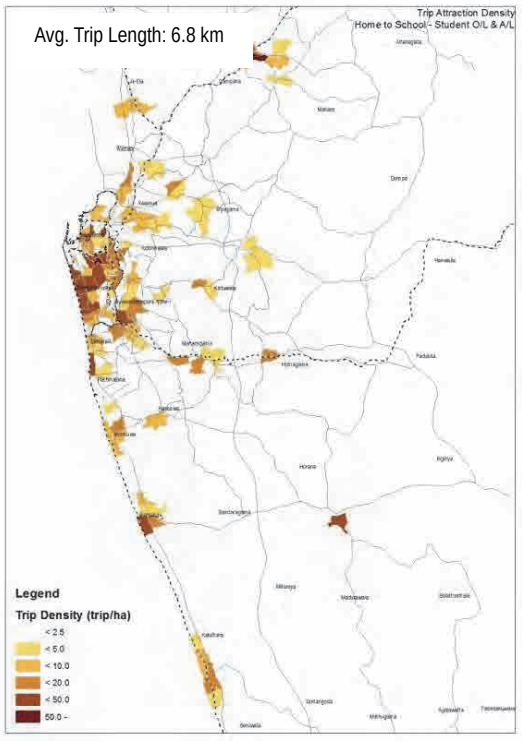
b) Students Grade 1-5



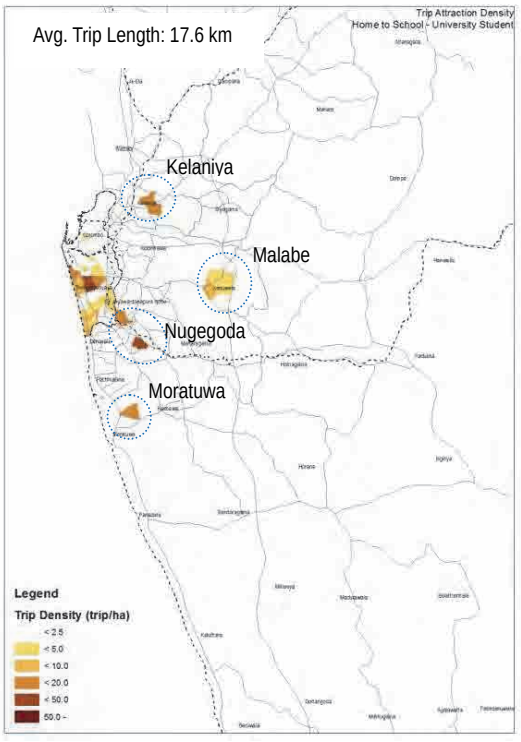
c) Students Grade 6-8



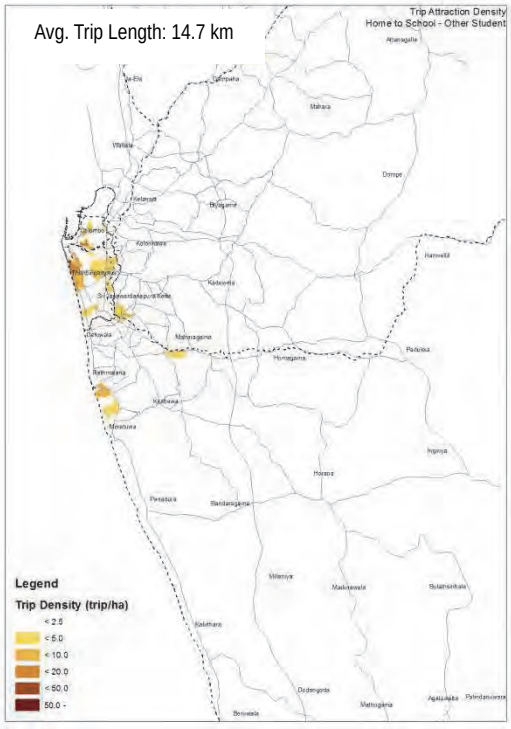
d) Students Grade 9-10



e) Students G.C.E. O/L and A/L



f) Students Graduate & Above



g) Other Types of Students

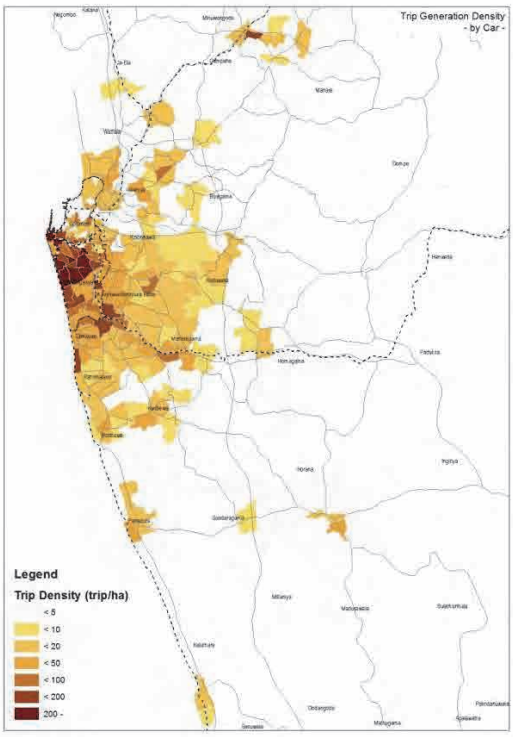
Source: CoMTrans Home Visit Survey 2013

Figure 3.1.14 Trip Attraction Density of Educational Trips

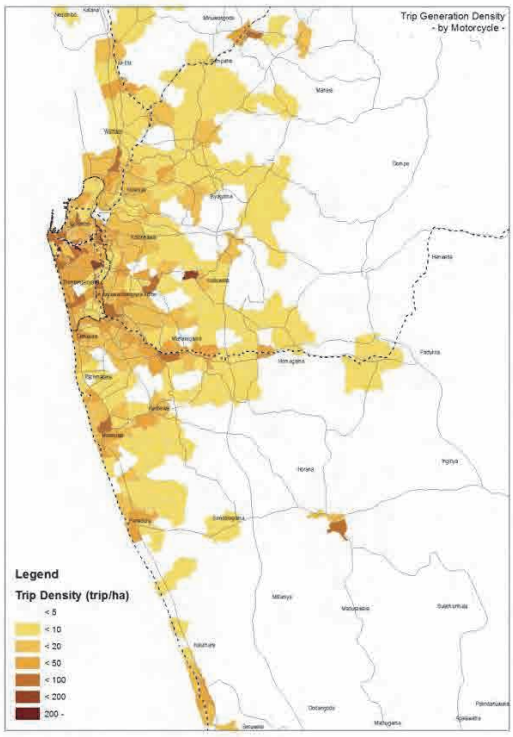
(2) Generated Trips by Mode of Transport

For all purposes, trip generations are high in CMC where the majority of workplaces, educational institutions as well as facilities for social and economic activities are located (see Figure 3.1.15).

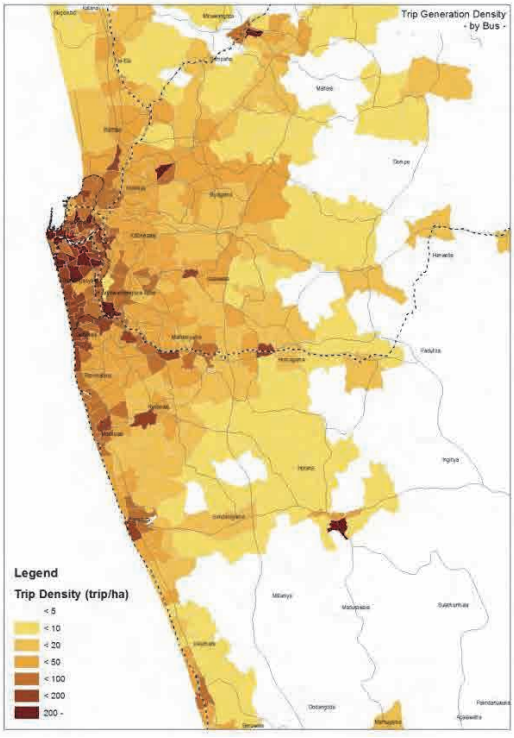
Outside of CMC, trip generation by car is notably high in the area to the East of CMC (up to Malabe) and to the South of CMC (up to Moratuwa), whereas trip generation by motorcycle spreads widely across the surrounding areas of CMC. As for public transport, trip generation by bus is widespread and the use of buses is even higher along the transport corridors. In contrast, trips by the railways are only observed along the railway line which underlines the low accessibility to the railways.



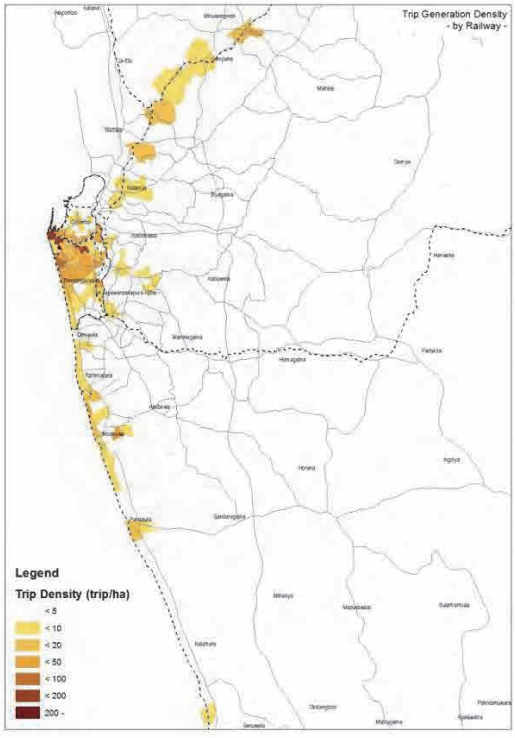
a) Car



b) Motorcycle



c) Bus



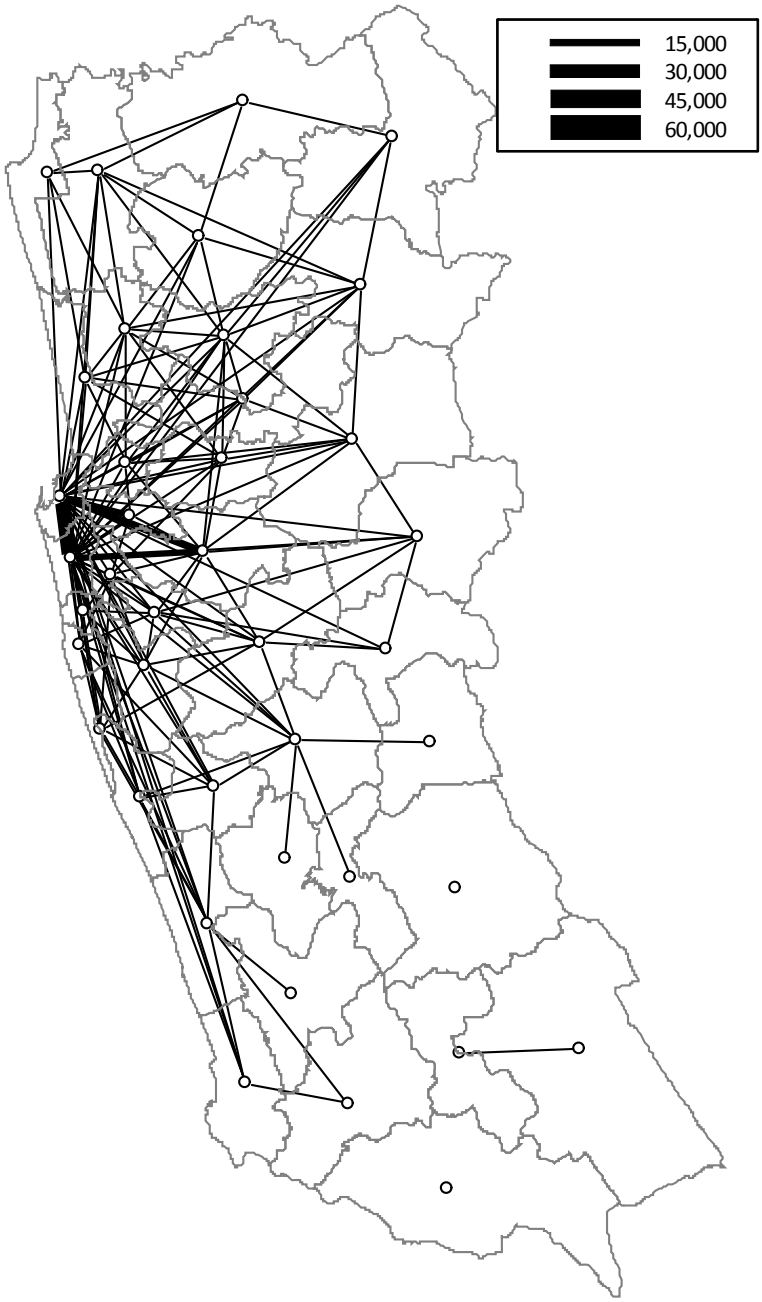
d) Railway

Source: CoMTrans Home Visit Survey 2013

Figure 3.1.15 Trip Generation Density by Transport Mode

(3) Trip Distribution of Home-based to Work Trips

Heavy flows are observed within CMC as well as between CMC and surrounding DS divisions such as Kaduwela, Sri Jayawardenepura Kotte, Dehiwala, and Moratuwa.



Source: CoMTrans Study Team

Figure 3.1.16 Home-based Work Trips (>=2000 trips only)

(4) Characteristics of Trips Entering CMC

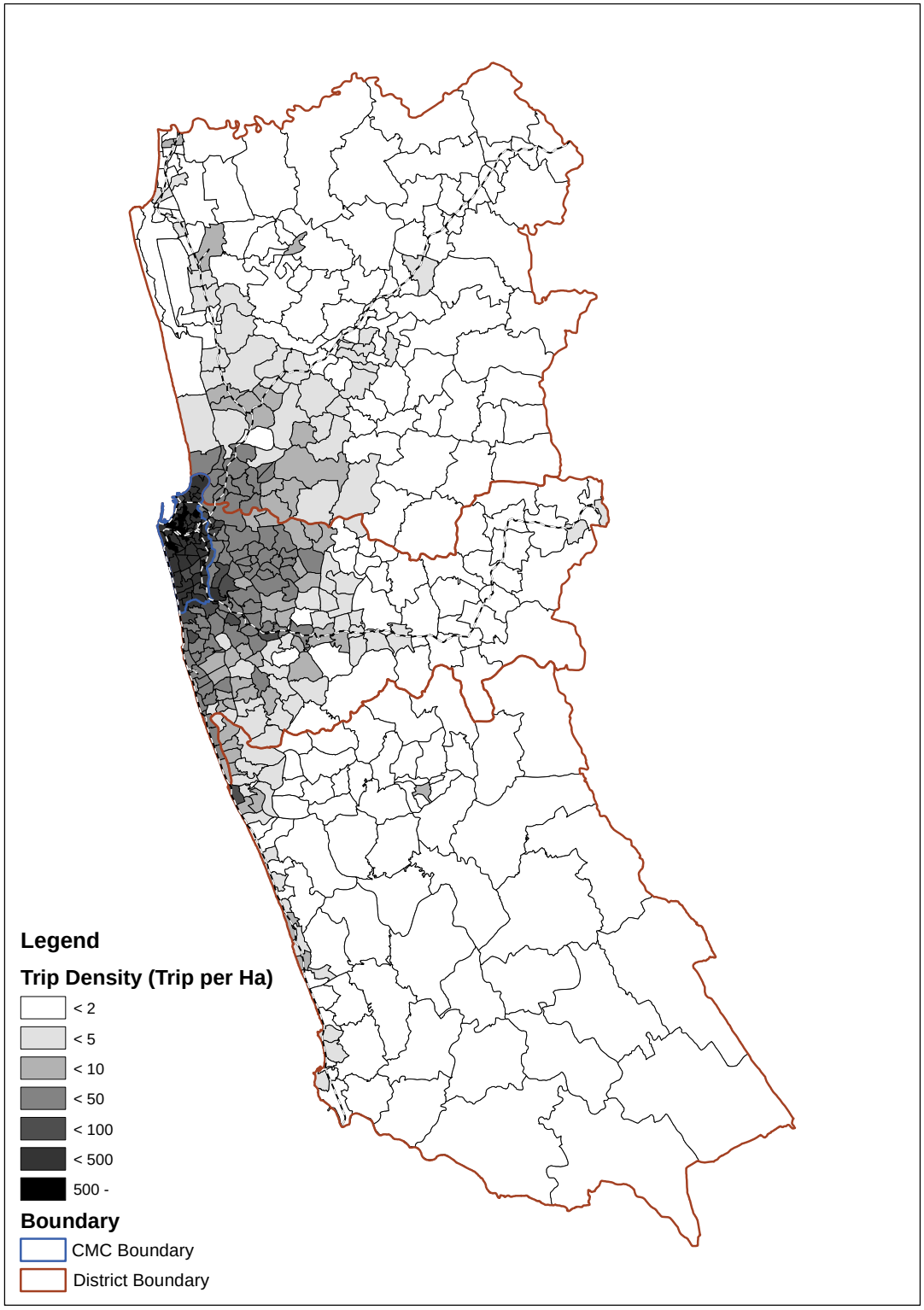
As shown in earlier sections, a considerable number of trips are made within CMC as well as between CMC and surrounding DS divisions. As calculated from OD matrices, approximately 705 thousand trips per day are from outside of CMC ending inside this city. As much as 20% of these trips are made within one hour of the busiest morning peak period (07:00-07:59),

Table 3.1.2 Trips Attracted to CMC from Outside per Day and per Peak Hour

Items	Transport Mode			Total
	Private	Public	NMT	
Daily trip (‘000 trips/day)	256	443	6	705
Peak hour trips (07:00-08:00) (‘000 trips/hour)	61	81	2	145
Peak Hour Ratio	24%	18%	36%	20%

Source: CoMTrans Home Visit Survey 2013

Figure 3.1.17 shows the generation density of trips ending in CMC observed at the Traffic Analysis Zone (TAZ) level. This figure also includes the trips produced in CMC where the highest trip attraction density is observed indicating that a significant number of trips are made within the city boundary. For trips from outside CMC, their origins are mainly located in the area surrounding CMC and along the major corridors. Figure 3.1.19 also implies that where public transport, especially railway service, is better, the travel distances seem higher and in the areas far from the city higher trip densities are also generated.



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.17 Trip Generation Density of Trips Attracted to CMC

3.1.7 Passenger Volume Crossing the Provincial Borders

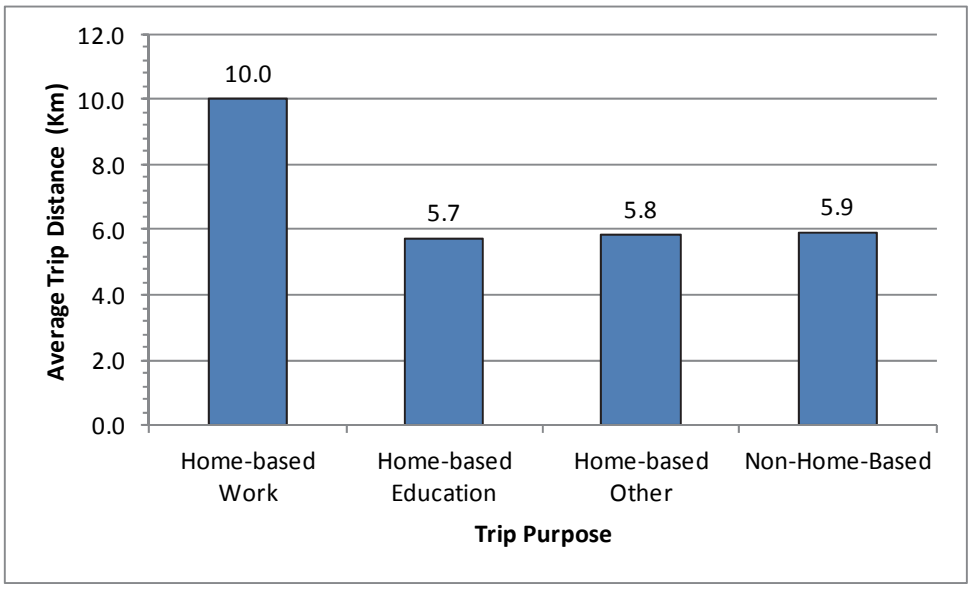
From the result of the Cordon Line Survey (CLS), the CoMTrans Study Team estimated the number of passengers travelling to/from the outside of the Western Province. Preliminary results of the passenger demand at each border by all modes (railways, buses, motorcycles, three-wheelers and cars) are summarised as follows:

- About 584,000 passengers in both directions cross the provincial border daily.
- 61% of the passengers use buses, 8% use railways and 11% use motorcycles/three-wheelers.
- There are four major corridors for inter-provincial movement such as Negombo, Kandy, Avissawella and Galle roads with more than 100,000 passengers per day.

More detailed analyses and findings are presented in Technical Report No. 3.

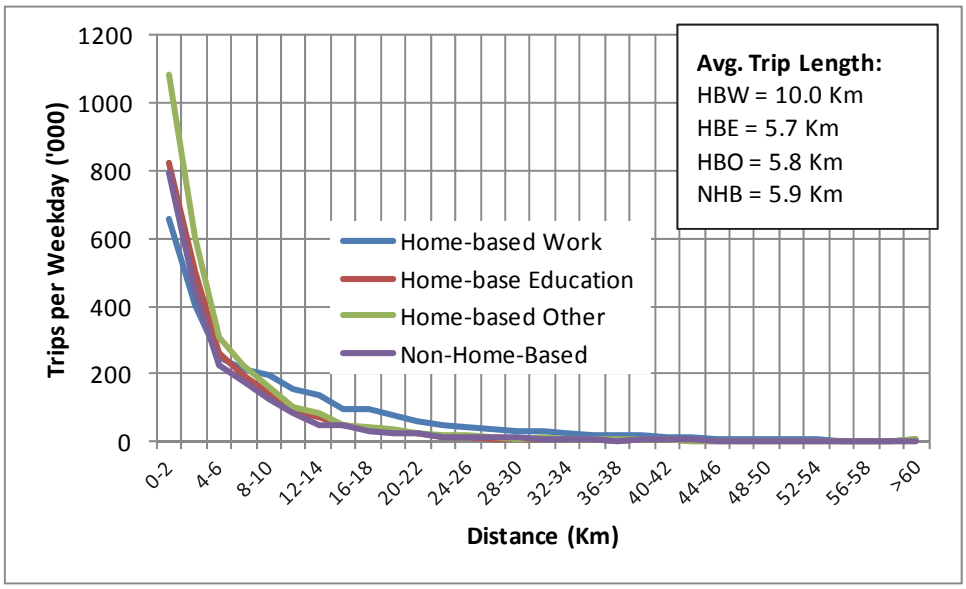
3.1.8 Travel Distance

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.



Source: CoMTrans Home Visit Survey 2013

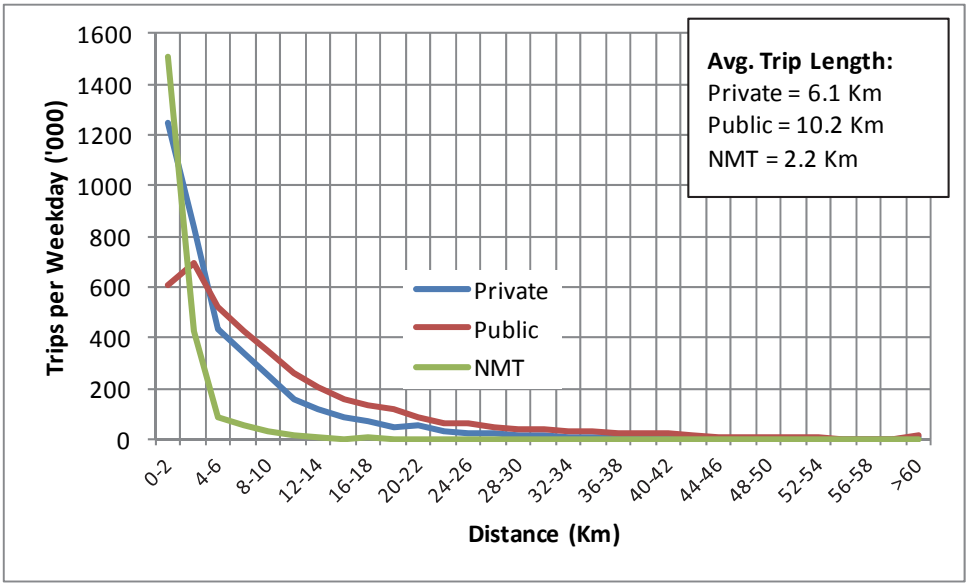
Figure 3.1.18 Average Travel Distance by Trip Purpose in the Western Province



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.19 Distribution of Trips by Purpose by Travel Distance in the Western Province

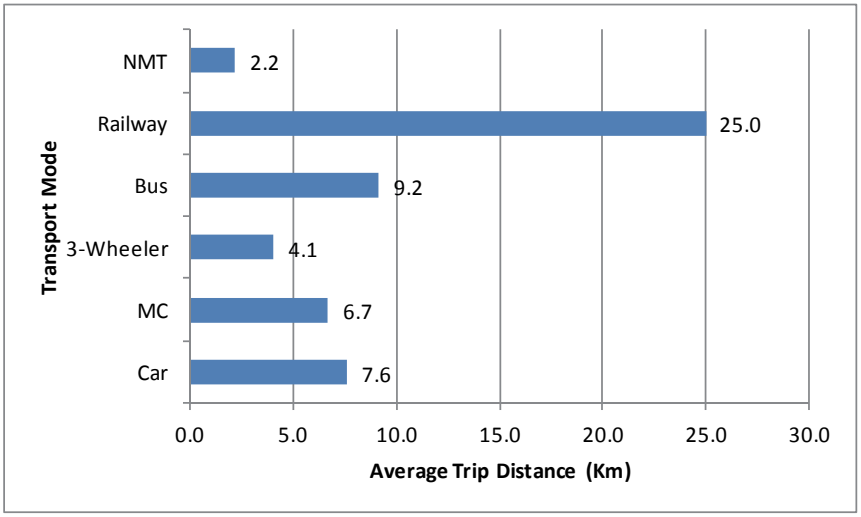
The analysis result also indicates that those who travel by public transport (including buses and the railways) travel further than those who use a private mode. The distribution of travel distance by transport mode depicts that when the distance is 4 km or longer, the number of trips by public transport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



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.20 Distribution of Trips by Mode by Travel Distance in the Western Province

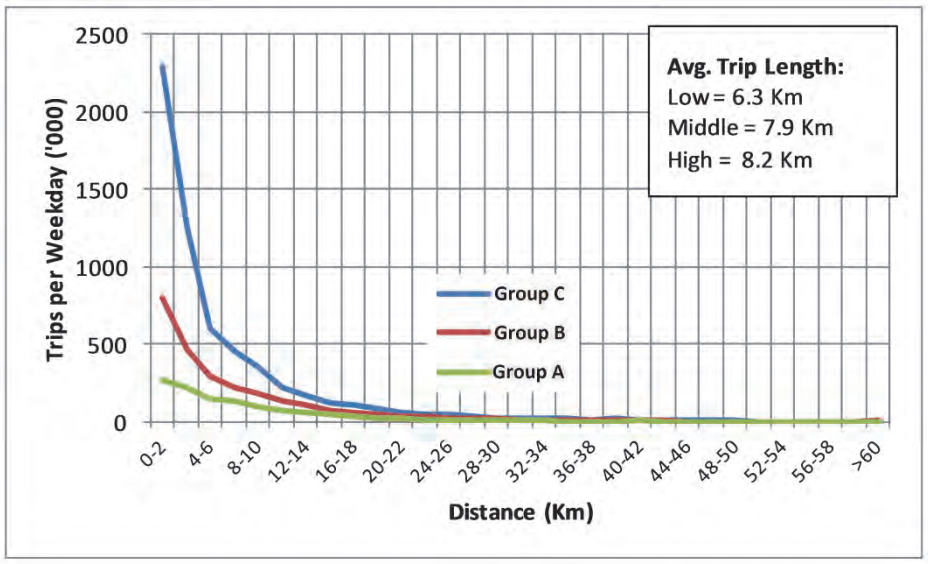
Further detail of trip distance by mode indicates that railway users have the longest trips in which the average distance is about 25 km. Bus users and car users have average travel distances of 9 km and 8 km respectively.



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.21 Average Travel Distance by Mode of Transport

As income increases, the average travel distance also slightly increases. The larger average distance of the 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.



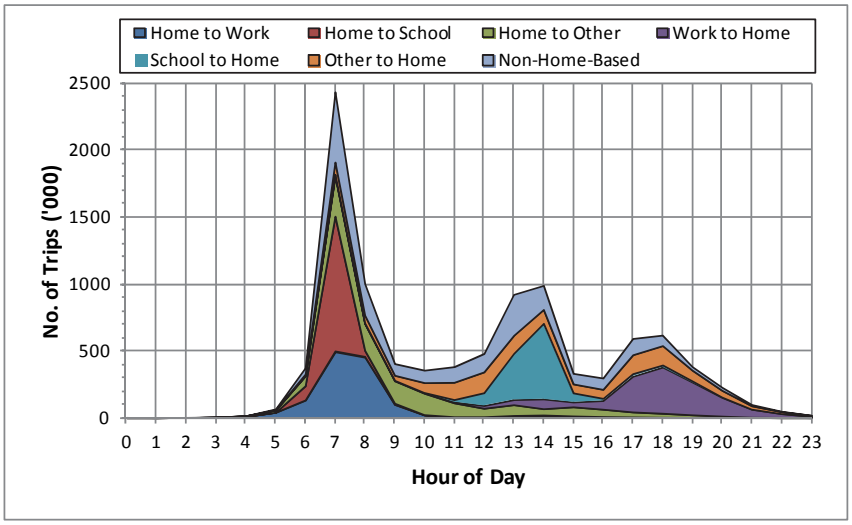
Source: CoMTrans Home Visit Survey 2013

Figure 3.1.22 Distribution of Trips by Income Group by Travel Distance in the Western Province

3.1.9 Hourly Fluctuation of Trips Generated and Attracted

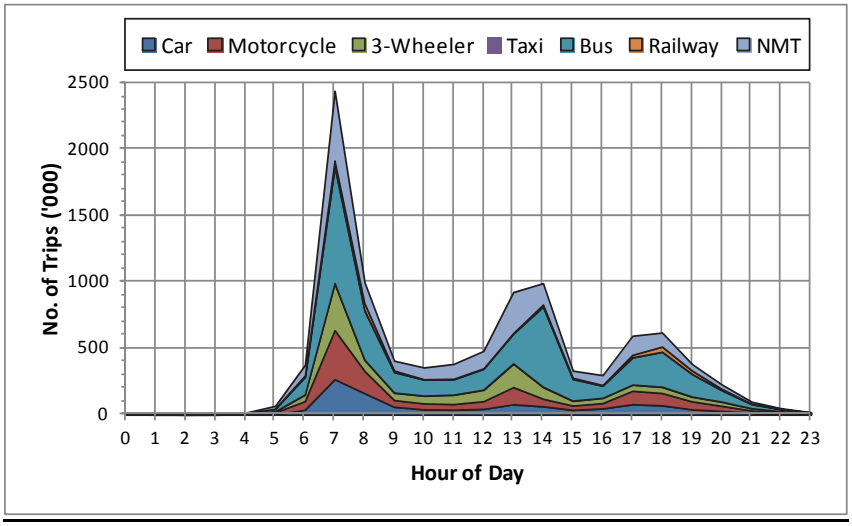
Analysis of hourly fluctuations of trips shows that there are three peaks within a day. The morning peak period is sharply seen within one hour between 7 A.M. and 8 A.M. while the afternoon and evening peak periods extend for about two hours from 1 P.M. to 3 P.M. and from 5 P.M. to 7 P.M. respectively. Accordingly, the shares of these peak hour trips to the daily trips are 24%, 19% and 12%.

The morning peak hour is dominated by home to work and home to school purposes, whereas afternoon peak hour and evening peak hours are dominated by school to home and work to home respectively. The analysis also indicates that buses have the highest share during the three peak periods. Further details are presented in Technical Report No. 3.



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.23 Hourly Fluctuations by Purpose at Trip Destination in the Western Province



Source: CoMTrans Home Visit Survey 2013

Figure 3.1.24 Hourly Fluctuations by Mode at Trip Destination in the Western Province

3.2 Railways

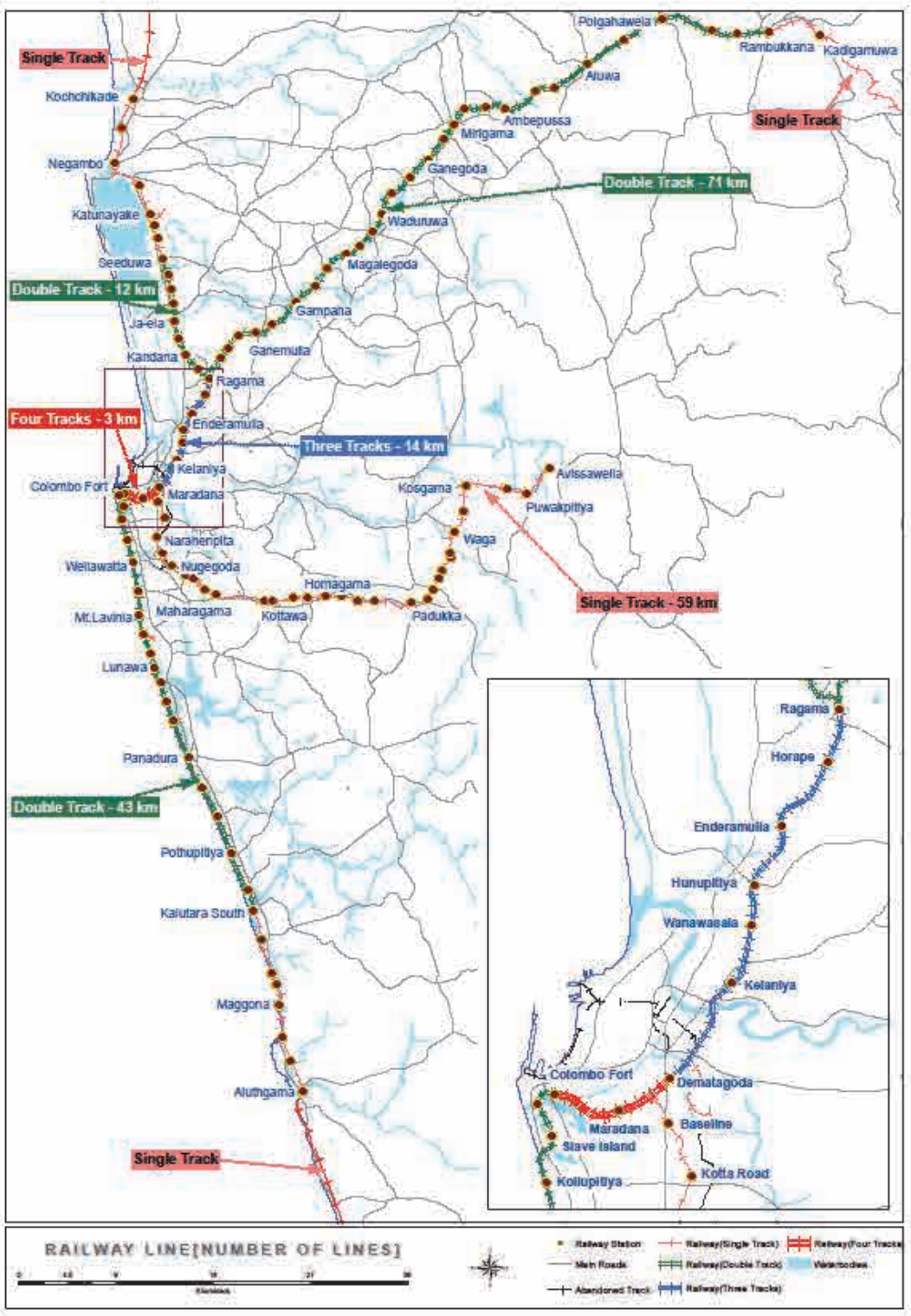
3.2.1 Railway Lines in the Western Province

In the Western Province, the Main Line, the Coastal Line, the Puttalam Line and the Kelani Valley Line are currently operated. The main line has double tracks for the whole section. The Coastal line has a double track section from Colombo Fort station to Kalutara. The Sri Lanka Railways (SLR) is extending its double track section further south. A part of the Puttalam line from Ja-ela to Seeduwa was improved to double track recently, and the double track section reached from Ragama to Seeduwa. However, no line is electrified. The Kelani Valley Line was built as a narrow gauge for rubber plantations in 1902. Although the line was upgraded to a broad gauge in 1996, the line has a number of sharp curves with radius less than 200m.

Figure 3.2.1 shows the number of tracks in railway lines of The Western Province. Details of the railway in Sri Lanka, history and trend of pax-km and Freight-ton-km in Sri Lanka are described in the Technical Report.

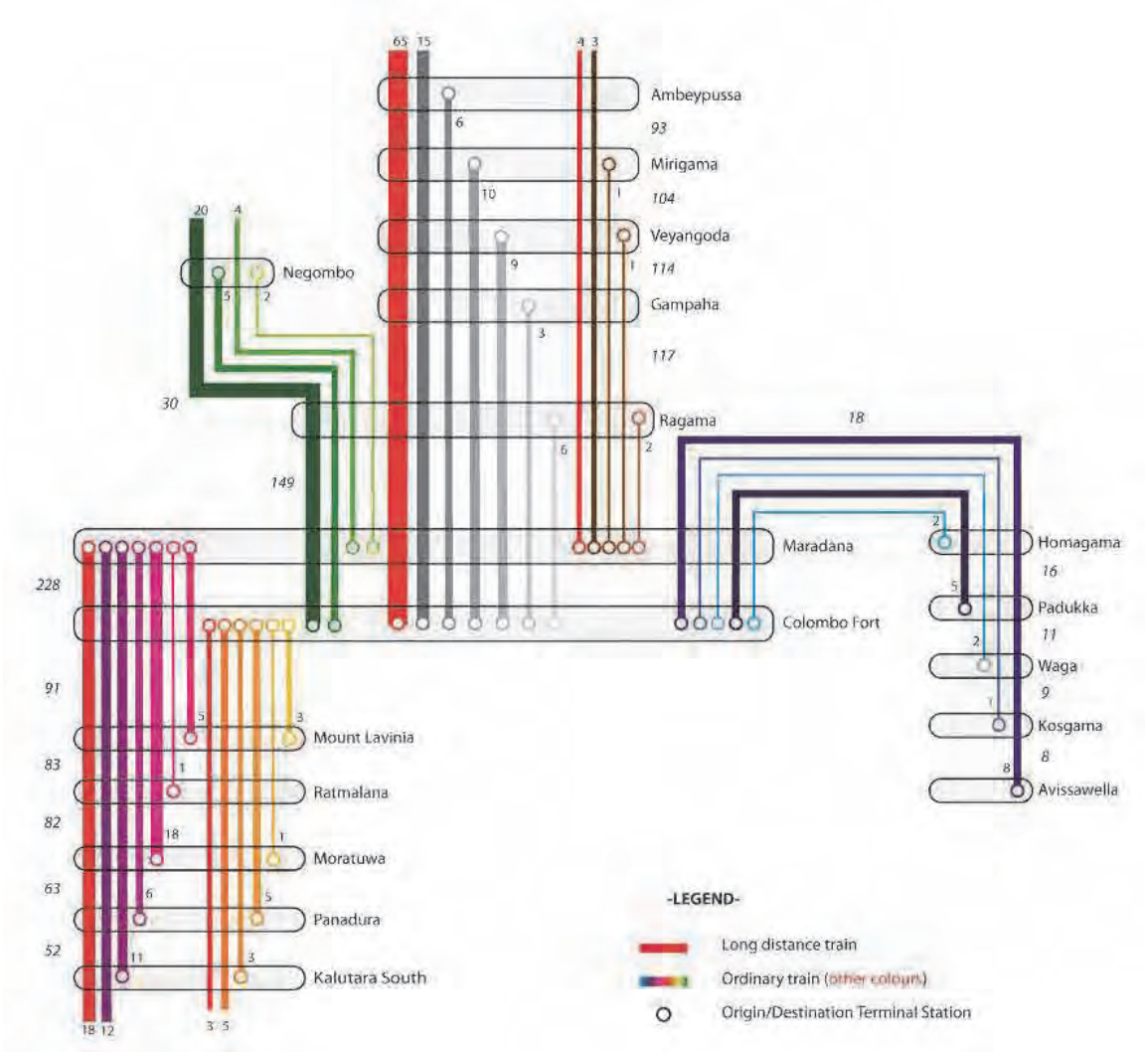
3.2.2 Train Operation

There are long distance trains and commuter trains operated in the Western Province area of Sri Lanka Railway for passenger service. Trains of the Coastal line start from Maradana station while most of the trains going north and east start from Fort station. Figure 3.2.2 indicates the train network of this area, number of trains running in each section, and scheduled speed.



Source: CoMTrans Study Team arranged from SLR data

Figure 3.2.1 Number of Tracks on Railways in the Western Province



Source: CoMTrans Study Team

Figure 3.2.2 Train Distribution Diagram of the Western Province

Trains going north start from Fort station and trains going south start from Maradana station. The number of tracks between Fort and Maradana is four but one track is designed for the KV line, therefore, the effective number tracks for the Main line and Coastal line is three. However, the number of trains operating between Fort and Maradana is about twice as many as the number of trains between Maradana and Ragama. Also, trains from the depot to Fort station or Maradana station run this section crossing the revenue line. Therefore, trains have to wait to pass this section until the track becomes clear.

Although no train is operated, there is a railway track from Katunayaka South station to a station roughly one kilometre from departure gate of the Bandaranayake International Airport. According to the CoMTrans cordon line survey at the airport, 38% of airport passengers access to airport by passenger cars followed by taxi which is 32% of passengers. Other access modes are bus, 16%, tourist bus, 5%, and three wheelers, 5%. 61% of airport passengers are from the

Western Province.

Average scheduled train speeds in the Western Province are in the range between 27 and 33 km per hour as listed in Table 3.2.1. However the average speeds in the sections between Fort – Ratmalana and Ratmalana – Panadura are 24 km/hour and 18 km/hour respectively. These speeds are low for railway operation. On the other hand the average speed of the Kelani Valley Line is 24 km per hour due to many sharp curves.

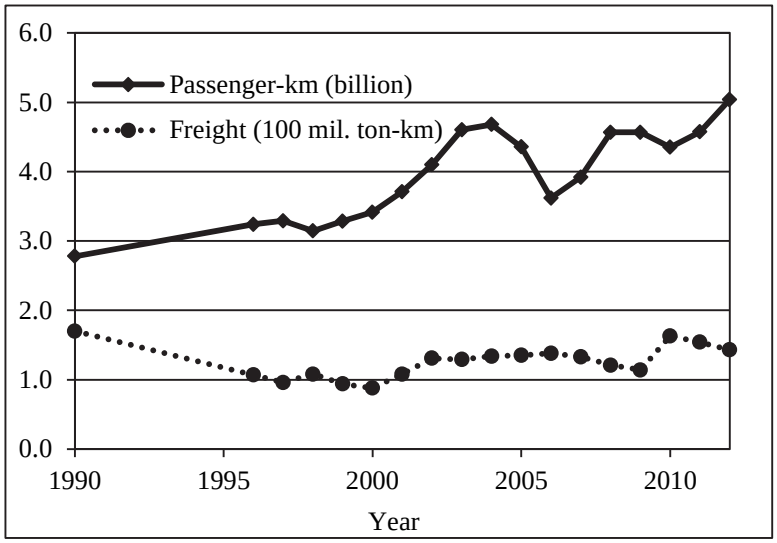
Table 3.2.1 Average Scheduled Train Operation Speed

Line	Section	Average Speed	Remarks
Main Line	Fort- Maradana	29 km/hr	Quadruple track
	Maradana – Ragama	32 km/hr	Triple track
	Ragama – Gampaha	33 km/hr	Triple track
	Gampaha – Ambepussa	35 km/hr	Double track
Puttalam Line	Ragama – Ja Ela	30 km/hr	Double track
	Ja Ela – Negombo	29 km/hr	Mainly single track (Seeduwa – Ja Ela is double track)
	Negombo – Kochchikade	27 km/hr	Single track
Coastal Line	Fort – Ratmalana	24 km/hr	Double track
	Ratmalana – Panadura	18 km/hr	Double track
	Panadura – Kalutara South	35 km/hr	Double track
	Kalutara South – Althugama	34 km/hr	Single track
Kelani Valley Line	Maradana – Padukka	25 km/hr	Single track, a number of sharp curve sections
	Padukka - Avissawella	25 km/hr	Single track, a number of sharp curve sections

Source: Calculated based on Time Table of Sri Lanka Railways

3.2.3 Railway Passengers

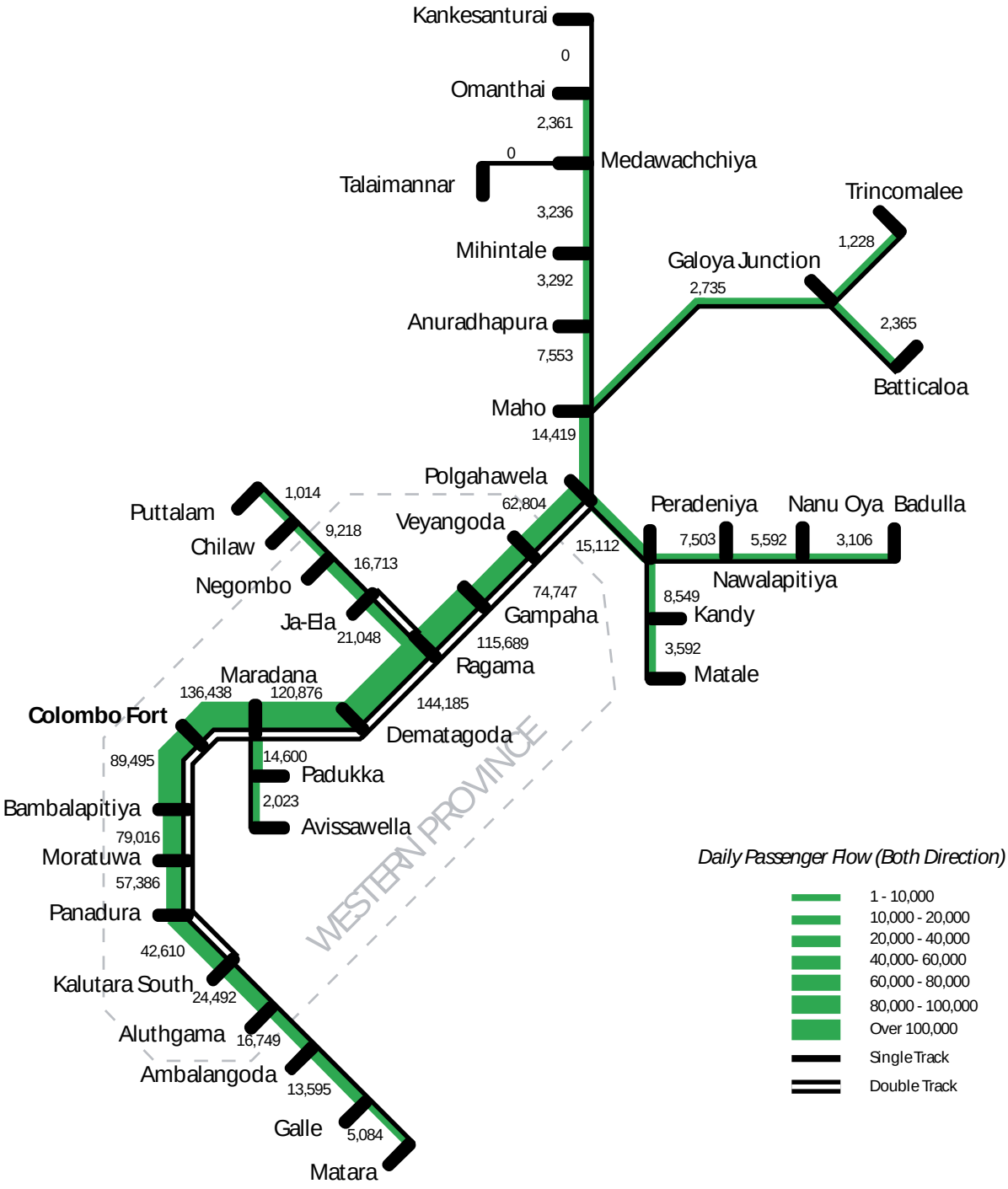
Railway passenger-kilometres and freight tonnage-kilometres in the Western Province for the last decade demonstrate an upward trend in general while annual fluctuations are observed. The passenger-kilometres of the Western Province accounted for approximately 64% of all passenger-kilometres in Sri Lanka in 2010. The passenger volume the Sri Lanka Railways is increasing trend in general since 2006.



Source: Economic and Social Statistics of Sri Lanka 2006-2013, Central Bank of Sri Lanka

Figure 3.2.3 Historical Trend of Passenger-Kilometres and Freight Tonnage-Kilometres in Sri Lanka

The daily sectional passenger volume is one of the key indicators to determine whether or not to improve the railway capacity. The estimated sectional daily passenger volume as determined by the University of Moratuwa based on the ticket sale data is shown in Figure 3.2.4. The highest sectional passenger volume for both directions of roughly 152,000 daily passengers is observed in the section between Dematagoda and Ragama, where the Main Line and the Puttalam Line merge, followed by the Fort – Maradana section with 136,000 passengers, Maradana – Dematagoda section with 121,000 passengers and Ragama – Gampaha section with 116,000 passengers. Other higher volume sections are on the double track sections of the Main Line and the Coastal Line. Some single track sections exceeded 15,000 passengers per day in the Western Province such as Kalutara South – Aluthgama and Seeduwa – Negombo.

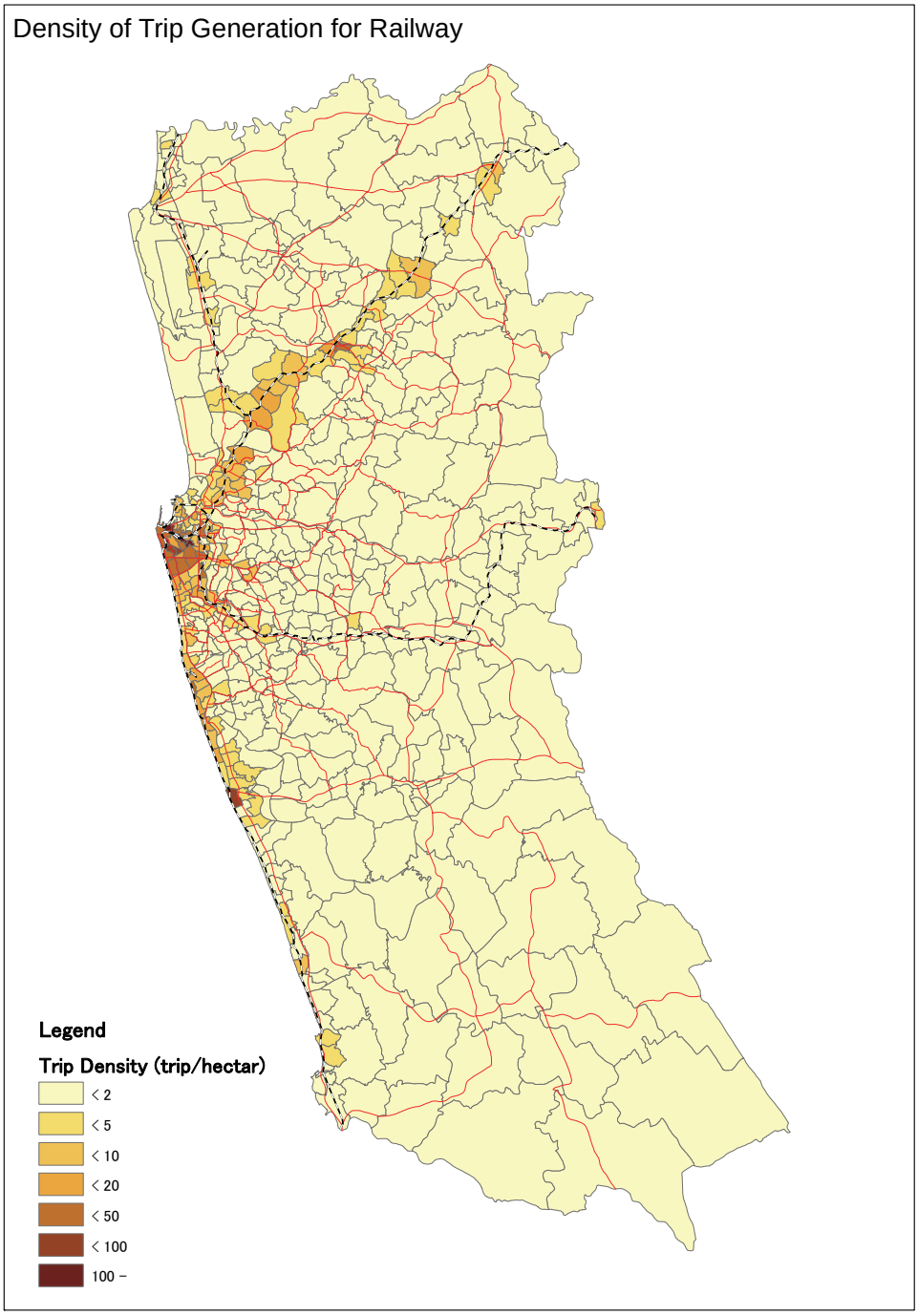


Source: University of Moratuwa

Figure 3.2.4 Daily Average Sectional Passenger Volume of Railway Network in 2009 in Sri Lanka

The trip density by railway is shown in Figure 3.2.5. It is evident that railway passengers are from zones close to a railway line. It is also noteworthy that average travel distance of railway,

25.5 km, is the longest among all public transport modes according to the CoMTrans Home Visit Survey. These imply that the railway is mainly catering for medium to long distance passengers along railway corridors.



Source: CoMTrans Home Visit Survey 2013

Figure 3.2.5 Trip Generation Density for Railways

3.2.4 Railway Fares and Financial Conditions

The following table summarises railway fares of the Sri Lanka Railways. While there are three classes of trains in operation, stations where a train with an upper class coach stops within the Colombo Metropolitan Area (CMA) are limited such as Gampaha, Kalutara South, Panadura, Moratuwa and Mount Lavinia. These trains do not function as an urban railway service for daily commuters.

Table 3.2.2 Railway Fares of Sri Lanka Railways

Class	Minimum Fare	10 km	20 km
First Class, with A/C	Rs. 40.0	Rs. 40.0	Rs. 80.0
Second Class, Non A/C	Rs. 20.0	Rs. 20.0	Rs. 40.0
Third Class, Non A/C	Rs. 10.0	Rs. 10.0	Rs. 20.0

Source: Sri Lanka Railways

Additionally, discounts are applied for school children and students as a public service obligation. Government officers and workers are also eligible to purchase a season ticket for less than half of the price of a one month commuter's ticket for other adult passengers.

Table 3.2.3 Fare for Monthly Commuter's Ticket

Category of Ticket	Fare
School Children below 12 years	5% of 30-day fare
All Other Students above 12 years	10% of 30-day fare
Government Officers / Workers*	15% of 30-day fare
All Other Adults (Private)	40% of 30-day fare

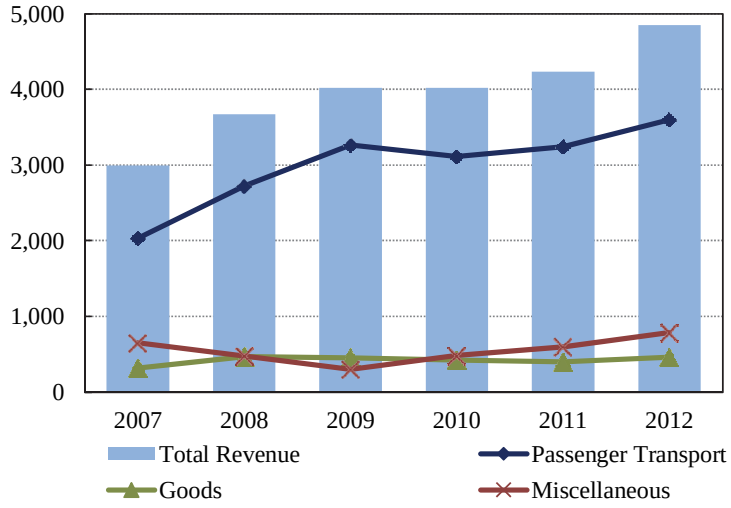
Note: * Government institutions have to reimburse the Sri Lanka Railways the difference of the fare with other adult private passengers.

Source: Commercial Department, Sri Lanka Railways

Although more than half of the railway passengers use bus as an access and/or egress mode of transport, fare schemes are independent. This means that majority of railway passenger has to pay a minimum fare twice or more.

Figure 3.2.6 shows the annual revenue of SLR. From 2007 to 2012, the total revenue has increased 61%. Most part of the growth was the revenue from passenger transport (77% increase). The number of ordinary ticket holders was 62 million (revenue: 2,806 million Rs.) and the number of season ticket holders was 43.7 million (revenue: 793 million Rs.) in 2012.

Roughly 10% of the revenue is from freight transport, and the amount of the freight is 2.06 million tons (143 million tons-km) in 2012.

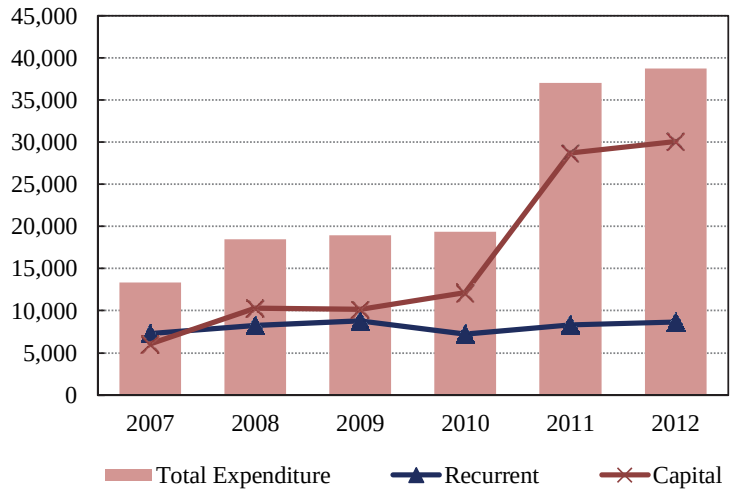


Source: Annual Report of Sri Lanka Railways (unit: Rs. Mn.)

Figure 3.2.6 Annual Revenue of Sri Lanka Railways 2007-2012

Figure 3.2.7 shows the annual expenditure of SLR. The expenditure consists of recurrent and capital expenditure. The recurrent expenditure has hovered around 7 to 9 billion Rs.

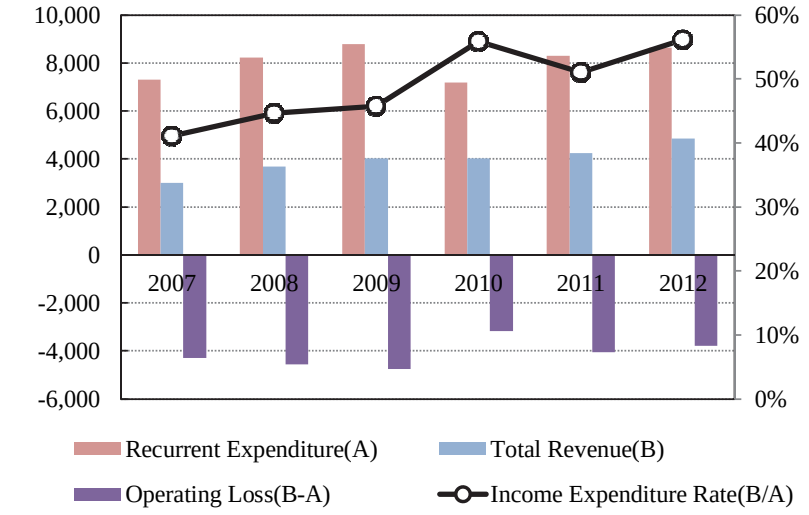
The capital expenditure has varied considerably from year to year, and it has large impact on the total amount of annual expenditure. In 2011 and 2012, the capital expenditure was roughly three times higher than that in other years. This is mainly because a large amount was invested in maintenance of permanent way and building.



Source: Annual Report of Sri Lanka Railways (unit: Rs. Mn.)

Figure 3.2.7 Annual Expenditure of Sri Lanka Railways 2007-2012

The SLR has continuously posted losses. Figure 3.2.8 depicts the revenue, expenditures, and profit/loss of the SLR in the last six years. The revenue could cover approximately only half of the expenditures. While the revenues are relatively level, there are some fluctuations in the expenditures.



Source: Sri Lanka Railways (unit: Rs. Mn.)

Figure 3.2.8 Revenue, Expenditure and Profit/Loss of the Sri Lanka Railways

3.2.5 Rolling Stock and Railway Facilities

(1) Railway Rolling Stock

There are 1777 units of rolling stock in Sri Lanka Railways. They are categorised as shown in Table 3.2.4.

Table 3.2.4 Number of Rolling Stock

Type of Rolling Stock	Number	unit
Diesel Electric Locomotive	60	car
Diesel Hydraulic Locomotive	10	car
Diesel Multiple Unit	55	unit
Carriage (Passenger Coach)	900	car
Goods Wagon	600	car
Oil Tanker	152	car

Source: Sri Lanka Railways

Passenger trains consist of a locomotive and passenger coaches or diesel multiple units (DMU).

A locomotive and passenger coaches is the conventional train system and one locomotive pulls many passenger coaches where a DMU has no locomotive but some cars have a diesel engine and push/pull the train. In a DMU each end car has a drivers cab, therefore the train can operate either direction without shunting the locomotive. The ratio of wheels with traction on a DMU is higher than on a locomotive pulled train. Generally, acceleration and deceleration are higher than that of a locomotive pulled train therefore DMU is suitable for commuter trains.

A DMU of Sri Lanka Railway consists of one motor car at one end and five trailer cars. Approximately two thirds of the space in the motor car is the machine room and the other one third is a passenger saloon. The engine and generator are installed in the machine room. Mostly two units are coupled to make one train to provide enough passenger capacity.

Locomotive and Passenger Coach

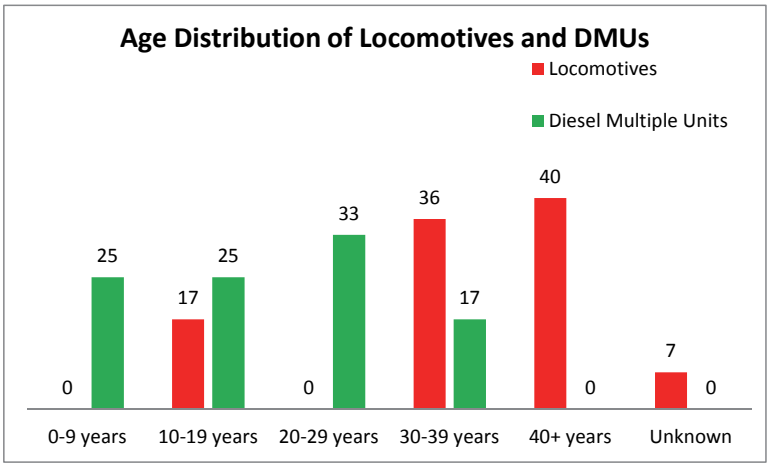
DMU

Source: CoMTrans Study Team

Figure 3.2.9 Trains of Sri Lanka Railway

The SLR possesses a variety of railway rolling stock. Most of the locomotives of the SLR were purchased more than 30 years ago and 40% of the locomotives are more than 40 years old as shown in Figure 3.2.10. On the other hand, diesel multiple units (DMU) are relatively new. A half of the DMUs were purchased within the last two decades.

During the period from the 50's to the early 80's, the SLR imported mainly from developed countries such as Canada, Japan, Germany and England. After the 90's, the SLR imported mainly from China and India except for 10 locomotives from France. Recently, the SLR is shifting to a DMU rather than a locomotive-coach system. China is a key provider of DMUs. In addition to a total of 30 DMUs in 2000 and 2008, the SLR is planning to purchase 13 DMUs from China as a part of the Southern Railway Upgrading Project and 20 DMUs from India for the Coastal Line.



Source: Ministry of Transport

Figure 3.2.10 Age of Locomotives and DMUs of Sri Lanka Railways

(2) Track

Sri Lanka Railways uses ballasted track mostly with concrete sleepers. Wooden sleepers are used in some areas. Tracks have many joints because of the use of short rails. Deformation of rails and installation of rails with insufficient width at the heads are seen at joints. (Figure 3.2.11)

In addition, significant irregularities in rail standards, alignments, and heights are observed because of low precision at rail joints and insufficient maintenance of track beds as shown in Figure 3.2.12. Therefore, trains rattle badly while running. These aspects become great obstacles when increasing the speed of the trains.

Source: CoMTrans Study Team

Figure 3.2.11 Deformation of Rail

Source: CoMTrans Study Team

Figure 3.2.12 Irregularity of Alignment

The noteworthy point is the Coastal Line. The Coastal Line is literary installed along the coast, and some sections of the line are constantly exposed to wave splashes which are resulting in significant corrosion caused by rust on the rails and fasteners. This creates the possibility that designated track gauges cannot be maintained, or the breakdown of rails may occur. Ballasts have been washed away toward the ocean due to wave motions in some areas, and sleepers are completely exposed from ballasts in such areas. (Figure 3.2.13) In the worst case scenario, these conditions may cause derailing or overturning of trains.

Source: CoMTrans Study Team

Figure 3.2.13 Exposed Sleepers

(3) Signalling System

The SLR has a variety of signalling systems as well. The Main Line is still using the 50-year old Colour Light Signalling and it will be replaced by a new colour light system including a Centralised Traffic Control (CTC) System and a telecommunication system. The 25-year old CTC system of the Coastal Line will also be replaced. These signalling systems are in the following condition:

- Lack of maintenance (Figure 3.2.14)
- Significant age-related deterioration
- Difficult to receive support from manufacturers
- Difficult to obtain replacement parts
- Unable to work with high speed and high frequency train operations

Source: CoMTrans Study Team

Figure 3.2.14 Broken Signal

Source: CoMTrans Study Team

Figure 3.2.15 Exposed Terminal Box

These conditions indicate that signalling devices are not functioning as intended, and malfunctions and damages cannot be quickly repaired. Delays and cancellation of trains frequently occur as a result. In addition, since these old signalling systems do not have features to protect trains automatically, there is a high risk that minor mistakes and a misunderstanding between train drivers and station officers could result in collisions of trains.

(4) Telecommunication Systems

For the Telecommunication system, a 155 Mbps ATM (Asynchronous Transfer Mode) System through optical fibre is applied in the Coastal Line while the other lines are Radio Telecommunication through UHF/VHF. Sri Lanka Railways is using a radio system using the UHF/VHF radio waves and the communication system using optical cables in the south as the backbone of its communication system.

Sri Lanka Railways have established communication methods as backbones, but age-related deteriorations are seen in some of the terminal devices.

Source: CoMTrans Study Team

Figure 3.2.16 Terminal Device

(5) Station Facilities

Railway station buildings are generally old fashioned. Some stations are still using buildings constructed during the colonial period. Unlike railways in developing Asian countries, the majority of SLR stations are equipped with a station square. Some bus terminals such as Moratuwa and Gampaha are just in front of the railway station. However, access roads to some stations in suburban areas do not have sidewalks.

Electronic signboards for passengers are also installed in some major stations such as Colombo Fort, Moratuwa and Negombo while small stations only have billboards.

Source: CoMTrans Study Team

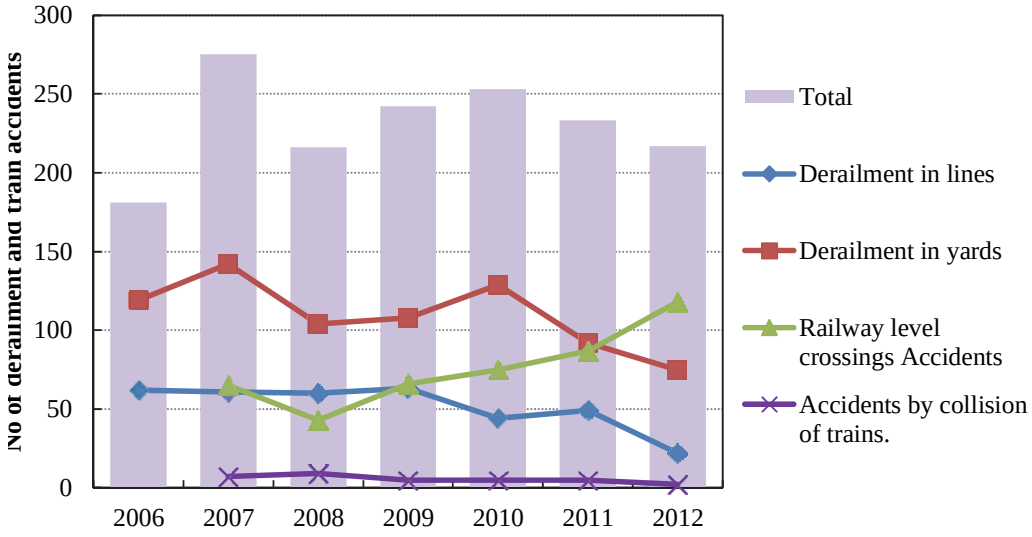
Figure 3.2.17
Colonial Station Facilities
of Egoda Uyana Station

Source: CoMTrans Study Team

Figure 3.2.18 Station Square of Negombo Station

3.2.6 Railway Accidents and Derailments

As shown in Figure 3.2.19 the number of total derailments and accidents has hovered around 200 to 250 in the recent years. Both the numbers of derailments in lines and in yards have decreasing trends in the figure. Especially, the number of the derailments in lines has decreased 65 percent in the last seven years. Instead, the number of accidents at the railway level crossings has increased 81% and became the main factor.

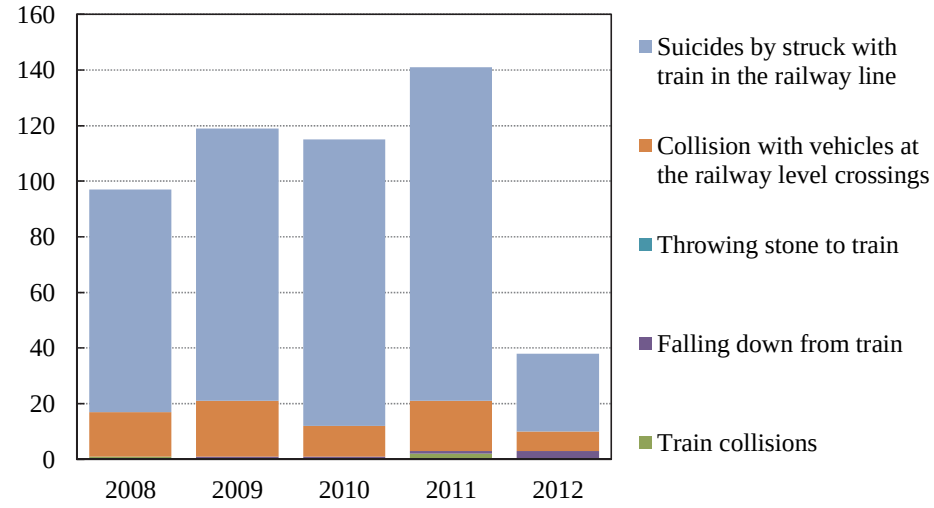


Source: Sri Lanka Railways

Figure 3.2.19 Number of Derailments and Train Accidents

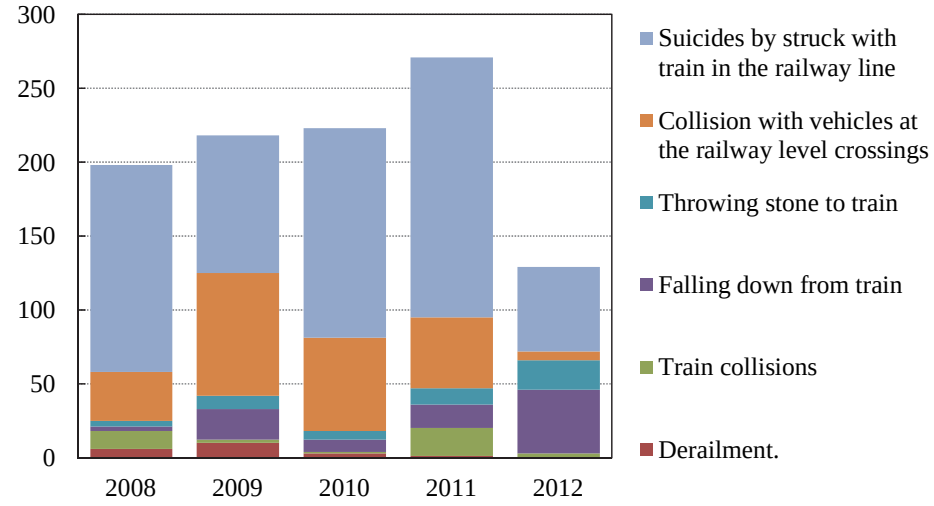
Figure 3.2.20 and Figure 3.2.21 show the reported number of fatalities and injuries due to the train accidents in the last 5 years. The total number of the fatalities had increased during 2008 to 2011. However it dramatically decreased from 141 to 38 between 2011 and 2012. The main factor of the fatalities was suicide struck with train in the railway line, and its ratio was 84% in the last five years. The second leading factor of the fatalities was collisions with vehicles at the railway level crossings and its ratio was 14%.

As shown in Figure 3.2.21, the number of injuries shows a similar trend with the number of fatalities. The total number of injured people had increased up to 271 from 2008 to 2011, and dropped down to 129 in 2012. The main factor of the injuries was suicide struck by a train in the railway line, and its ratio was 59% in the last five years. The second most cause of injuries was collisions with vehicles at the railway level crossings (22%) and the third was falling down from the train (9%) in the last five years.



Source: Sri Lanka Railways

Figure 3.2.20 Number Fatalities due to Train Accidents



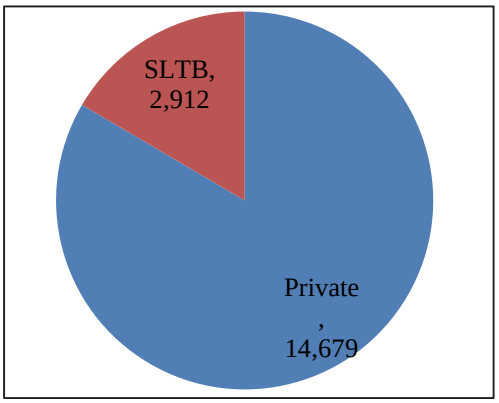
Source: Sri Lanka Railways

Figure 3.2.21 Number Injured due to Train Accidents

3.3 Bus Transport

3.3.1 Bus Routes and Operations

The Sri Lanka Transport Board (SLTB) and private bus operators have roughly 680 intra-provincial bus routes and 400 inter-provincial bus routes in the Western Province according to the bus route information from the National Transport Commission (NTC). Bus passenger kilometres of the SLTB and private buses are shown in Figure 3.3.1. While the share of kilometres of private buses is approximately 78%, the share of passenger kilometres of private buses is roughly 83%. This means that load factors of private buses are generally higher than that of SLTB.



Unit: Million Passenger Kilometres in 2011

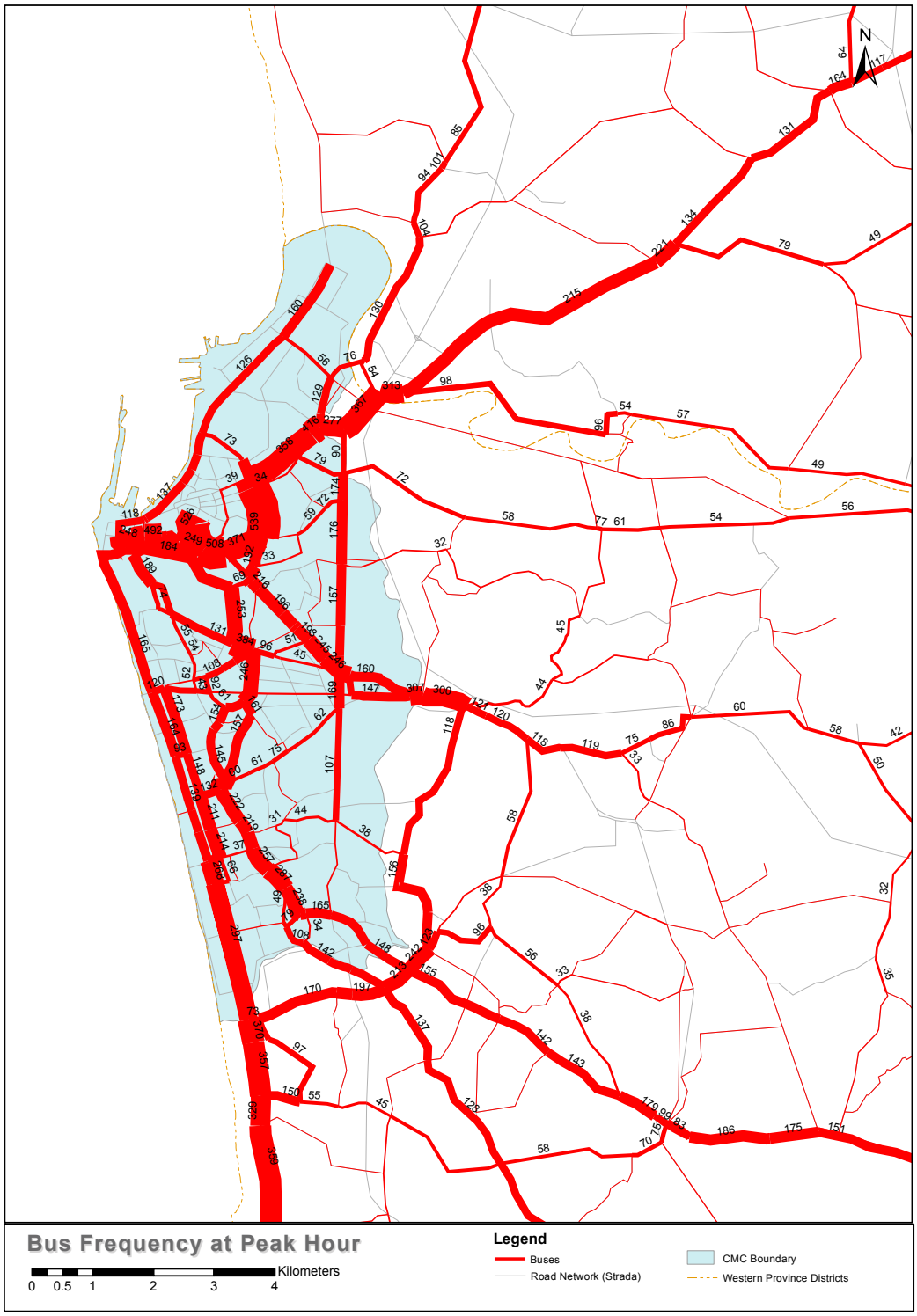
Source: Economic and Social Statistics of Sri Lanka 2013

Figure 3.3.1 Passenger Kilometres of Bus Transport in the Western Province

It is evident that one third of intra-province bus routes operated in the Western Province have one of their ends in the Pettah area of Colombo where three bus terminals are located. Although it is complicated for passengers to find the routes appropriate for their origin and destination, no maps for passengers are available at this moment.

There are also several initiatives to improve bus services of the region. The SLTB has started to procure 100 luxury low floor buses equipped with air conditioners for the routes in the Western Province. Routes to suburban cities located around 20-40km from Colombo Municipality such as Moratuwa, Kesbawa, Homagama, Kaduwela, Gampaha and Negombo were selected. Export credit from the Bank of Sweden is being utilised.

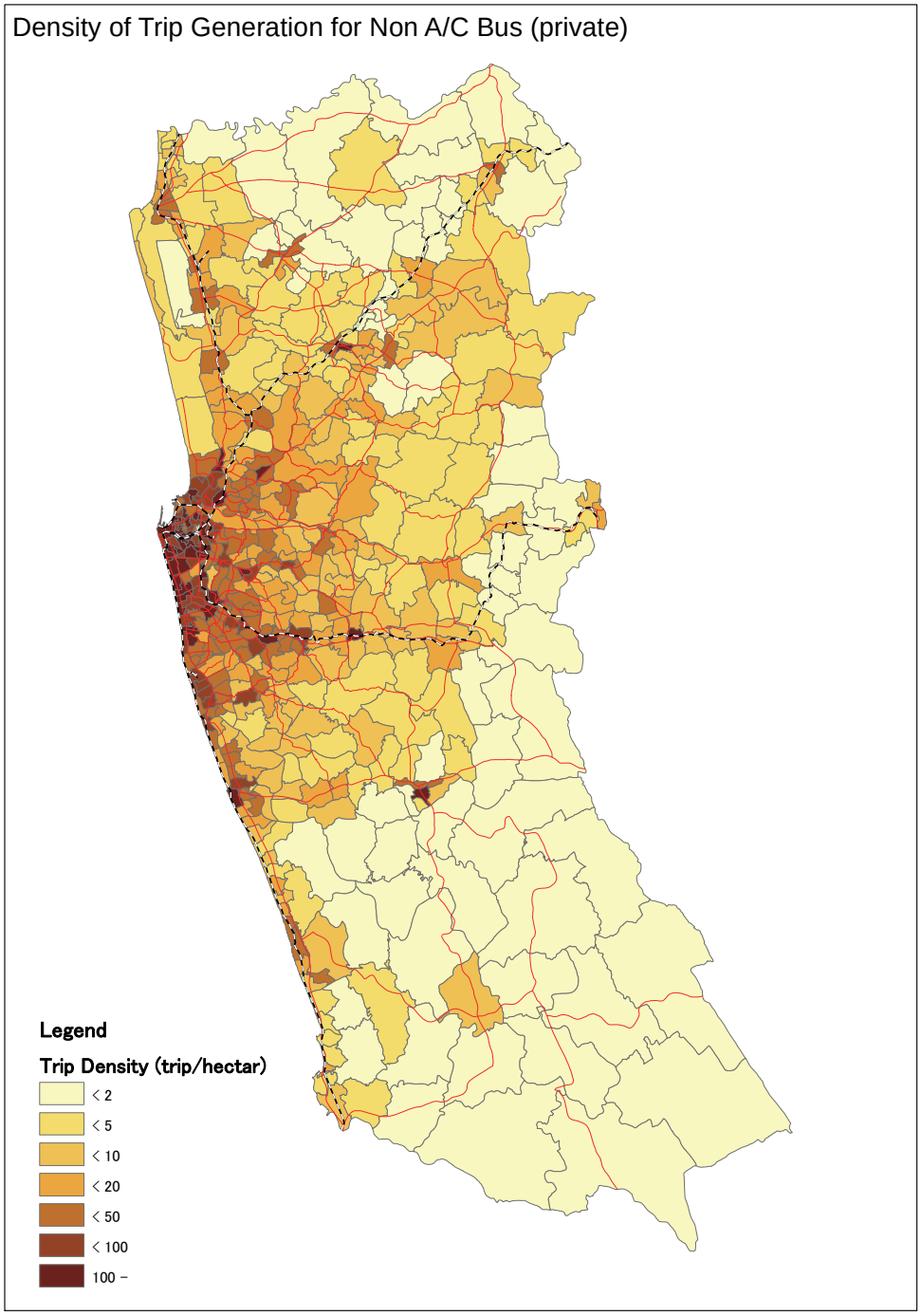
Based on the bus route information from the SLTB and the Western Province Road and Passenger Transport Authority (WPRPTA), buses that are operated during peak hour are shown in Figure 3.3.2. The number of buses on the seven major radial corridors outnumbers other roads. Kandy, Galle and Malabe corridors are the highest followed by High Level, Negombo, Horana and Low level corridors. A number of buses are operated around Pettah bus terminals.



Source: Time tables and bus operational information from the Western Province Road and Passenger Transport Authority (WPRPT), the Srl Lanka Transport Board (SLTB) and the National Transport Commission (NTC). Time tables and bus operational information was summarised and visualised by the CoMTrans Study Team.

Figure 3.3.2 Bus Operation during 7 – 8 AM in the CMC and Surroundings

The trip density by non-air-conditioned private bus is shown in Figure 3.3.3. Compared with the trip density map of railways in Figure 3.2.5, trips are scattered around the Colombo Metropolitan Area (CMA). Trip density is much higher than railway even in cities along the railway lines.



Source: CoMTrans Home Visit Survey 2013

Figure 3.3.3 Trip Generation Density for Buses

3.3.2 Load Factors of Bus Transport

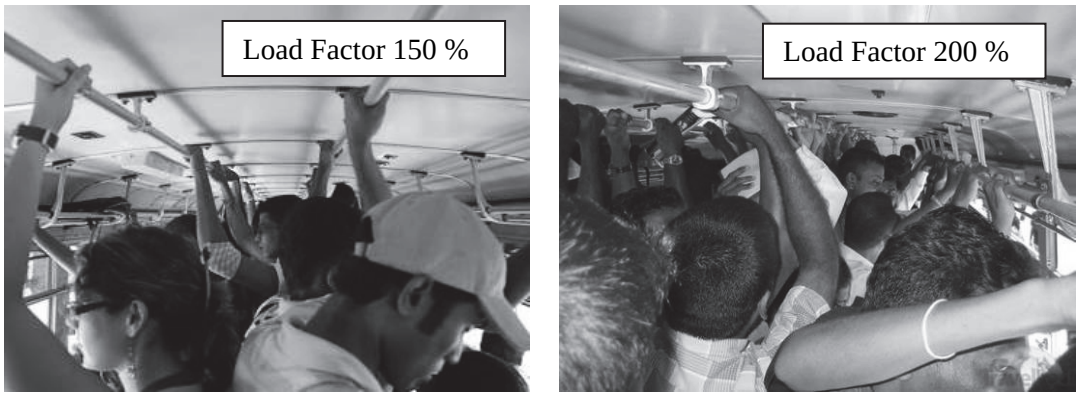
Buses are the major public mode of transport in Colombo. In the morning period buses are over-crowded on the inbound direction on almost all major corridors according to the Screen Line survey. The load factors on the all corridors indicate more than 100%. In particular on Kandy, Low Level Road and Horana road, the load factors are more than 150%. In the evening peak period, buses are crowded on the all corridors except Sri Jayawardenepura Mawatha of which the load factor was 87%.

Table 3.3.1 Bus Load Factor of Major Transport Corridors

Corridor	Road	Morning Peak Period (Inbound)			Evening Peak Period (Outbound)		
		CMC Boundary	5 km	10 km	CMC Boundary	5 km	10 km
Negombo Road		142	122	117	115	120	133
Kandy Road		116	142	171	120	108	143
Low Level Road	Avissawella Road	171	-	-	143	-	-
	Kolonnawa Road	127	-	-	127	-	-
Malabe	Kotte Road	130	126	127	111	123	156
	Sri Jayawarde-nepura Mawatha	138	-	-	87	-	-
High Level Road		106	121	134	124	133	108
Horana Road		166	174	-	147	169	-
Galle Road		101	-	-	102	110	-

(Unit: per cent) Bus load factor is estimated by dividing loading passenger by seating capacity. Cells of tables are coloured by load factor. Green is less than 120%. Yellow is 120-149%, and, pink is 150% or more.

Source: CoMTrans Screen Line Survey, 2012



Source: CoMTrans Study Team

Figure 3.3.4 Images of Load Factors

3.3.3 Bus Fares and Financial Conditions

(1) Bus Fares

The National Transport Commission defines service standards by classes. There are three classes of buses services. The luxury class buses are equipped with air-conditioners. The semi-luxury buses are seat-allocated. The fare of luxury buses is two times the normal bus fare, and, that of semi-luxury buses is 1.5 times the normal bus fare. Bus fares are collected on board and by cash by a bus conductor while the SLTB started trial is on a pre-paid card system. The SLTB and some private operators are using portable ticketing machines with global positioning system (GPS). Bus conductors are collecting fares manually.

Table 3.3.2 Bus Fare System

Bus Type	Minimum Fare	10 km	20 km
Luxury	Rs. 18	Rs. 56	Rs. 82
Semi Luxury	Rs. 14.	Rs. 42.	Rs. 62
Normal, Non-Air-Conditioned	Rs. 9	Rs. 28	Rs. 41

Source: National Transport Commission, Revised Fare of 1 November, 2013

(2) Bus Fares Discount System

A governmental bus operator, the Sri Lanka Transport Board (SLTB), has a 10% fare commuter's ticket for school children, 30% for students of educational institutions and 65% for adult commuters as a public service obligation. However, there is limited discount ticket for private buses except for several schemes assisted by the government such as school bus service, night bus service and rural bus service. As frequency of the SLTB buses is low for some routes, a commuter's ticket holder cannot avoid waiting for a long time. Special passes are issued to members of the armed forces and police officers, where the cost of such passes is completely paid to the SLTB by the Police and the respective force. Trips made by these passes should be within 50km from the work place. Also SLTB provides a special pass service for employees of media and other government organisations on requests made through the ministry of transport. In this case the organisation pays the complete amount to the SLTB. SLTB has also recently launched a pilot project to issue new electronic prepaid cards and has already issued around 500 passes to travel from Mattegoda to Maharagama.

Table 3.3.3 Monthly Commuter's Ticket Fare of the SLTB

Category of Season Ticket	Fare
School Children	10% of 21-day fare
Students of Other Educational Institutions	30% of 26-day fare
All Other Adults	65% of 26-day fare

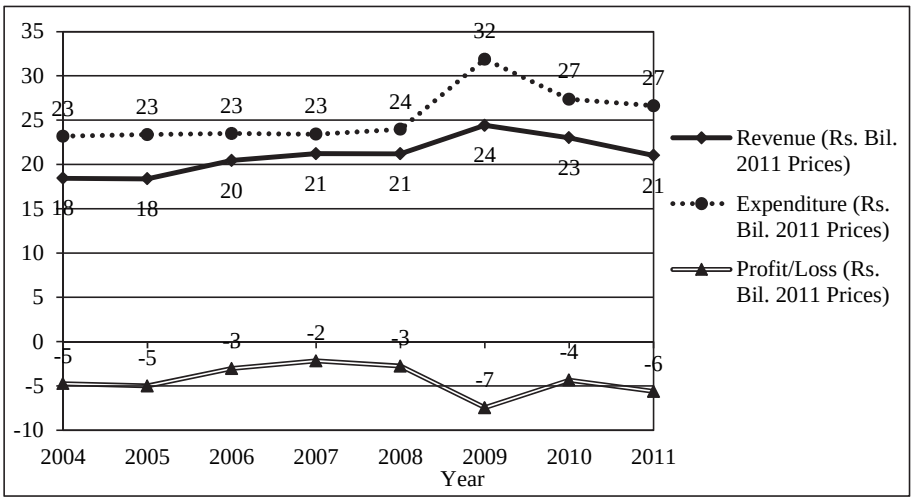
Source: Sri Lanka Transport Board

(3) Government Assistance on Bus Transport

Currently the Government supports three types of bus transport services; 1) *Sisu Seriya* school bus for school students to provide safe and affordable bus transport, 2) *Gemi Seriya* service to provide a reliable and economical transport service for villagers to reach the city centres for their daily requirements, and 3) *Nisi Seriya* Service to provide night time bus service. The details of these services are described in the Technical Report.

(4) Financial Condition of the SLTB

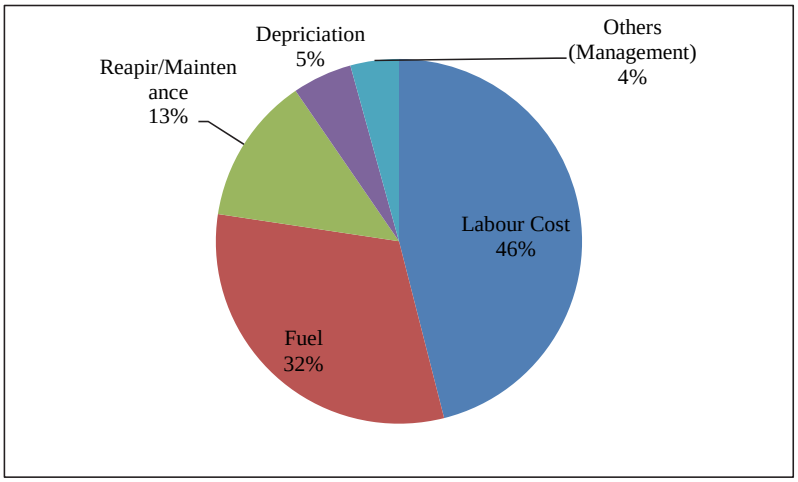
While some statistics mention that the revenue, cost and financial loss of the SLTB are increasing in current prices, those of 2011 prices are almost constant for the last 8 years. The increase in 2009 might be affected by termination of the conflict in Sri Lanka as well as other factors such as a model depot program. The revenue covers around 78% of the expenditures of the SLTB, and the annual financial loss was around 6 billion rupees in 2011.



Source: Economic and Social Statistics of Sri Lanka 2006-2012, Central Bank of Sri Lanka, adjusted by CoMTrans Study Team

Figure 3.3.5 Revenue, Expenditures and Profit/Loss of the SLTB (2011 Prices)

In terms of the composition of the expenditures of the SLTB, 46% accounts for labour cost followed by fuel cost (32%), repair/maintenance (13%), depreciation (5%) and others (4%). More than three fourths of the costs are from labour cost and fuel cost.



Source: National Transport Statistics Report 2011, National Transport Commission

Figure 3.3.6 Expenditure Composition of the SLTB (2011)

3.3.4 Bus Sector Administration and Operators

Bus services in the Western Province are regulated, operated and, implemented by several organisations. The organisations and their functions are summarised in the Table 3.3.4. With route permission issued by the Western Provincial Road Passenger Transport Authority, intra-provincial private buses are typically operated by individuals who own a single bus while there are some owners who own more than one bus. The private operators hire a driver or drive by themselves. With regard to the function of private buses and the SLTB, unprofitable routes are not operated by private buses while the SLTB operates on both profitable and unprofitable routes.

Table 3.3.4 Bus Sector Organizations

Name of Organisation	Level of Government	Purpose	Functional Responsibilities
National Transport Commission	Central	Regulator	· Advise the Central Government on passenger transport policy and services; · Grant permits in specified areas; · Ensure service on unprofitable routes; · Provide permits for inter-provincial bus services; · Provide managerial expertise and assistance to Provincial Transport Authorities
Sri Lanka Transport Board	Central	Operator	· Provide public bus services in Sri Lanka; · Provide shelters/stations/terminals for SLTB buses; and · Provide service for unprofitable routes and times.
Western Province Road Passenger Transport Authority	Province	Regulator	· Regulate intra-provincial private buses and routes; · Provide annual permits for each bus on a specific route; and · Provide shelters/stations/terminals for private buses.
Road Development Authority	Central	Implementer	· Provide bus stops along the routes.
Local Authorities	Municipal	Implementer	· Provide bus stops along the routes.
Operator Federations	Private	Representation	· Represent members' issues to the regulatory authorities; and · Represent members during strike action.
Route Associations	Private	Route Oversight	· Facilitate bus schedules on routes if route timetable does not exist.
Private Bus Operators	Private	Operator	· Operate both inter-provincial and intra-provincial private bus service.

Source: The Study on Urban Transport Development for the Colombo Metropolitan Region by JICA, 2006; modified by the CoMTrans Study Team

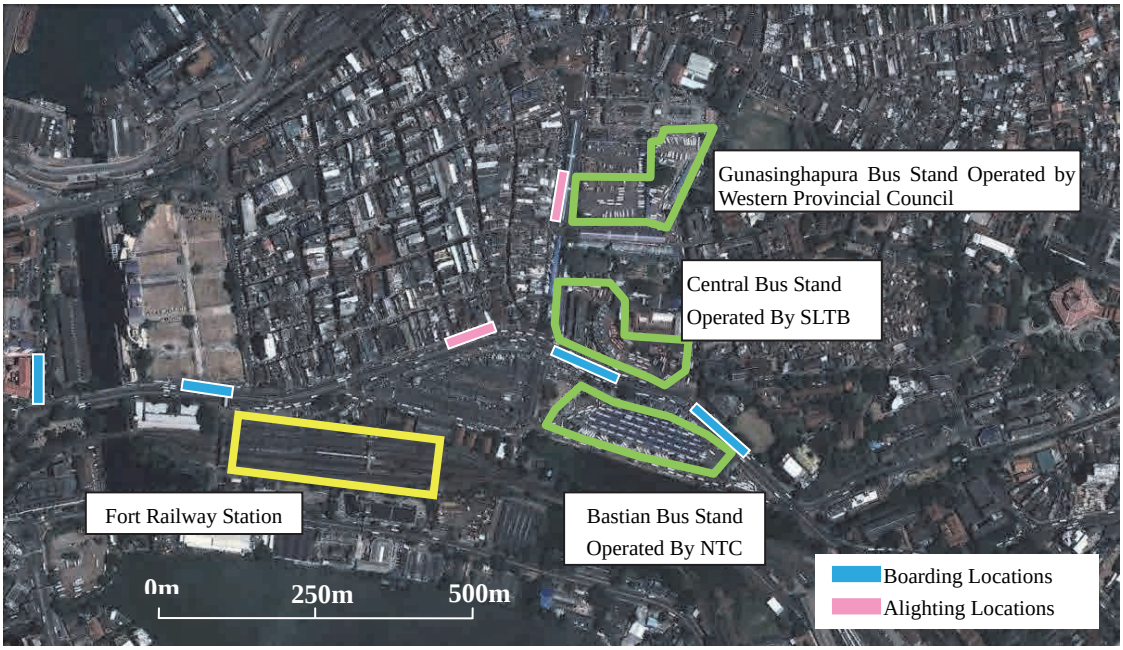
3.3.5 Bus Terminals

There are a number of bus routes using bus terminals and bus stops in the Pettah area of Colombo. Three bus terminals are operated by each bus regulator and operator. Colombo Central Bus Stand is operated by the SLTB only for the SLTB buses. The National Transport Commission (NTC) operates Bastian Bus Stand for private inter-province buses. The Western Provincial Council also operates the Gunasinghapura Bus Stand mainly for a bus pool of intra-provincial buses. Passenger boarding and alighting locations of the intra-provincial buses are different by destination and bus routes as shown in Figure 3.3.7. Roughly 11,000 buses arrive and depart in the Fort-Pettah area (Inter-province: about 3,300 and Intra-Province: about 7,500). The summary

of the surveys at the three bus terminals are shown in Figure 3.3.8. The number of buses departing from each terminal is roughly 1,000 to 1,200. The loading level of buses when they leave each bus terminal is not high. Especially, at the Gunasinghepura bus terminal, more than 90 percent of buses depart without passengers.

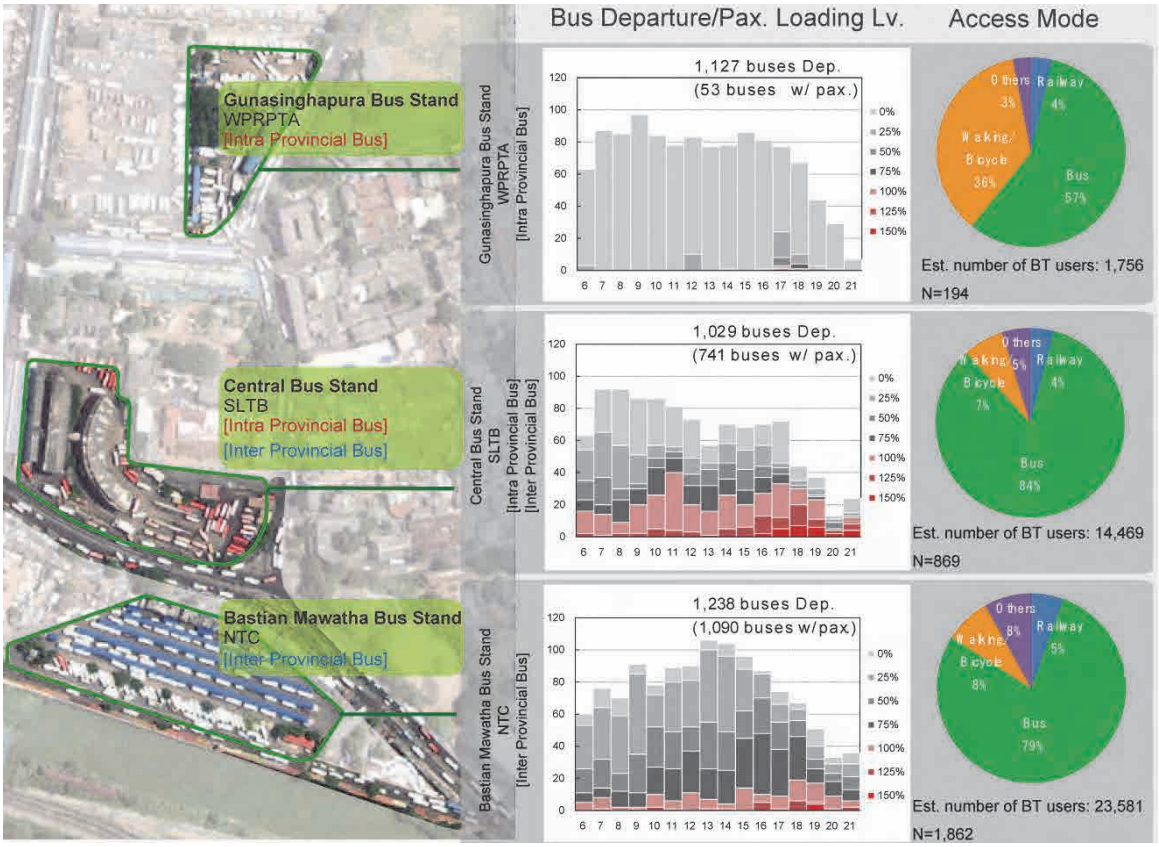
In addition, there are inter-modal transfer passengers at Colombo Fort Railway Station. This segmentation of public transport terminals and Fort railway station makes transfer between buses and the railway as well as between buses difficult. Furthermore, many transfer passengers need to cross arterial roads around this area.

Other major cities in the Western Province also have their own bus terminals. Some bus terminals such as Moratuwa and Gampaha are located adjoining the premises of the railway station square. Some bus terminals do not have enough space or facilities for handling many buses. For instance, Maharagama bus terminal, a key bus terminal where express buses utilising the Southern Expressway depart from, is utilising the median of an arterial road.



Source: Ministry of Transport and CoMTrans Study Team

Figure 3.3.7 Bus Terminals and Stops in the Pettah Area



Source: CoMTrans Study Team Survey,6:00~22:00, Nov.7 (Thu.), 2013

Figure 3.3.8 Locations and Summary of Surveys at 3 Bus Terminals

3.4 Paratransit and Other Road-Based Public Transport

3.4.1 School Vans and Buses

Several types of paratransit and road-based public transport serve the Colombo metropolitan area. This includes 1) school vans and buses and 2) staff services. The security of the buses is a concern for parents; thus, private operators and individuals operate vans called "School Vans" dedicated for school children to go to schools catering to parents' concerns on security.

A "Staff Service", which is operated by a private company or an individual for transporting commuters from suburban areas to the city centre, especially for female office workers who prefer secured service. The Staff Service usually utilises vans or minibuses with a capacity range of 8-30 persons and they collect passengers in suburban areas and drop them off in front of their offices.

3.4.2 Taxis and Hired Three Wheelers

<u>Increase of Three Wheelers</u>

Three-wheelers were introduced to Sri Lankan in the 1980's. The increase in the number of

three-wheelers in the Western Province is significant. According to the Department of Motor Traffic, the number of three-wheelers was 25,043 in 1999 and 96,650 in 2004. The number reached 213,045 as of 2011 according to the Divisional Secretariats, Central Bank of Sri Lanka. This is also having a significant impact on urban transport.

The increase in the number of three-wheelers can be explained by the needs of customers in a niche market of short distance trips and the ease of starting a business due to loose restrictions and inexpensive initial cost. Since large buses are not able to enter narrow streets, the three-wheeler caters for service between the house and railway stations or bus stops. There are three-wheeler stops or parking at the junctions of major corridors and minor streets in suburban areas. Three-wheeler driving is also one of the sources of employment for entry-level workers. The drivers can start their business with only a driver's licence and a three-wheeler vehicle. They can also rent their three-wheeler.

Safety Issue of Three Wheelers

However, disadvantages of the three-wheelers are not negligible. Safety is one of the major aspects to be considered for the three wheelers. Since there is virtually no restriction on three-wheeler taxi business, drivers tend to ignore traffic rules such as illegal turns to pick up customers and allow passengers to disembark from the right side of roads. However, they are not the main vehicles which caused fatal accidents according to the statistics of the traffic police. The three-wheeler was responsible for approximately 13% of fatal traffic accidents in the Western Province in 2011. This number is smaller than 18%, the share of three-wheelers in the total number of vehicles in the Western Province. Illegal turns, parking and movement of the three-wheelers affects traffic flow and reduces the capacity of roads.

No Transparent Fare System

Another issue related to the three-wheelers is that it is not a customer-friendly mode of transport. While the number of three-wheeler taxis with metres is increasing, some three-wheelers are not equipped with metres and customers have to negotiate with drivers. The fare decision process is also not transparent. There are several three-wheeler operators' associations in the region. As the market is unregulated, the fare policy is also dependent on each association.

Regulatory Framework on Three Wheelers

This sector is less regulated and is market-driven. While an initial registration and an annual renewal of the three-wheeler licence are required, there is no restriction on the number of three wheelers. The Western Province has tried to regulate it several times. In 2002, the Western Province gazetted the Three-Wheeler Service Statute, No. 6 (2002). The statute established a three-wheeler service bureau within the Western Province Road and Passenger Transport Authority, to introduce passenger transport service permits, and to set the maximum limit of the number of three wheelers. However, it did not come into effect due to strong opposition by some operators and drivers. Although the Western Province amended the same Statute to enable the Provincial government to apply the policy in 2008, this also did not come into effect because of opposition from some operators and politicians. The Private Transport Service Ministry is now working with the associations of three-wheeler operators to work out a policy framework for the three-wheeler industry.

3.4.3 Taxis

Taxi Company

The taxi operation in Sri Lanka is not regulated or controlled by any law at present. There are many taxi operators. Some large operators operate as companies which own several hundreds of vehicles, and some medium scale operators operate with 10 to 30 vehicles whereas small operators are mostly individuals who own a few vehicles (less than 10) to run a taxi service.

Taxi Operation

According to the interview survey of taxi operators by the CoMTrans Study Team in 2013; many taxi operators, around 60%, have opted to employ their drivers on a temporary basis; around 30% on a contract basis and the remaining 10% on a permanent basis. The taxi drivers can use the normal driver's licences for taxi operation. Currently, there is virtually no regulation specifically on taxi service such as taxi service operation licence. Some operators register their company at the registrar of companies under the registration of business names act (section 4 (1) of companies act No:7 of 2007). Taxi operators pay a commercial assessment tax to the local authority they belong to similar to any other business. Due to its relative novelty and scattered nature of operators, the taxi industry does not have any taxi related associations such as taxi industry associations, taxi driver associations or trade unions. There are a variety of vehicles used for taxi service including, small cars (hatchback cars), large cars (sedans), and vans. It should be noted that Tata Nano cars are widely used as taxis in the country.

Taxi Fare

The taxi fare policy is decided by each operator and there is no governing law to regulate it. There are several methods which are used to set the taxi fares considering the service type. Many operators charge a fixed amount for the first 1 to 3 kilometres and a per kilometre rate thereafter. Some operators use a package system, which allows the users to travel up to a fixed number of kilometres within a certain number of hours for a predefined fee. In special cases such as airport drop offs and pickups, a fixed fee is charged per trip. These fares change from operator to operator according to the vehicle type and air-conditioned or non-air-conditioned characteristics and comfort level of the vehicle.

3.5 Road Network

3.5.1 Classification of Road Network in the Western Province

The existing road network of Sri Lanka has been divided into five classes. Classes A and B are applied to national roads managed by RDA, classes C and D are applied to provincial roads managed by the provincial road development department (PRDD), and class E is applied to local roads managed by local authorities.

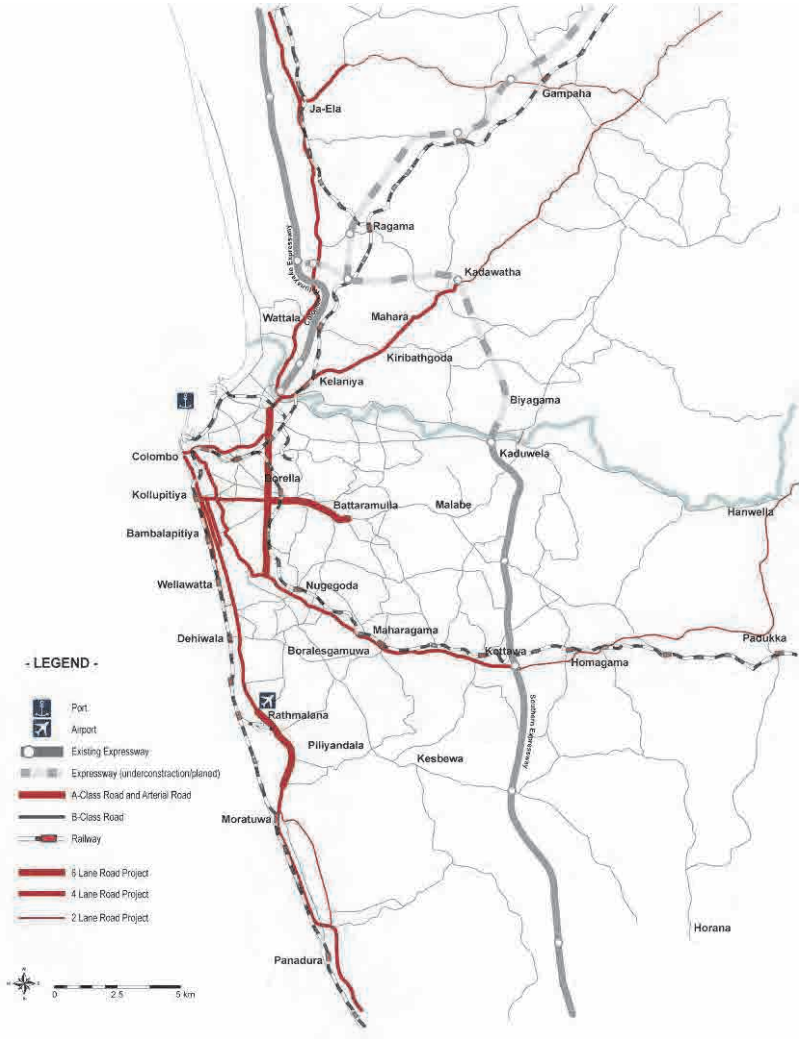
The national roads that connect major cities of the Western Province to other cities or towns, such as Negombo Road (A3), Kandy Road (A1), Low Level Road (B435), Malabe Road (A0-B240), High Level Road (A4), Horana Road (B84), and Galle Road (A2), are radiated from the Fort area of CMC. As part of the national road network, Baseline road running North-South is connecting

some of the above national roads.

Additionally, there are also existing and planned expressways in the province that are already in service or at various stages of construction/planning. Further details are in a later section of this chapter.

3.5.2 Existing Road Network in the Western Province

The existing road network map of the Western Province is shown in Figure 3.5.1. Expressway and major arterial roads are summarised in Table 3.5.1 and Table 3.5.2 respectively.



Source: CoMTrans Study Team

Figure 3.5.1 Existing Road Network in CMA

(1) Expressways

The existing and planned expressways of the Western Province are shown in Table 3.5.1 and Table 3.5.2. The expressways in service in the Western Province as of April 2014 are the Southern Expressway (SEW) including an extension section (Pinnaduwa - Godagama), the Colombo - Katunayake Expressway (CKE) and the 1st section of the Outer Circular Highway (OCH). Additionally, the Outer Circular Highway (OCH) is also under construction, the opening schedules are shown in Table 3.5.1

In addition, there is a plan for the Northern Expressway that is at present under a feasibility study. After construction of the OCH and CKE, the access between the SEW and Bandaranaike International Airport is going to be connected as an expressway link. However, due to these expressways basically running outside the suburbs around Colombo city, there are some serious issues such as a) low accessibility to/from Colombo city and between the northern and southern areas of Colombo city and b) lack of alternative routes in case of emergency.

Table 3.5.1 Existing and Planned Expressways in the Western Province

Name of Expressway	Description	Status
Southern Expressway	a) Developed section Kottawa – Pinnaduwa : 95.3km Pinnaduwa – Godagama : approx. 30km b) Design speed : 120km c) Lanes : Future - 6 , Temporarily – 4	Opening schedule Kottawa - Pinnaduwa : in-service Pinnaduwa – Godagama: in-service
Outer Circular Highway	a) Developed section 1st section Kottawa - Kaduwela : 11.0km 2nd section Kaduwela - Kadawatha : 8.9km 3rd section Kadawatha - Kerawelapitiya: 9.2km b) Design speed : 100km/hr c) Lanes : Future - 6 , Temporarily – 4	Opening schedule 1st Section: in-service 2nd Section: 2015 3rd Section: 2016
Colombo Katunayake Expressway	a) Developed section New Kelani Bridge - Katunayake: 25.8km b) Design speed : 80km and 100km c) Lanes : New Kelani Bridge - Peliyagoda : 6 Peliyagoda - Katunayake : 4	Opening schedule in-service
Northern Expressway	Feasibility study is in progress.	

Source: RDA

(2) Major Arterial Roads

Major arterial roads of the Western Province are shown in Table 3.5.2. According to Table 3.5.2, radial roads have already been developed to some extent, however these roads don't work well under the existing conditions because connections between each major arterial road are not sufficiently developed. Especially, this has become a serious issue outside of the suburbs around the CMC boundary due to low road network development. On the other hand, traffic demands on the existing roads are almost at capacity or exceed each capacity in CMC and around the CMC boundary, it has caused traffic congestion at each point.

In order to solve these problems, although some partial improvement plans such as the development of fly-overs, widening of existing roads and development new roads are planned by RDA, drastic improvement is difficult without a comprehensive planning policy including public transport such as BRT and railway, traffic control and management, and highway development.

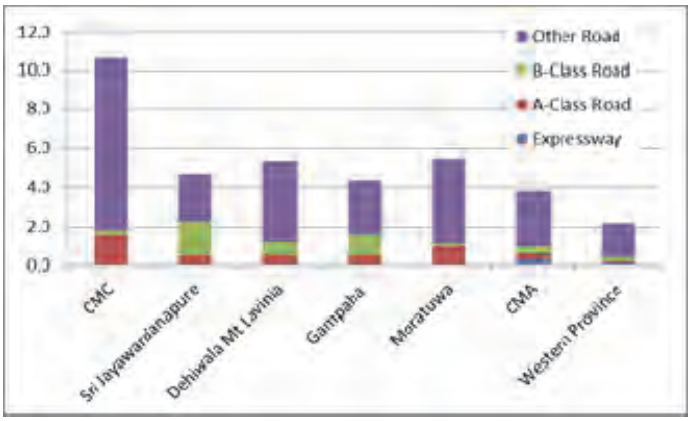
Table 3.5.2 Existing National Roads

Road Name	Road Section	Number of Lanes	Road Width*(m)	Length (km)**
Negombo Road (A3)		4	20	37.8
Kandy Road (A1)	1)Colombo – Kadawatha	4	18 - 20	13.7
	2) Kadawatha -	2	13	41.8
Low Level Road (B435)		2	10 - 12	24.5
Malabe Road (A0 – B240)	1) Colombo – Battaramulla	6	18 – 25	8.1
	2) Battaramulla – Malabe	2	12	27.8
High Level Road (A4)	1) Colombo – Kottawa	4	12 - 18	20.8
	2) Kottawa -	2	12	41.2
Horana Road (B84)		2	12	28.0
(g) Galle Road (A2)	1) Colombo – Ratmalana	4	18 - 25	13.0
	2) Ratmalana – Moratuwa	6	30	48.5
(h) Baseline Road		6	28 - 30	8.0

Source: RDA, Western Provincial Council Ministry of Road Development, CMC
Road width*: This value is not the width of ROW, but the existing cross section.
Length**: This value is calculated using the data provided by RDA and Google Earth. The Baseline Road includes a section which overlaps Kandy road.

3.5.3 Road Density in the Western Province

The road density of CMC is 10.7 % whereas those of the surrounding areas are in the range from 4% to 6%. The average of CMA is 3.8 % at present. Although the urbanised area has expanded outward from CMC, the road network development in these areas has not caught up with the suburbanisation.



Note: Unit is in percent. Road density is a value dividing total land area by road area.
CoMTrans land use survey results were utilised for Colombo Metropolitan Area (CMA). For the area outside of CMA, survey department road network data and road width data from the road development authority were utilised.
CMC stands for Colombo Municipal Council. Sri Jayawardanapure, Dehiwala and Mt. Lavinia, Gampaha and Moratuwa are average road density of municipal council area.

Figure 3.5.2 Road Density of Municipal Councils in CMA and the Western Province

Table 3.5.3 Road Density in Selected Cities

City/Area*	Data Year	Administrative Area (km^2)	Road area	
			km^2	% of Administrative Area
City of London	2005	3.2	0.8	25.0
CMC	2013	40.0	4.3	**10.7**
Inner New York	2010	59.0	15.2	25.7
Inner Tokyo	2009	75.0	16.2	21.6
City of Paris	1999	105.0	27.0	25.7
Inner Shanghai	2008	108.0	13.0	12.0
Inner Bangkok	2006	225.0	16.0	7.1
Taipei City	2008	272.0	20.9	7.7
Inner London	2005	310.0	56.5	18.3
Seoul City	2007	605.0	82.3	13.6
Tokyo 23	2010	622.0	101.2	16.3
Jakarta City	2007	656.0	48.0	7.3
New York City	2010	789.0	165.9	21.0
CMA	2013	996.0	37.4	**3.8**
Greater London	2005	1595.0	196.0	12.3

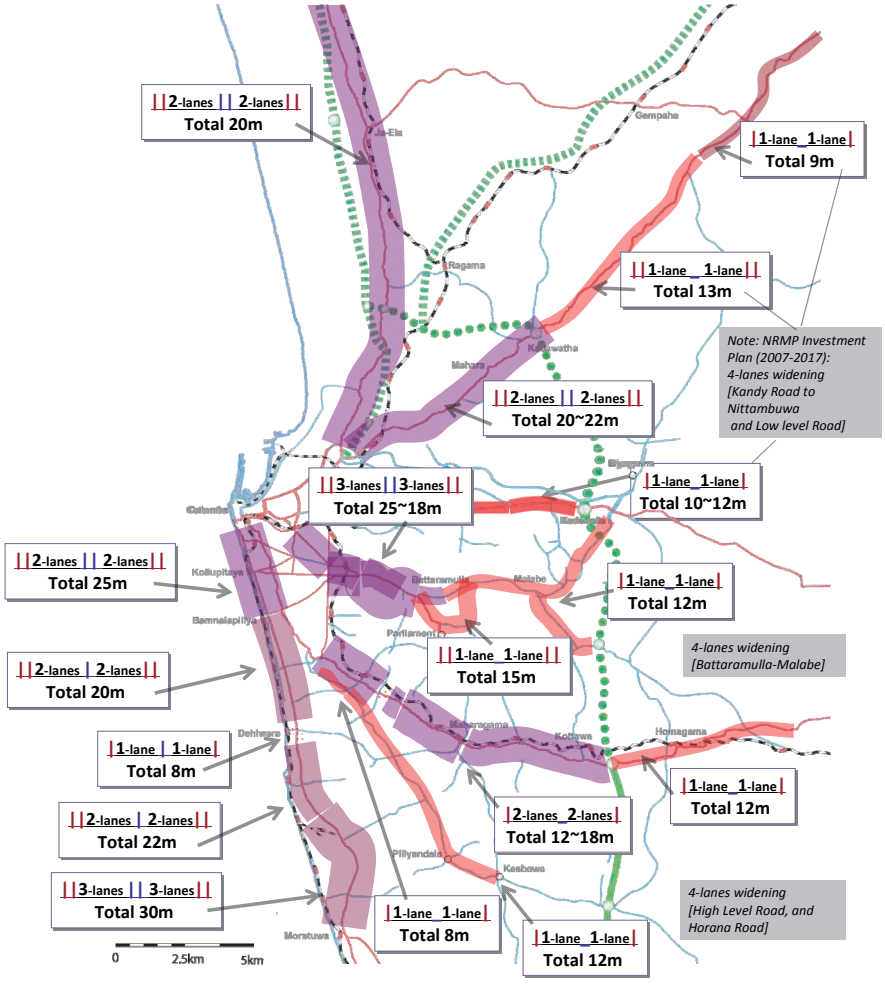
Source: Transport Development in Asian Megacities

CoMTrans Study Team, Land Use Survey

3.5.4 Road Traffic Capacity and Demand of Selected Corridors

The Study Team examined existing road widths and the number of lanes of each corridor. The general lane composition and widths are illustrated in Figure 3.5.3.

Along with the increase in the number of private vehicles in the Western Province, the number of private vehicles entering the Colombo Municipal Council (CMC) is clearly increasing over the past three decades. The annual average growth rate of the number of passengers entering CMC using a private mode of transport reached 4.2% during 1985 and 2013 according to traffic count survey results by Road Development Authority (1985) and the CoMTrans Screen Line Survey (2013). Approximately one million people are entering the CMC every day by private mode of transport.



Note: A flyover section indicates the number of lanes for flyover only and does not include at the number of lanes of the at-grade section.

Figure 3.5.3 Cross Section Composition and Road Width

3.5.5 Average Travel Speed on Road Network

In order to understand the level of traffic congestion, travel speed is a key indicator, and it helps us to find congested intersections and road sections.

Average travel speeds on the roads during morning peak hour of 7 – 8 a.m., afternoon school traffic hour of 1 – 2 p.m. and evening peak hour of 5 – 6 p.m. are illustrated in Figure 3.5.4, Figure 3.5.5 and Figure 3.5.6 respectively based on the survey results of the Travel Speed Survey (TSS). In the Study, the section with 20 km/hour or less travel speed is defined as congested considering the perception of drivers, travel speed survey results and international examples.

(1) Travel Speed of Morning Peak Hour (Inflow to City Centre)

In the morning peak hour from 7 to 8 am, travel speeds in CMC and its surrounding area are mostly less than 20 km per hour and some sections are observed at even less than 10 km per hour.

a) Maradana roundabout and Town Hall intersection are the most remarkable congested points in the city centre.

b) The traffic congestion is seen at many intersections on Baseline road intersecting with radial roads since major traffic flows go from the suburbs to the city centre in the morning and road traffic capacity is limited at the intersections.

c) The other congested points are the intersections where the roads merge with the arterial road in Battaramulla. This is caused by lack of east-west direction arterial roads in the suburban area.

d) Traffic congestion is seen at flyover sections such as Dehiwala flyover. Despite construction of the flyover, it is still congested because straight traffic volume is more than the one-lane traffic capacity on the flyover section.

(2) Travel Speed of Afternoon Peak Hour (School Traffic Hour)

Travel speeds of afternoon peak hour, 1 – 2 p.m., are superimposed with school location and the number of students in Figure 3.5.5. Traffic congestion is severe especially in the city centre where a number of schools are located. This is also fomented by business activities in the city centre.

a) Kularatne Mawatha between Maradana and Borella are heavily congested where there are many large schools such as Ananda College and Zahira College.

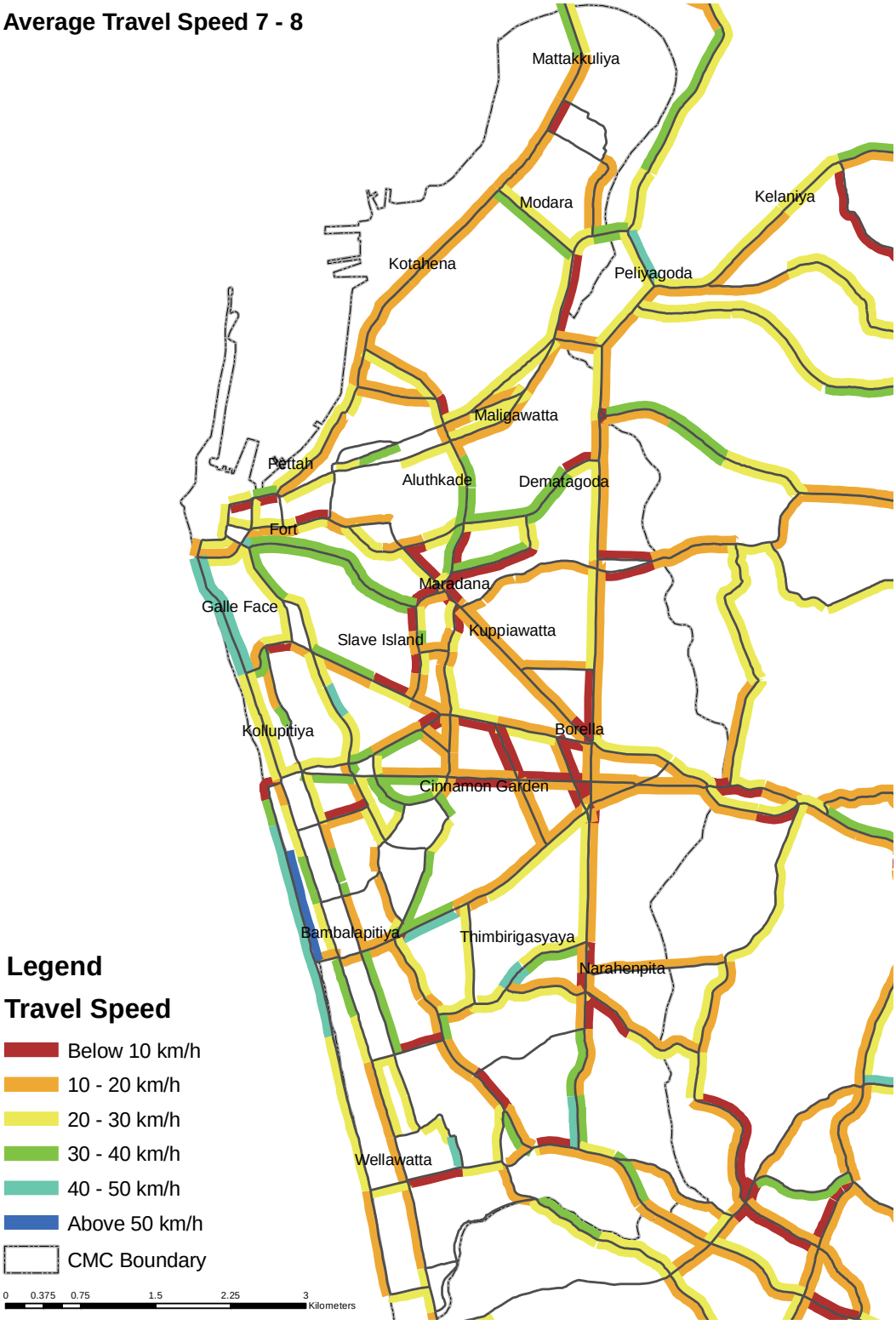
b) The southern part of Duplication Road (R. A. De Mel Mawatha), High Level Road and Armour Street are also congested where there are many schools.

(3) Travel Speed of Evening Peak Hour (Outflow from City Centre)

The area to the west of baseline road is heavily congested in the late afternoon from 5 to 6 pm. The traffic congestion is more severe than that in the morning period. In the city centre, many intersections and roundabouts are congested.

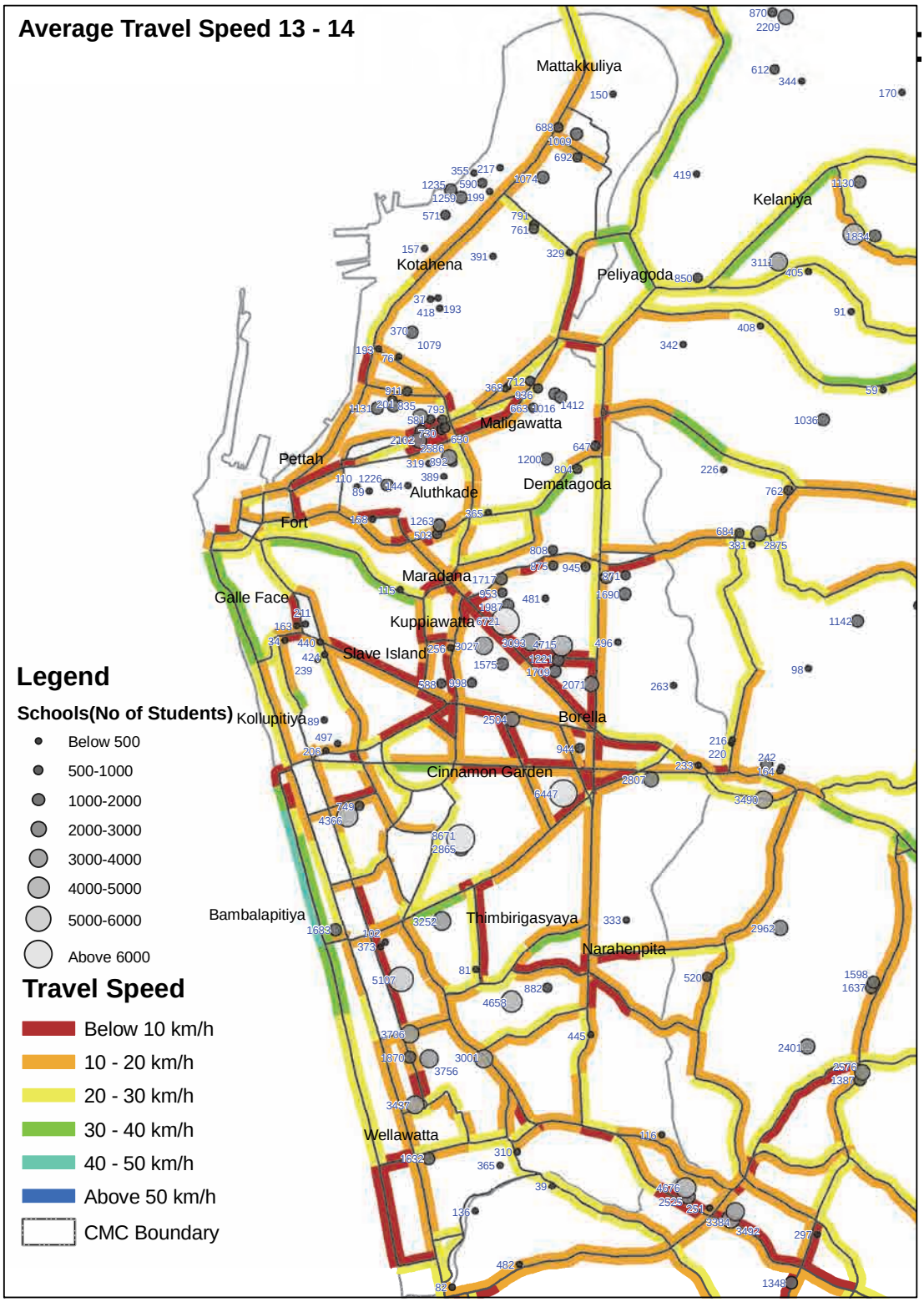
a) Maradana roundabout and the Town Hall intersection are congested in the late afternoon as well. At these intersections traffic flows come to this point from various directions and traffic volume often exceeds traffic capacity of the intersections.

b) Compared to the traffic congestion in the morning peak period, outbound directions are congested at many major intersections on Baseline road.



Source: CoMTrans Study Team

Figure 3.5.4 Travel Speed in CMC in the Morning Peak Hour



Source: CoMTrans Study Team

Figure 3.5.5 Travel Speed in CMC in the Afternoon Peak Hour

Source: CoMTrans Study Team

Figure 3.5.6 Travel Speed in CMC in the Evening Peak Hour

3.6 Traffic Control and Management

Traffic control and management can be regarded as an essential countermeasure to tackle the traffic congestion in the metropolitan area. At present many intersections exist with various geometrical and roadside conditions. Especially in urban areas improvement of layout of intersections as well as enhancement of the signal control should be carefully examined to increase its traffic capacity and to enhance traffic safety at the intersections.

3.6.1 Traffic Signal System

(1) Traffic Signals

At many intersections in CMC, traffic demand exceeds traffic capacity of the intersections in particular in peak hours. The majority of traffic signals at these intersections are stand alone; therefore, the signals do not coordinate with each other. The existing signals apply a pattern control unit for the day of week and for time of day; therefore, the existing signal system does not provide efficient traffic control.

Different types of signal control systems are installed at intersections managed by RDA and CMC. These systems are currently manufactured by domestic system and equipment companies. Even though countdown display devices are installed at some intersections, current controllers are basically multi-pattern controllers with different phasing parameters based on the time of day. Traffic-actuated signal systems with vehicle detectors which adjust signal timing to optimise throughput have not been introduced yet. In the past, coordinated signal operation was installed along Malabe Road (A0), centring at Senayayaka intersection where the Malabe road intersects with Baseline road. The system does not work at present due to poor maintenance; hence the signals are being used as a standalone system. Police officers switch off the signals and control traffic by hand signals at signalised intersections when congested.

(2) Signals for Pedestrian Crossing

A few signals for pedestrian crossing have been installed in the Colombo metropolitan area. Some pedestrian signals have been installed on Galle Road and Baseline Road.

Source: CoMTrans Study Team

Figure 3.6.1 Traffic Control by Hand Signal

Source: CoMTrans Study Team

Figure 3.6.2 Signal Switch

Source: CoMTrans Study Team

Figure 3.6.3 Pedestrian Signals

Source: CoMTrans Study Team

Figure 3.6.4 Countdown Display

(3) Roundabouts

Symbolic monuments (Buddha statues, big trees) have been placed in the centre of many roundabouts. Under a certain level of traffic demand, roundabouts are known as an efficient intersection solution because of non-stop operation that maintains higher throughputs based on the first-come-first-in principle. However, once traffic volume exceeds a certain level and there is not enough space to accommodate enlargement of the roundabout layout and circulating lanes to secure room for inbound traffic flows and so congestion will occur. In such cases a roundabout should be converted to a signal controlled intersection. Basically, a signal controlled intersection is more compact than a roundabout, so that it could provide more space for pedestrians and vehicular traffic flows. Current roundabouts with heavy traffic congestion shall be examined carefully to determine whether they will remain as roundabouts or be converted to signal controlled intersections in view of current traffic conditions and projected traffic demand.

Traffic signals have been installed from the 1980's and the most of the current traffic signals were installed in the 1990's at various intersections. Figure 3.6.8 shows the locations in which traffic signal systems have been installed and roundabouts in CMC and its surrounding area.

Source: CoMTrans Study Team

Figure 3.6.5 Roundabout at Panadura

Source: CoMTrans Study Team

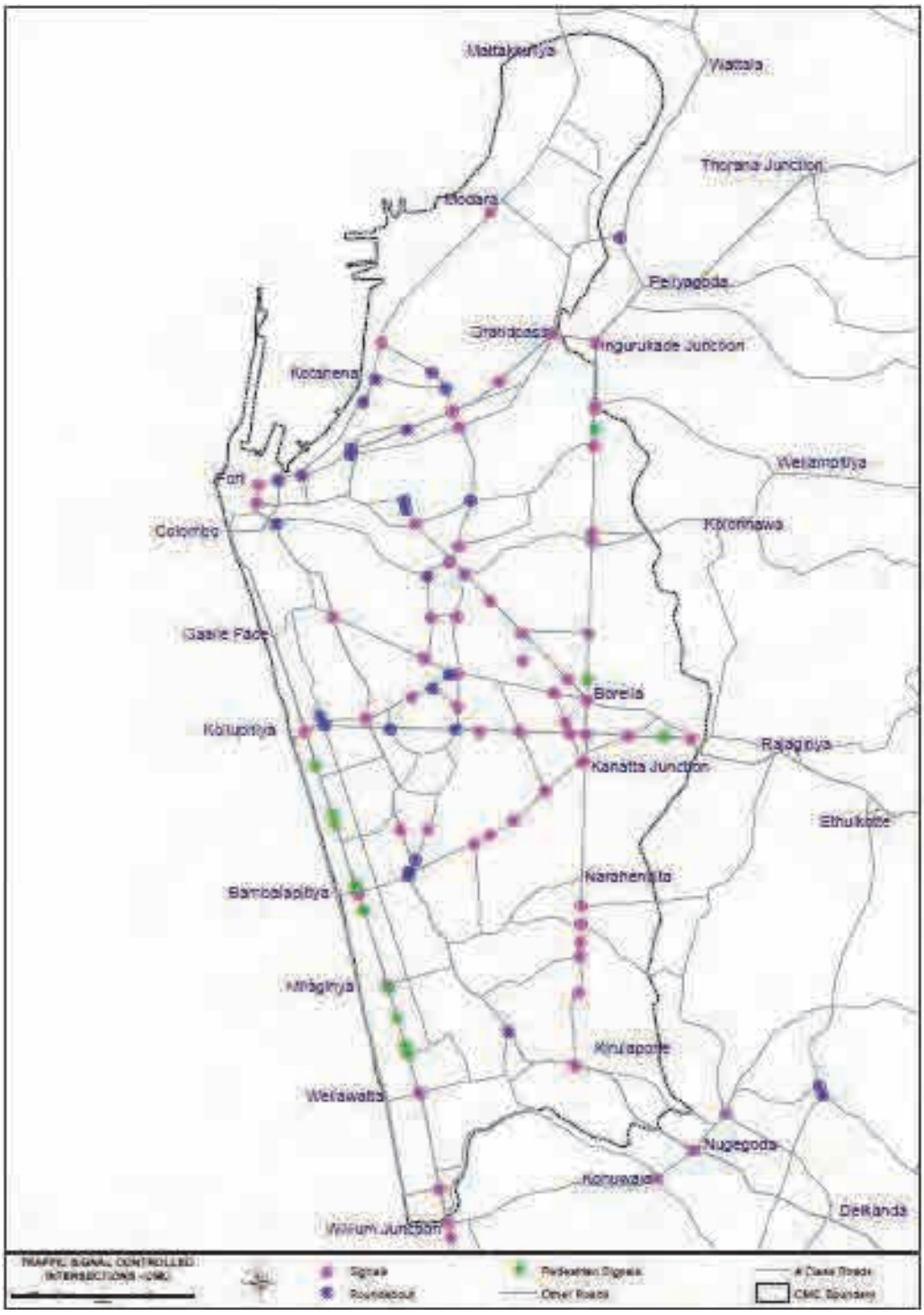
Figure 3.6.6 Roundabout at the Intersection of Main St.

Source: CoMTrans Study Team

Figure 3.6.7 Roundabout at Town Hall

(4) Non-Signalised Intersections

There is limited number of signalised intersection outside of CMC. Exceptions are adjacent area of CMC such as Peliyagoda, Nugegoda and Dehiwala as well as suburban centres such as Moratuwa and Negombo. Roundabouts have been installed in many crossings. This is satisfactory at a crossing with little traffic. However, it has become a dangerous place where traffic volume exceeds a certain level because it is necessary to find a short inter-vehicle space in order to flow into the intersection.



Source: RDA,CMC, CoMTrans Study Team

Figure 3.6.8 Traffic Signal and Roundabouts in CMC

3.6.2 Traffic Surveillance System and Traffic Information System

(1) Traffic Monitoring System (CCTV)

The CCTV Division of the Traffic Police undertakes surveillance for security and for traffic monitoring. The CCTV centre is located on the 6th floor of the Central Welfare Building in the traffic police office. A total of 128 cameras at 27 locations have been installed at major intersections. The system started its operation in March 2009. The system and equipment were made in Singapore. The system is utilised for traffic monitoring but it is not fully utilised for managing traffic.

The Traffic Police disseminates traffic information to radio companies based on traffic conditions collected by patrol teams on-site and CCTV cameras. Some other media tools, such as twitter based disseminations, are in use on a voluntary basis.

(2) Parking Management

Roadside parking is allowed on roads with "P" marks which are managed by RDA, the Western Provincial Council Ministry of Road Development, CMC and local authorities. In case of a violation, a fine of Rs. 500 is imposed. The fine is in fact not very expensive so it is doubtful that it is effective for controlling parking violations. In CMC, fifteen bicycles and five radio cars monitor parking violations. Furthermore, the traffic police are considering the implementation of a driving offence point deduction system as a means to reinforce penalties against violators. CMC is planning to prepare more roadside parking spaces and RDA plans car parking facilities which will be distributed throughout CMC. Recently private parking companies have started business and they are also providing additional parking spaces.

3.7 Road Safety

The number of people injured in traffic accidents has continuously increased in the last five years in the Western Province. Especially, the number of pedestrians injured and killed in traffic accidents is significant compared to other areas in Sri Lanka. If no action is taken, a much more severe situation will develop in the near future.

To reduce traffic accidents, it is necessary to make an effort to decrease both victims and responsible offenders. Therefore, in this section, recent trends and factors of traffic accidents are analysed and discussed from both the victims and offenders side. And based on the analysis, measures to reduce traffic accidents are suggested in the latter part of this section. The analysis is supported by the traffic accident database which is provided by the traffic police.

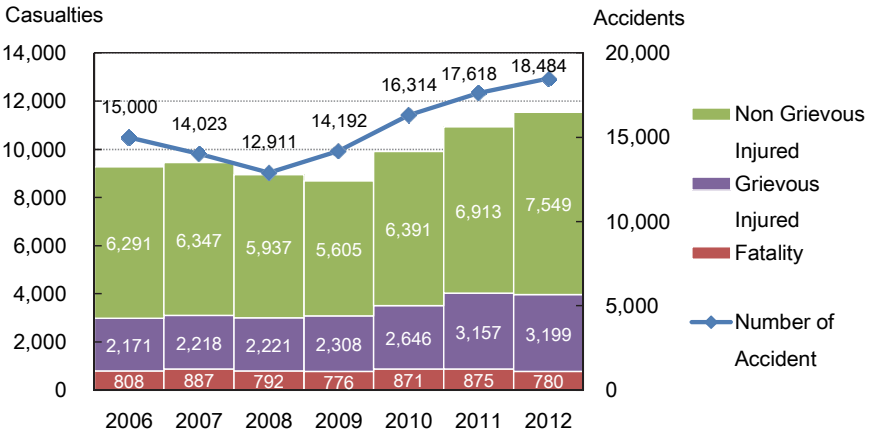
3.7.1 Overview of recent trends in the Western Province

Number of Accidents and Injured/Fatalities

Figure 3.7.1 shows the number of accidents and injured/fatalities in the Western Province. The total number of traffic accidents continuously increased from 2008 to 2012, and the growth rate is 43% in the Western province.

The number of fatalities has not changed much for the last seven years. On the other hand, the number of grievously injured persons continuously increased and the increase rate in the seven years is 47%. Especially, the growth between 2009 and 2012 is remarkable.

With regard to Table 3.7.1, the number of grievously injured per 100,000 people has also increased at the rate of 41%. The number of fatalities per 100,000 registered vehicles has decreased, and that of grievously injured remains roughly flat. The same kind of graph and table for the whole of Sri Lanka is in the Appendix.



Source: CoMTrans Study Team

Figure 3.7.1 Number of Accidents and Injured in the Western Province

Table 3.7.1 Number of Injured/Fatalities per Population and Registered Vehicles

Western Province						
Year	Population	Fatality per 100,000 population	Grievous Injury per 100,000 population	Registered Vehicles	Fatalities per 100,000 vehicles	Grievous Injury per 100,000 vehicles
2006	5,581,430	14	39	876,109	92	248
2007	5,621,477	16	39	967,022	92	229
2008	5,661,523	14	39	972,787	81	228
2009	5,701,570	14	40	969,720	80	238
2010	5,741,617	15	46	1,075,069	81	246
2011	5,781,663	15	55	1,205,708	73	262
2012	5,821,710	13	55	1,279,616	61	250

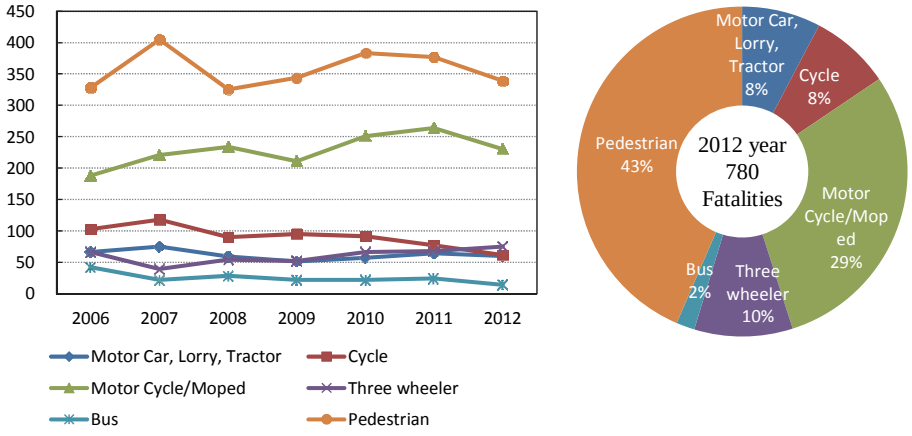
Source: Population from 2006 to 2011 is the liner interpolation of Census population in 2002 and 2012.

Number of Fatalities by Transport Mode

Figure 3.7.2 shows the number of fatalities by transport mode. Generally, the largest part of the fatalities in traffic accidents are pedestrians and motorcycles/mopeds.

In the Western Province, pedestrians have constituted the highest fatality rate for the last seven years. The second highest group is motorcycles/mopeds and the number has gradually increased. In 2012, total fatality was 780 and up to 43% of those fatalities are pedestrians.

Comparing with the whole of Sri Lanka (pedestrian ratio: 31%), which is in the Appendix, it is clear that the number of pedestrian deaths is significant in the Western Province. The number of pedestrian deaths in the Western Province is almost half of that in all of Sri Lanka. The number of deaths in the other mode in the Western Province is only one third of that in all of Sri Lanka.

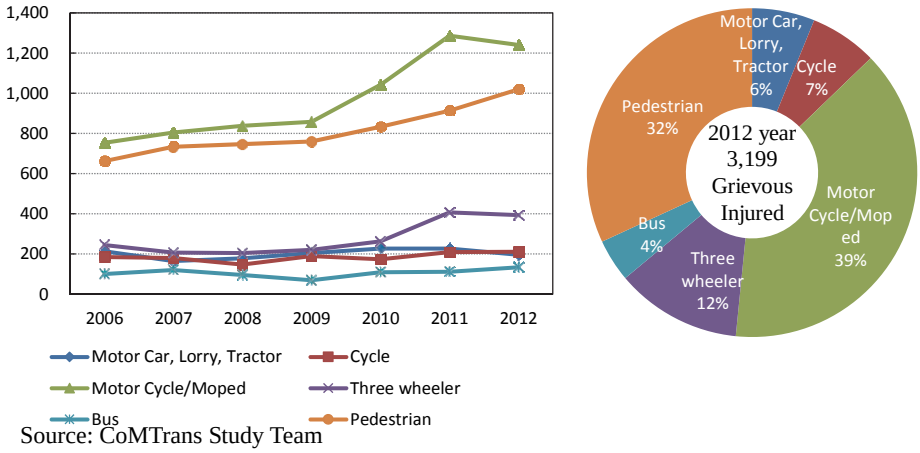


Source: CoMTrans Study Team

Figure 3.7.2 Fatalities by Transport Mode in the Western Province

Number of Grievously Injured by Transport Mode

As shown in Figure 3.7.3, pedestrians and motorcycles/mopeds are remarkable and growing in the number of grievously injured. They combine to more than 70% of all those grievously injured in 2012. Compared to the values in 2006, grievously injured pedestrians increased 54% and motorcycles/mopeds increased 65%. Besides, the number of three wheelers involved in accidents resulting in grievous injury also increased 62% in the last seven years.



Source: CoMTrans Study Team

Figure 3.7.3 Grievously Injured by Transport Mode in Western Province

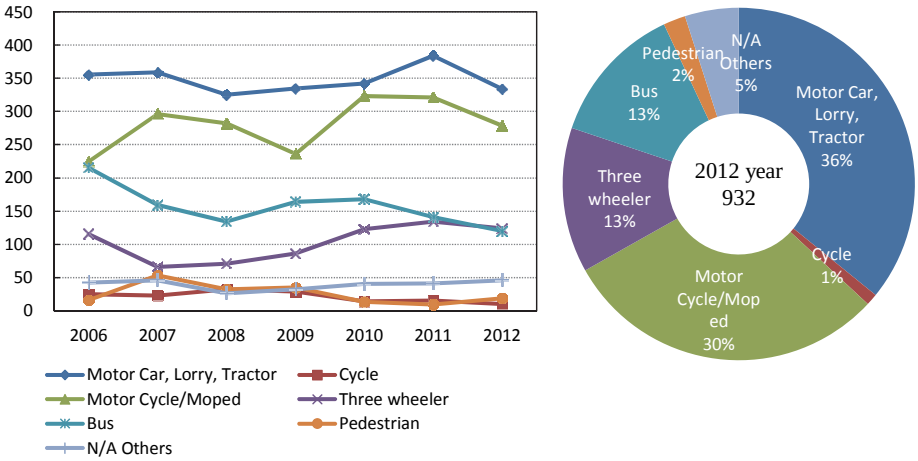
Responsible Offender for Fatal Accidents by Transport Mode

"Responsible for Fatal Accidents" is defined as the driver, rider or pedestrian who is at fault for a fatal accident. Therefore, sometimes the deceased is responsible for the fatal accident. Indeed, 34% of the people responsible for a fatal accident were the fatality.

Figure 3.7.4 shows the offenders in fatal accidents. Motor cars, lorries and tractors amount to 36%, which is broken down into roughly motor cars 8%; dual purpose vehicles 14%; lorries 13%; and tractors 1%, and the number has hovered at around the 350 veh/year level for the last seven years. Motorcycles/mopeds is the second largest group with 30%, and it has been in an increasing trend.

The number of buses involved in fatal accidents has decreased to almost half in the last seven years. However, as shown in the upper half of Table 3.7.2, the responsible bus driver per registered vehicle is more than 20 times than that of others. Of course, bus drivers are at a high risk while they drive long distances. However, the number of responsible per vehicle km for buses is still triple that of all other vehicle types.

The same kinds of graphs for the whole of Sri Lanka are shown in the Appendix, and their trends are similar to that of the Western Province.



Source: CoMTrans Study Team

Figure 3.7.4 Responsible for Fatal Accident in the Western Province

Table 3.7.2 Responsible by Registered Vehicle and Vehicle Kilometres in the Western Province

Year 2011	Registered vehicles	Responsible for Fatal Accidents	Responsible per 1,000 registered vehicles
Omnibuses	7,778	141	18.13
Private Cars	364,197	237	0.65
Goods Transport Vehicles	107,244	147	1.37
Motor Cycles	510,509	321	0.63
Three wheelers	213,177	134	0.63
All vehicle types	1,202,905	980	0.81
Year 2011	Vehicle km Mn.	Responsible for Fatal Accidents	Responsible per Mn. Vehicle km
Bus	362	141	0.39
All vehicle types	8,160	1,045	0.13

Sources : Registered vehicles from Divisional Secretariats;

Vehicle km of Private and Public Bus from Central Bank of Sri Lanka, National Transport Commission (http://www.cbsl.gov.lk/pics_n_docs/10_pub/_docs/statistics/other/econ_&_ss_2013_e.pdf) page 124.

Responsible for Fatal Accidents and Vehicle km of all vehicle type from The Study Team

3.7.2 Comparison with Other Countries

The following table shows the traffic accident data of western pacific and south-east Asian countries (only countries which have a population of more than a million). The number of road traffic deaths per population and per registered vehicle is comparatively not so high in Sri Lanka, 11th and 10th out of the sixteen countries respectively. On the other hand, the ratio of pedestrian deaths out of all traffic accident fatalities is ranked in the top four. Additionally, the number of pedestrian deaths per population and per registered vehicle is ranked 6th for each.

Table 3.7.3 Comparison with Other Countries

Country	Region	Number of registered vehicles (1,000)	Population (1,000)	Year	Estimated number of road traffic deaths	Estimated road traffic death rate (per 100 000 population)	Estimated road traffic death rate (per 10 000 registered vehicle)	Year	Pedestrian deaths	Number of registered vehicle per 1,000 population	Estimated pedestrian death rate (per 100 000 population)	Estimated pedestrian death rate (per 100 000 registered vehicle)	Pedestrians rate in fatal traffic accident	Year	Gross national income per capita (Atlas method)	Year
Bangladesh	S	1,625	148,692	2010	17,289	11.6	106.4	2010	7,054	11	4.7	0.7	40.8%	2009	700	2010
Republic of Korea	W	19,711	48,184	2010	6,784	14.1	3.4	2010	2,564	409	5.3	2.1	37.8%	2010	19,720	2010
Japan	W	89,871	126,536	2010	6,625	5.2	0.7	2010	2,292	710	1.8	0.8	34.6%	2010	42,050	2010
Sri Lanka	S	4,877	20,328	2012	2,443	12.0	5.0	2012	762	240	3.7	4.9	31.2%	2012	2,260	2010
Singapore	W	946	5,086	2010	259	5.1	2.7	2010	74	186	1.5	19.7	28.5%	2010	39,410	2010
Myanmar	S	2,327	47,963	2011	7,177	15	30.8	2010	1,902	49	4.0	2.1	26.5%	2010	0	2010
Mongolia	W	366	2,756	2010	491	17.8	13.4	2010	123	133	4.5	36.3	25.1%	2010	1,870	2010
China	W	207,061	1,348,932	2010	275,983	20.5	13.3	2010	68,996	154	5.1	0.1	25.0%	2010	4,240	2010
Indonesia	S	72,693	239,871	2010	42,434	17.7	5.8	2010	8,954	303	3.7	0.4	21.1%	2010	2,500	2010
Australia	W	16,061	22,268	2010	1,363	6.1	0.8	2010	174	721	0.8	4.5	12.8%	2010	46,200	2010
Cambodia	W	1,653	14,138	2010	2,431	17.2	14.7	2010	292	117	2.1	7.1	12.0%	2010	750	2010
New Zealand	W	3,227	4,368	2010	398	9.1	1.2	2010	37	739	0.8	22.9	9.3%	2010	29,350	2010
Malaysia	W	20,189	28,401	2010	7,085	25	3.5	2010	645	711	2.3	3.5	9.1%	2010	7,760	2010
India	S	114,952	1,224,614	2009	231,027	18.9	20.1	2010	20,099	94	1.6	0.1	8.7%	2010	1,260	2010
Thailand	S	28,485	69,122	2010	26,312	38.1	9.2	2010	2,052	412	3.0	1.4	7.8%	2010	4,150	2010
Lao People's Democratic Republic	W	1,009	6,201	2010	1,266	20.4	12.5	2010	80	163	1.3	16.1	6.3%	2010	1,010	2010

Source: WHO, *S: South-East Asia, *W: Western Pacific

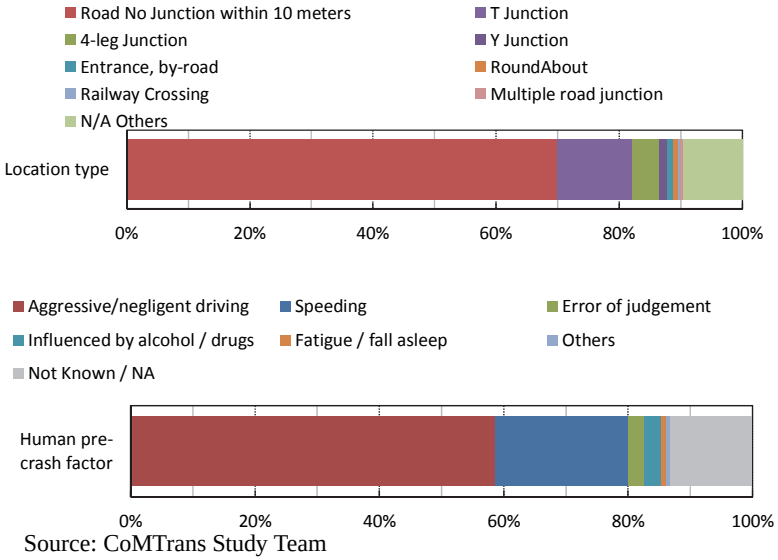
3.7.3 Location type and Collision type top 30

Figure 3.7.5 shows location type and human factor of fatal accidents in the Western Province between 2006 and 2012. About 70 percent of the accidents happened at a cross roads intersection. The second largest group is T-junctions, and it covers 12%. For the human factor, aggressive/negligent driving and speeding covers more than 80% of all factors.

Detailed collision types are shown in Table 3.7.4. The collision types are categorised into 88 types in the original database, but only the top 30 are shown here. Cells shaded with blue colour means pedestrian related accidents, and twelve in top the 30 types are related to pedestrians. Most pedestrians are killed while crossing a road (no. 1,3,6,8,12,14,etc.), and no.1 and 3 together amount to more than 1,000 fatalities.

Other than pedestrians, "Other head on crash", "In conjunction with overtaking" and "Rear-end crash" are remarkable. They are related to aggressive/negligent driving and speeding in Figure 3.7.5. On main corridors, even when there is only one lane each way, drivers try to overtake others by using the opposite lane. That should be one reason why "Other head on crash" and "In conjunction with overtaking" shows such a large value.

Effective countermeasures: improvement of pedestrian crossings and sidewalks, Traffic lights, Centre Medians, Development of fast lane and no-passing zone, Education, Setup speed traps



Source: CoMTrans Study Team

Figure 3.7.5 Location type and Crash type of Fatal Accidents

Table 3.7.4 Detailed Collision type of Fatal Accidents Top 30

	Description	Fatality	
1	With pedestrian entering the road section from the left sidewalk, shoulder etc.	668	11.5%
2	Other head on crash	630	10.9%
3	With pedestrian entering the road section from the right sidewalk, shoulder etc.	369	6.4%
4	In conjunction with overtaking	306	5.3%
5	Rear-end crash hitting a vehicle in position for going straight ahead	304	5.3%
6	With pedestrian staying on the road	255	4.4%
7	Other crashes with pedestrian	237	4.1%
8	With pedestrian entering the road from behind parked car to the left	209	3.6%
9	Crash between cyclist and motor vehicle both going straight ahead in the same directions on the same road without turning off	184	3.2%
10	With pedestrian walking on the left hand side of the road	156	2.7%
11	Vehicle travelling straight ahead leaving the road to the left	148	2.6%
12	With pedestrian entering the road from the left prior to intersection	143	2.5%
13	Vehicles intersecting without turning off	100	1.7%
14	With pedestrian entering the road from behind parked car to the right	100	1.7%
15	Other crashes with fixed object	100	1.7%
16	Other approaching crashes	97	1.7%
17	Crash between cyclist and motor vehicle going straight ahead in opposite directions on the same road without turning off	92	1.6%
18	Other crashes with cyclists	77	1.3%
19	Vehicle travelling straight ahead leaving the road to the right	76	1.3%
20	With pedestrian entering the road from the left after an intersection	75	1.3%
21	Vehicle turning over and remains on the road	73	1.3%
22	With passenger falling off vehicle	71	1.2%
23	Overtaking on the right	67	1.2%
24	With pedestrian entering the road from the right prior to intersection	58	1.0%
25	With pedestrian entering the road from the right after an intersection	55	1.0%
26	With pedestrian walking on the right hand side of the road	54	0.9%
27	Other single crashes	52	0.9%
28	Crash between cyclist and motor vehicle both going in the same direction on the same road and at least one of them turning off in a T, Y, + junction or roundabout	51	0.9%
29	Between vehicle and train	47	0.8%
30	Turning to the right ahead of vehicle going straight ahead in the opposite direction	45	0.8%
	Abbreviations		
	Total	**5789**	

Source: CoMTrans Study Team

3.7.4 Road Safety for Pedestrians

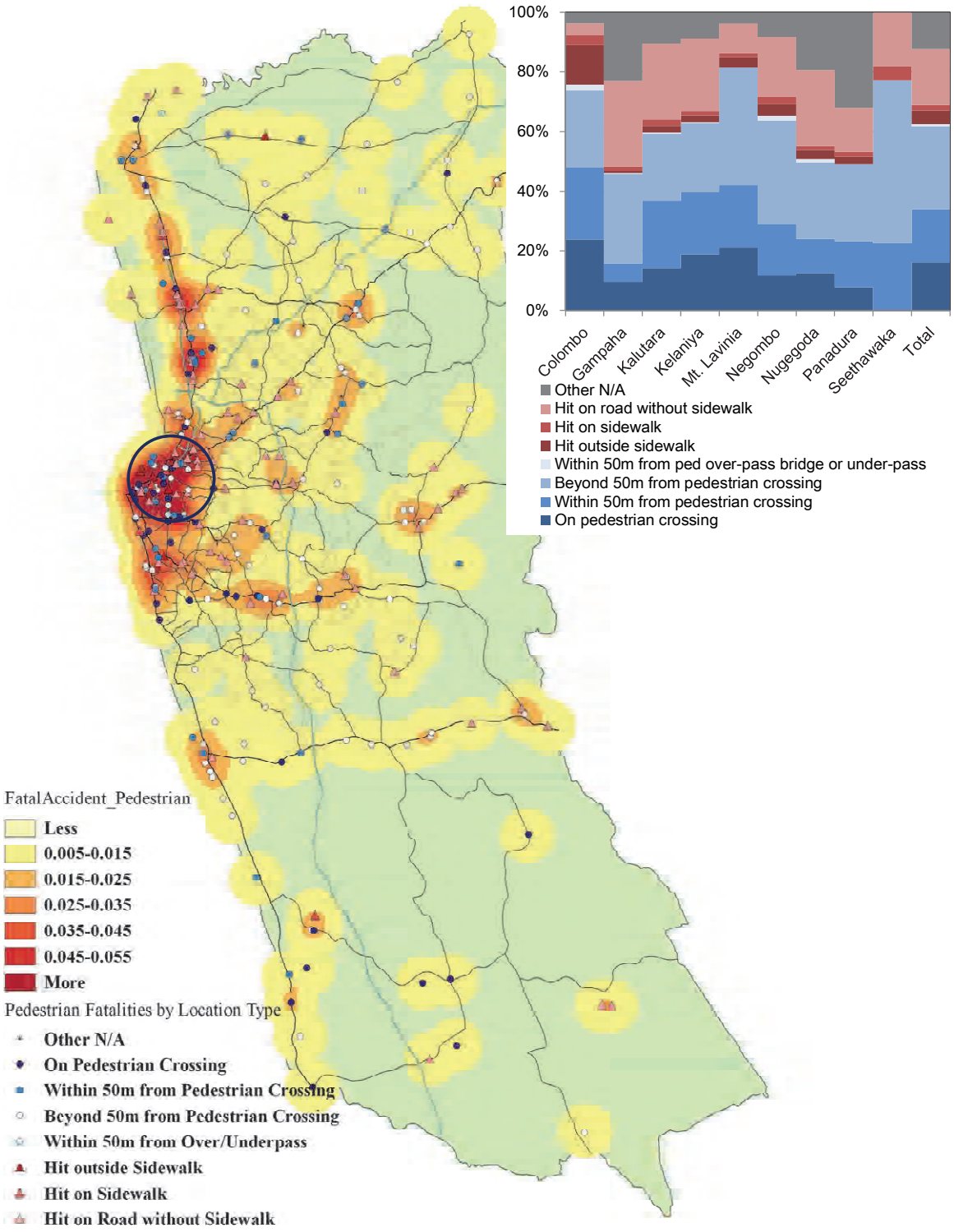
Figure 3.7.6 shows the locations of pedestrian fatal accidents in the Western Province in 2012. The heat map is displayed using a kernel density function with radius parameter of 2.5 km.

The accident location points are concentrated around Colombo, Ja-Ela, Wattala, Dehiwala and Panadura. Especially, 24% of the pedestrian fatal accidents are focused in the circle with a radius of 5 km around Colombo, even though the area of the circle is only 2% of the area of the Western Province.

Location type of accident differs according to area. For example, in suburban areas of Colombo and on the road to Negombo, “Hit on road without sidewalk” is significant. “Beyond 50m from pedestrian crossing” is distributed evenly across the north half of the Western Province, especially near junctions or turns.

As shown in the graph, more than half of the accidents occur during crossing. In many divisions, “Beyond 50m from pedestrian crossing” is the highest factor. In Colombo, Kelaniya and Mt.Lavinia, “Within 50m from Pedestrian Crossing” and “On Pedestrian Crossing” shows a measurable value. In Gampaha, Kalutara, Kelaniya and Negombo, fatal accidents which seemed to be caused by lack of a sidewalk covers 20 to 30%. In Colombo, more than 10% of accidents occurred under the situation that a pedestrian was walking outside of a sidewalk even though there was sidewalk.

Effective countermeasures: improvement of pedestrian crossings and sidewalks in the appropriate locations, installation of road traffic signs warning of pedestrian crossings, installation of traffic lights at intersections in the city area



Source: CoMTrans Study Team

Figure 3.7.6 Location and Heat map of Pedestrian Fatal Accidents in the Western Province

3.8 Urban Transport Problems and Planning Issues

The current status of urban transport has been discussed in the previous Sections. In this section, overall urban transport problems have been dealt with to identify the urban transport planning issues.

3.8.1 Problems and Issues of the Railways

(1) Insufficient Linkage of the Railway Network

The Main Line, the Coastal Line and the Kelani Valley Line go out from Colombo and the Puttalam Line branches from Ragama on the Main Line. All the lines converge on the Fort area but there are no mass transport systems connecting laterally. That will force the passengers to travel a long way to get to their destinations. Some metropolitan areas in developed and developing countries have succeeded in developing an extensive railway network with high service levels. This contributes to promote the use of public transport and to alleviate traffic congestion. While there is a radial railway network in the Western Province, the increase in service level of the existing railway lines and connection of these radial lines with high service level public transport is essential. A well connected railway network is required for the convenience of the passengers.

(2) Lack of Feeder Service for Railways

The circumstances in and around the stations are not sufficient for other transport modes to provide feeder service such as station plazas, bus stands and park and ride facilities. These facilities are not located close to the railway station in some cases. Railway stations should be connected with other modes of transport for easy transfer to the other transport modes.

(3) Insufficient Integration among Public Transport

Railways should not compete with other public transport modes but should cooperate with them. Railways only provide service from station to station. To use the railway, passengers have to come to the station somehow. Bus or other road transport mode will provide feeder service to the railway. However, railways are currently competing with buses running parallel to the railway line such as Galle Road.

In terms of time tables of public transport, railways and buses servicing to railway stations functioning as feeder service are generally independent in the Western Province. If bus and railway frequency is significantly high, there would be minimum waiting time at transfer stations. Coordinated time tables of the railways and buses will be significantly important in suburban railway stations where frequency of railways and buses are relatively low.

(4) Lack of Public Transport Master Plan for the CMA

A number of organisations are involved in planning, implementation and operation of public transport of the Colombo Metropolitan Area such as Ministry of Transport, Ministry of Private Transport Services, Sri Lanka Transport Board (SLTB), Sri Lanka Railways (SLR), Department of Motor Traffic (DMT), National Transport Commission (NTC), Western Province Road and

Passenger Transport Authority (WPRPTA), and local authorities. Coordination with road sector organisations such as the Ministry of Highways, Ports and Shipping and the Road Development Authority (RDA) is also essential as road-based public transport use roads. However, there is no master plan for urban public transport for Colombo Metropolitan Area (CMA). In addition to sector-based or organisation-based plans, a comprehensive master plan to integrate all public transport is also essential to plan, implement and operate public transport in a coordinated and integrated manner.

(5) Necessity to Provide Sidewalks for the Access Roads to Railway Stations

In urbanised areas, a number of passengers walk to railway stations. According to experiences in many countries, the walking distance from a railway station can reach 500 to 800 metres. A good walking environment around a railway station is also essential to increase railway passengers. However, there are only a limited number of railway stations which have a sidewalk network.

(6) No Public Transport Fare Integration

The current fare system of railways is independent from other public transport modes such as buses. Thus, passengers have to pay a fare every time they transfer between public transport modes. There is no incentive for transfer passengers such as discount fares for feeder bus services.

(7) Lack of Public Transport Information

Information on railway transport as well as connections with other modes of transport is not sufficiently provided in Sri Lanka. Although the railway time table is available on the internet, the real time information such as the delay of trains is not accurate. Even at railway stations, bus routes departing from the station are not available.

(8) Lack of Railway Access to the International Airport

Railways can also provide feeder service to the International Airport. The Puttalam line runs close to the airport but passenger service is not provided.

(9) Slow Operational Speed of Trains

As shown in Table 3.2.1 the average speed is less than 30 km/h which is relatively slow compared to commuter railways in other countries. For instance, ordinary trains of private railways in Tokyo is in the range of 40 – 45 km/hour and that of express trains are 50 – 60 km/h according to Morichi (2005). Other typical urban heavy railway examples in the world show the range of 40 – 50 km/hour (Gwilliam, 2002).

Gwilliam, K. (2002) “Cities on the move – a World Bank urban transport strategy review”, The World Bank, pp. 113.

Morichi S. (2005) “Long term strategy for Transport System in Asian megacities” Journal of Eastern Asia Society for Transport Studies. Volume 6, pp. 1-22.

(10) Less Comfort on the Train

Most trains are not air-conditioned except for the upper class cars of express trains. This is not attractive to passengers and they might choose another mode of transport.

(11) Deteriorated Rolling Stock, Track and Signalling Systems

Of the total rolling stock, the availability of functional locomotives is about 70% and that of DMUs about 75%. It can be said that more than half of the rolling stock are aged or not available. DMUs and lower class passenger coaches are not air-conditioned. Trains are running without closing the doors to intake air for cooling. This is very dangerous for the passengers. In modern railway systems trains cannot start when a door is open and the doors cannot open when the train is running. Renewal and modernisation of the rolling stock is urgently required.

As explained in Section 3.4, railway tracks are deteriorated and in a dangerous condition. An important point is to build safe tracks with minimum irregularities by replacing railroad materials including rails and fasteners and then maintaining ballast in good condition to counteract age-based deterioration and lack of maintenance.

The Signalling System has deteriorated and it causes delays and the cancellation of trains occasionally.

(12) Insufficient Line Capacity

The tracks of Sri Lanka Railways are installed in a way that they are radiating from Colombo, the capital city of Sri Lanka. Therefore, many trains gather near Colombo Fort and Maradana during morning and evening rush hours. Thus, triple tracks and quadruple tracks are already used in the Main Line.

(13) Insufficient Expenditure for Maintenance

Distribution of recurrent expenses of Sri Lanka Railway in Year 2010 indicates labour cost accounts for almost three quarters of the total cost and fuel cost follows. Material cost is only 0.5% and this is extremely small. Internationally, in most systems it will cost 5 to 10 % for procuring spare parts or replacing the systems. It is deemed that maintenance of the system is neglected or postponed.

Higher efficiency in the use of labour and energy is required to reduce these costs and more allocation for maintenance cost is required.

(14) Low Level of Service of Kelani Valley Line

The Kelani Valley Line runs along High Level Road. It is located in highly populated areas and reaches Fort station. However, only ten trains a day are operated in each direction. Trains going to Fort are concentrated in the morning and most of the trains from Fort are operated in the afternoon. KV line was originally constructed as narrow gauge and converted to broad gauge in 1996. There are still a lot of sharp curves and the track condition is not good. The line does not

fulfil its role. Modernisation of this line is also recommended.

(15) Small Share of Railway in Freight Transport

The share of freight transport in Sri Lanka railway is only 0.7% while it was 38% in 1964. Railway freight transport has come into disfavour as road transport has developed. The declining share of the railways in freight transport could be attributable to the double handling of cargo. Additional unloading and loading is required at the station from truck to train or train to truck compared to transporting the goods directly by truck. This causes transport time to increase and an additional handling charge thus it makes railway transport less attractive for consigners.

3.8.2 Problems and Issues in Bus Transport and Other Road-Based Public Transport

(1) Low Bus Operation Speed due to Traffic Congestion on Roads

As mentioned in Section 3.3, roads in the CMA, especially radial transport corridors, are congested during peak hours. Since buses share the road space with private motorised modes of transport such as cars, motorcycles and three-wheelers the travel speed of bus transport is dependent on the other modes. Moreover, travel speeds of buses are usually even slower than passenger cars as they have to stop at bus stops and passenger car can take the shortest path regardless of routes.

In line with economic growth, the shift to private motorised modes of transport is expected. This will further decrease the travel speed of buses. Therefore, this causes a vicious circle of losing public transport. Public transport with a dedicated track, lane or road is requisite to break the vicious circle. Thus, the development of space for bus and road-based public transport is required.

(2) Pettah-Centred Bus Network

In the Western Province, approximately 25,000 round-trips of intra-province buses are operated. Amongst those, 8,000 round-trips are made from/to the Pettah and Fort areas of Colombo. This means that bus routes in the Western Province are directed toward the Pettah area. In the case of inter-province buses, a half of the bus routes which cross the boundary of the Western Province have one of their terminal points in the Pettah or Fort area. The route system in the region is a radial pattern. This creates a significant load on the road system in the city centre. From the passengers' point of view, they cannot help going to the Pettah or Fort area to go to a city in another corridor.

(3) Lack of Integration with Railways and Other Bus Terminals

Unlike private modes of transport, public transport requires connecting with each other. Railways are generally suitable for longer and high demand trunk routes with high capacity and relatively straight alignment. On the other hand, buses can serve narrow roads even with less traffic demand. However, some buses in Colombo have both of these functions. These two modes are often competing such as on the Colombo to Negombo, Gampaha, Homagama and Moratuwa corridors. This results in excessive congestion in the bus fleets and congestion on the roads.

Although some railway stations have station squares and bus stops in front of them, those two modes of public transport are not properly connected in terms of train/bus schedules and routes. Since the public transport is a network system, these two modes should be planned in an integrated manner.

(4) Low Service Level of Bus Operation

Although the private bus operators are making a profit with the current fare levels, their business is dependent on depreciated bus fleets with minimum maintenance due to the lack of proper management and ownership.

(5) Difficulty in Improvement of SLTB's Bus Service

The SLTB suffers a financial loss every year and they are not able to improve the level of bus service, including frequency, travel time and the comfort of bus fleets. This is partly because the SLTB is providing a public service such as school buses for school children, night buses and buses for rural areas where sufficient bus passenger revenue cannot be obtained. Inefficiency in operation and political intervention and competition with private operators are also affecting this.

(6) Inconvenient Bus Operation for Passengers due to Bus Rental System of Private Operators

Although some operators have a large number of buses, the majority of private bus operators are small scale companies and owners have only a few buses for rent to bus crews. In some cases bus drivers and conductors must pay the bus rental cost and fuel cost from the bus fares they collect from bus passengers. They attempt to maximise fare revenue and they are not very concerned with the convenience of passengers. This leads to unpleasant bus services to bus passengers.

On the other hand bus owners are not able to manage bus operation since they cannot trace the location of buses on the road. Furthermore bus operators cannot check the bus fare collection exactly which is collected by bus conductors on board. Thus the bus owner and operators utilise the bus rental system to reduce their management efforts and risk from the bus operation. This bus operation system makes it difficult to provide reliable bus operation; buses on the same routes are operated based on the time table but it is difficult to make real time adjustments of bus operation due to lack of coordination.

(7) Difficult Coordination between Public and Private Bus Operators

The bus time tables are prepared for many bus routes in the region; however, in the case of public and private bus operators jointly operate buses on the same route, bus operation in accordance with timetables is difficult to achieve due to traffic congestion and difficult coordination between two operators.

(8) Insufficient Support for Bus Fare Discount for Transport the Transport Poor

Bus fare is set by NTC at an affordable level by taking the ability to pay of ordinary people into account. Bus crews of private operators should operate buses at regulated fare levels thus it is difficult for them to get students and pupils on board at discounted rates compared to the SLTB

buses and Sisu Seriya. Under these situations, only public buses and limited private buses could provide transport service for students and pupils at a discounted fare. Since these people are regarded as "transport poor" whose ability to pay for transport is generally low, the government provides subsidy for this kind of service.

The support for public transport is available for passengers on SLTB buses and the limited private buses and Sri Lanka Railway only. There is no discount ticket for pupils and students on private bus services except Sisu Seriya because the government does not provide financial support to the private bus operators. As a result, pupils and students do not use private bus services except special bus services supported by the government due to relatively high fares. From the bus operator point of view, private bus operators are not able to take pupils and students at very low discounted fare.

SLTB operates buses on the same bus routes where private bus operators run buses for helping bus passengers who travel at a discount rate. However this kind of arrangement of bus operation made by two different operators brings about inconvenience for bus passengers. Eventually bus frequency is reduced for students and pupils.

(9) Insufficient Management on Bus Operation

Bus operation is not well managed since it is difficult for the management to monitor the bus operation on a real time basis. Moreover bus fare collection is also difficult to check whether it is properly collected and whether the full amount is submitted to the management of the bus. To avoid such difficulties, sometimes management use a bus rental system with bus crews. In the bus rental system, bus operators and bus owners do not have to take care of bus operation and bus fare collection. They do not take operational risks and force responsibility on to the bus crews. This improper management of bus operation leads to a low level of bus service.

(10) Market-Driven Regulatory Scheme of Road-Based Public Transport Modes

Three wheelers and other road-based public transport vehicles are usually owned by small operators and individuals as this sector is less regulated and is market-driven. While an initial registration and an annual renewal of the three-wheeler licences are required, there is no restriction on the number of three wheelers.

Notably the surge in the number of three-wheelers is significant. As the industry is directly linked with the employment of drivers as well as transport in areas which are not covered by buses, coordination among relevant agencies and stakeholders to find a solution which will not affect the employment or transport service is essential.

3.8.3 Problems and Issues on regarding the Road Network

(1) Insufficient Road Network

Current traffic demands mean that the roads are almost at capacity or exceed capacity at several points during the peak hours as shown in Sub-section 3.5. Especially, road traffic between the CMC and the eastern part of the suburban areas, such as Battaramulla, depends on one major arterial road and no alternative roads parallel to the major arterial road have been developed yet.

As a consequence the road network forms a "fish bone" shape and excessive traffic flows are concentrated on the one major arterial road. Merging points at major intersections in suburban areas have become bottleneck intersections.

(2) Lack of Pedestrian Space

Almost none of the roads have sufficient space for sidewalks and shoulders under the existing conditions as shown in Sub-section 3.5.1. Most urban roads lack space for pedestrian traffic. Only a few arterial roads provide sidewalks for pedestrians and this lack of sidewalks might cause frequent and serious traffic accidents involving pedestrians. Therefore, establishment of design standards for urban roads is needed and it is essential to improve the urban roads in accordance with the urban road design standards for road traffic safety.

(3) Lack of Road Network Master Plan for the CMA

The arterial road network has been developed and maintained by the Road Development Authority and CMC, however, no arterial road network development plan has been established for the whole of CMA. Therefore a road network master plan which considers comprehensive development of public transport should be established.

(4) Lack of Road Design Standards for Urban Roads

Highway design standards for interurban roads have been established and have been applied for road development and maintenance. The characteristics of urban traffic are different than intercity traffic, for instance, the traffic speed of interurban traffic is generally higher than urban traffic and pedestrian traffic is more important in urban areas. Thus it is desirable to develop a highway design standard specifically for urban roads.

(5) Low Accessibility of the Existing Expressway Network

The existing Southern Expressway (SEW) and on-going Outer Circular Highway (OCH) will form a circumferential expressway network which will run in the fringe of the metropolitan area. At present it is a considerable distance from the existing Kottawa interchange to the City centre of Colombo and it takes around one hour, depending on traffic conditions. Car drivers and passengers cannot fully enjoy express service on the expressway due to the long distance from the nearest interchange. Therefore, accessibility between expressway's interchanges, the suburbs and the centre of Colombo should be enhanced. In addition traffic flows on the existing ordinary road network should also be distributed to secure proper travel time and speed.

(6) Need to Enhance Access to Colombo Port for Cargo Transport

In terms of cargo transport, there is no expressway access to the Port of Colombo at this moment. The Port of Colombo is an international hub in the Indian Ocean and the nation's largest port. Roughly three quarters of container throughput is transhipped in the Port of Colombo and the volume of import and export cargo has drastically increased in the last decade. According to the Screen Line Survey results and Truck OD Interview Survey results of the CoMTrans, a large number of large trucks utilise the Negombo corridor where several export processing zones (EPZs) and industrial estates are located followed by the Kandy corridor which has large

hinterlands in the northern and central parts of the Island.

Although the Port Access Road functions as a main access road to the Port as an exclusive road for the port-related vehicles, the Port Access Road does not connect with the expressway network of the Colombo Katunayake Expressway (CKE) and the Southern Expressway. Congestion is, therefore, observed in the area around the entry points of the Port Access Road as explained in Section 3.3. The situation might be similar or even aggravated after the completion of on-going expressway projects, the Outer Circular Highway (OCH) and the Northern Expressway, as there is no direct access from the Port to the expressway network. This can significantly contribute to worsen the congestion along with the projected surge in the number of private vehicles in urban areas.

(7) Planning Issues Regarding Expressway Network Development

When the Colombo – Katunayake Expressway (CKE) is connected with the on-going OCH and the planned Northern Expressway, a considerable amount of vehicular traffic flow from the northern parts such as Kandy and Negombo would come to the city centre through CKE and cause traffic congestion at the end of CKE at the northern part of the new Kelani Bridge. A significant amount of traffic flow would approach the bridge but it is expected to cause traffic congestion at the bridge due to the limited traffic capacity. To deal with this anticipated traffic problem at the bridge, elevated road development is planned to distribute the traffic concentration to other areas. Even if an elevated road which connects with the CKE is developed, it would merely move the traffic congestion to the next intersection.

3.8.4 Problems and Issues on Traffic Control and Traffic Management

(1) Traffic Congestion at Intersections

Traffic congestion is seen at many intersections in the city centre of Colombo Municipality. Signal phasing is not appropriate at many signalised intersections. Traffic congestion is also observed at roundabouts and it is caused by the shortage of traffic capacity at roundabouts. As traffic demand increases, traffic flows cannot be properly dealt with without traffic signals.

(2) Reduction of Traffic Capacity due to On-street Parking

Traffic congestion is caused by the reduction of traffic capacity due to on-street parking because there are only a few parking spaces available in the city and the regulation of street parking is not strict in the Colombo Municipality.

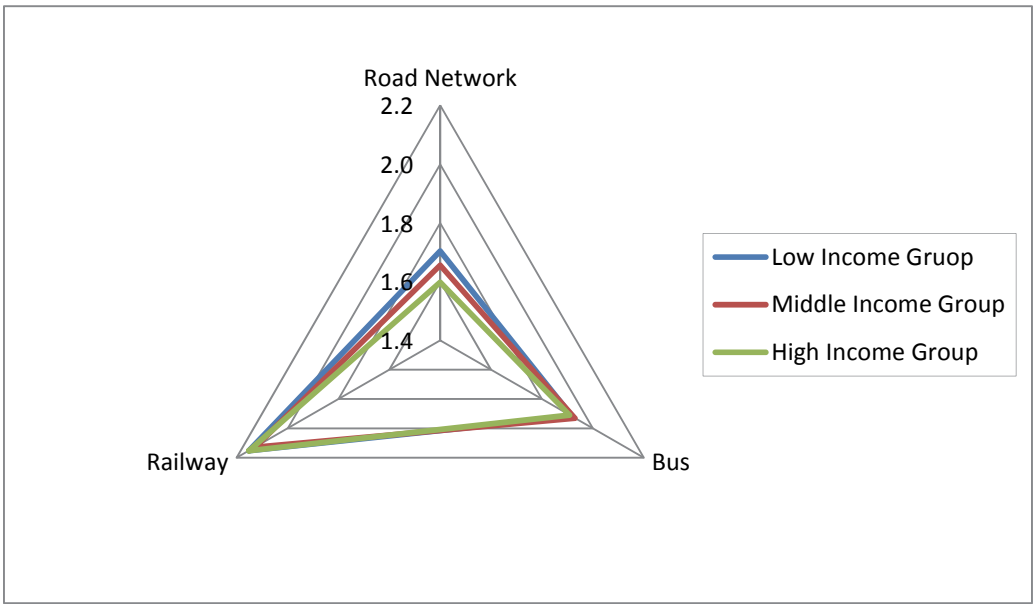
3.8.5 Residents' Evaluation of Transport System Performance

(1) Transport Sector's Evaluation by Residents

To get an insight into people's perceptions regarding urban transport problems, respondents to the HVS were asked to score from 1, for "Strongly Agree", to 5, for "Strongly Disagree", with the given statements pertaining to problems related to the urban transport sector.

Figure 3.8.1 shows how residents of the Western Province evaluate transport sectors which they

use in their daily life. The average score for all statements relevant to "Road Network", "Bus" and "Railway" are shown in Figure 3.8.1, in which the higher the average score, the better the perception of the transport sector is. Figure 3.8.1 reveals that the evaluation of the "Road Network" is generally lower than "Bus" and "Railway". From the viewpoint of income group, the average score of the "Road Network" decreases as income increases. However, there are no noticeable differences of average scores across income groups on "Railway" and "Bus".



Source: CoMTrans Home Visit Survey 2013,

Figure 3.8.1 Transport Sector Evaluation

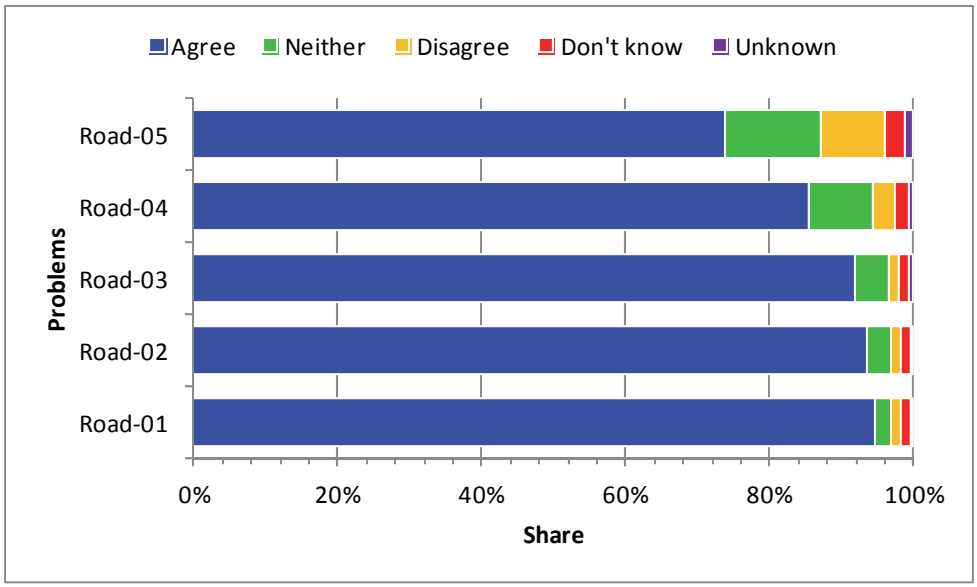
(2) Evaluation of Road Network's Problems

Figure 3.8.5 shows the residents' evaluation of the road network. Over 80% of the respondents agreed all the problems asked in the questionnaire exist.

Table 3.8.1 Description of Road Network Problems

Problems/Issues on Road Network	Problem Code
(a) Roads are congested in the morning peak period	*Road-01*
(b) Roads in the areas surrounding schools are congested in 1:30-2:30 P.M.	*Road-02*
(c) Roads are congested in the evening when people go home	*Road-03*
(d) On-street parking reduces road capacity thus results in road congestion	*Road-04*
(e) Roads are in poor condition and they are dangerous for driving	*Road-05*

Source: CoMTrans Home Visit Survey 2013



Source: CoMTrans Home Visit Survey 2013

Figure 3.8.2 Residents' Evaluation on Problems Related to the Road Network

(3) Evaluation of Public Transport's Problems

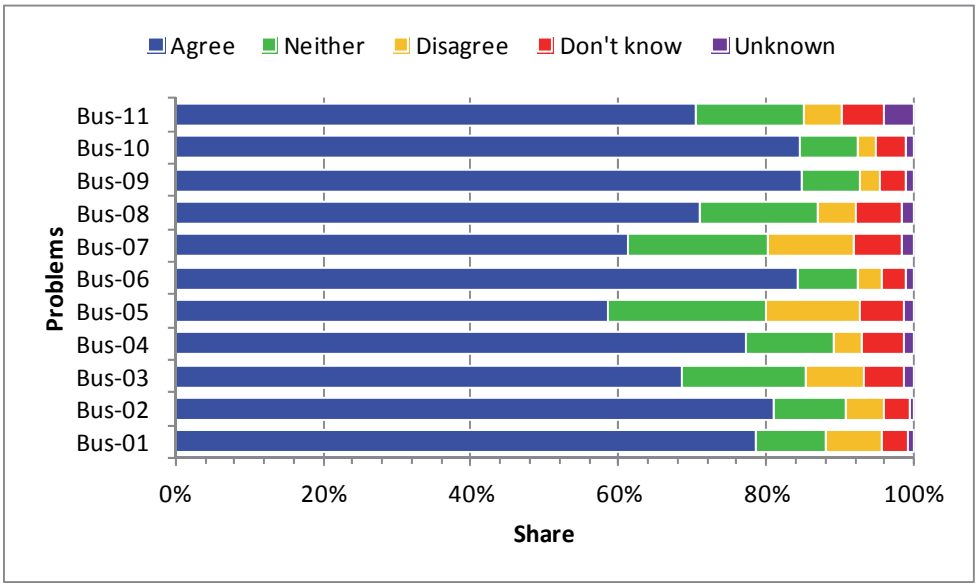
The evaluation of public transport, including bus and railway, is presented in Figure 3.8.3 and Figure 3.8.4. Current bus services also exhibits severe dissatisfaction from the residents' points of view. As for the railway, there are a notable number of respondents who answered "Don't know" because they do not use the railway. However, the share of respondents who agree is absolutely larger than those who disagree on the statements of the problems pertaining to the current railway service.

Table 3.8.2 Description of Public Transport Problem

Problems/Issues on Public Transport	Problem Code
Bus	
(a) It is not comfortable because it is overcrowded on buses	*Bus-01*
(b) It is not convenient because of long waiting time when it has few passengers	*Bus-02*
(c) It is not convenient because bus frequency reduces during the night	*Bus-03*
(d) Frequency of bus operation is not sufficient thus waiting time is long	*Bus-04*
(e) Buses are often delayed due to traffic congestion	*Bus-05*
(f) It is too expensive if we get on air-conditioned buses	*Bus-06*
(g) It is not comfortable because behaviour of the bus conductor and staff is not good	*Bus-07*
(h) Security on buses is not fully guaranteed	*Bus-08*

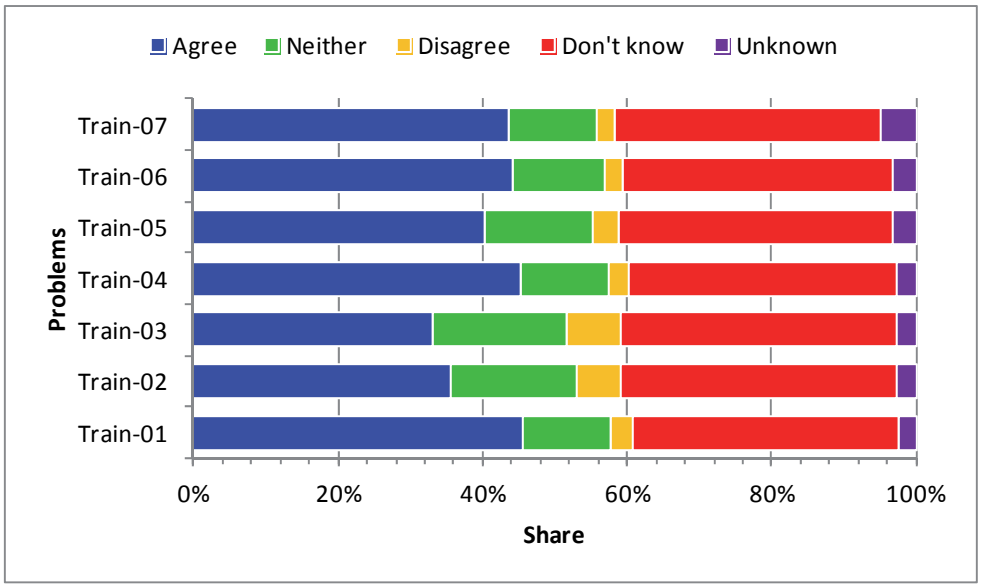
Problems/Issues on Public Transport	Problem Code
(i) It is not comfortable since it is hot on buses without air conditioners	*Bus-09*
(j) Bus routes are limited thus bus passengers need several transfers	*Bus-10*
(k) It is not comfortable because buses are dirty on board	*Bus-11*
Railway	
(a) Frequency of train operation is not sufficient thus waiting time is long	*Train-01*
(b) It is not comfortable because it is overcrowded on trains	*Train-02*
(c) It is not convenient because train frequency reduces during the night	*Train-03*
(d) It is not convenient because connection of railways and buses are not well organised	*Train-04*
(e) Security on trains is not fully guaranteed	*Train-05*
(f) It is not comfortable since it is hot on trains without air conditioners	*Train-06*
(g) It is not comfortable because rail coaches are dirty on board	*Train-07*

Source: CoMTrans HVS 2013



Source: CoMTrans HVS 2013

Figure 3.8.3 Residents' Evaluation on Problems Related to Bus Service



Source: CoMTrans HVS 2013

Figure 3.8.4 Evaluation of Public Transport

3.8.6 Overall Urban Transport Problems and Planning Issues

(1) Traffic Congestion

Traffic congestion has been worsening in recent years on the road network in the central area of CMA. Traffic congestion has brought about huge economic loss by increasing vehicle operating cost as well as travel time cost.

Traffic congestion is observed in the morning and evening peak periods at intersections of radial arterial roads, especially around the periphery of CMC and inner cities such as Borella, Maradana, Dematagoda, Town Hall and Nugegoda according to the travel speed survey and the traffic volume and capacity analyses.

In terms of the seven major transport corridors, heavy traffic congestion is observed in Malabe corridor. Lack of high capacity and high service level public transport is one of causes of the congestion. This is also partly due to the characteristics of the Malabe corridor. As the only east-west direction 4-lane-arterial road, Parliament Road (Malabe - Battaramulla – Borella) serves the traffic flows from these areas to the CBD; a number of private vehicles are merging onto the Parliament Road from the north-south roads connecting to it. It should be noted that the population has been increasing in this area as an administrative capital. Considering the future growth in this area, it is expected that the road will be grid-locked.

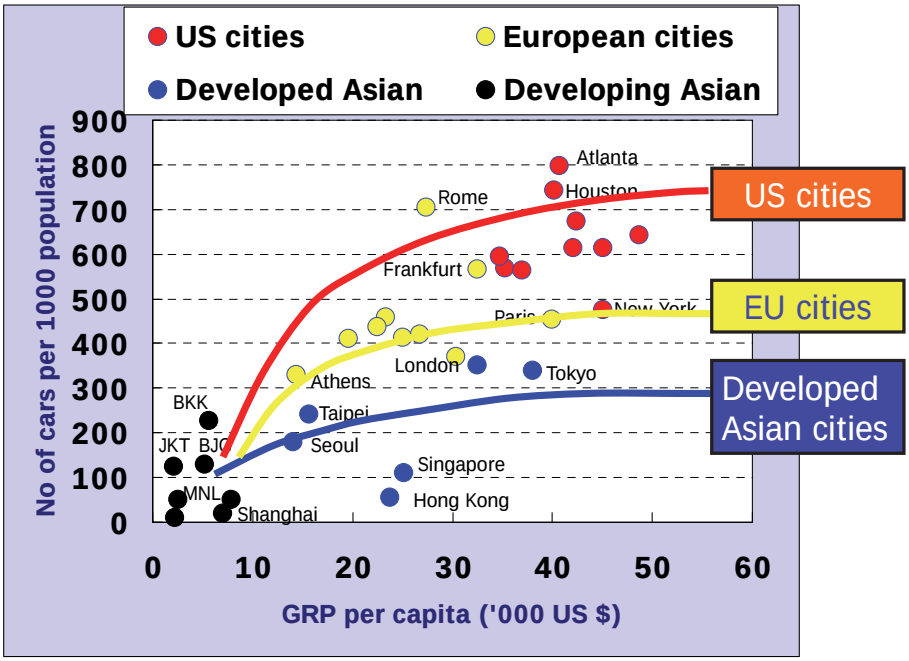
(2) Need to Shift to Public Modes of Transport

According to the historical trend of modal shift in the last 28 years, the number of passengers

crossing CMC boundary by private mode of transport increased approximately 2.5 times while the number of passengers using public transport remained roughly static. The vehicle ownership in recent years also shows a surge in the number of passenger cars, three-wheelers and motorcycles.

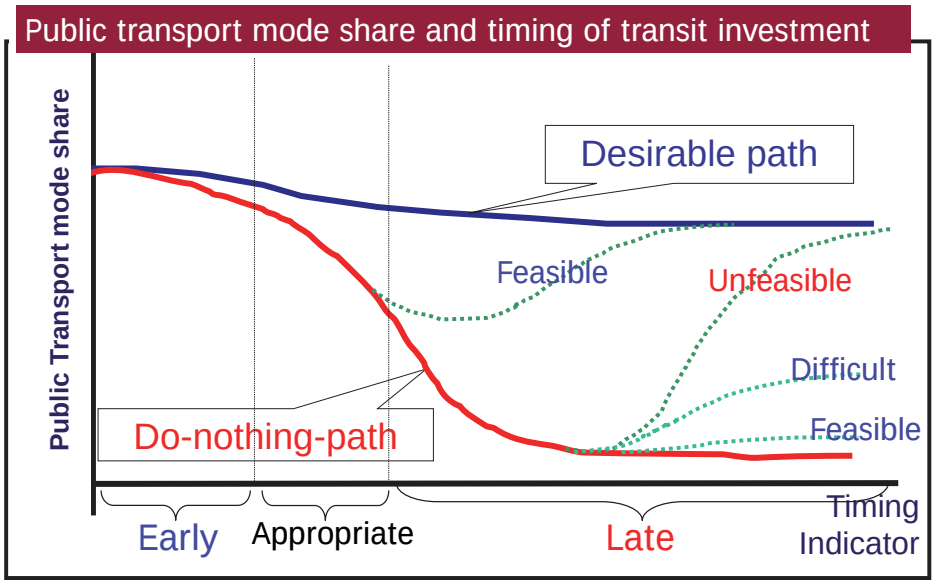
Group A households are captive to private modes of transport according to the Home Visit Survey results. Taking into consideration the fact that economic growth is expected in the CMA with huge urban development projects, the modal shift to private modes of transport will be accelerated if no government intervention is taken. Figure 3.8.5 shows vehicle ownership and gross regional products (GRP) per capita of cities in the United States (U.S.), the European Union (EU) and Asia. Cities in U.S., EU and developed Asian cities took different paths. While U.S. cities are dependent on cars, developed Asian cities succeeded to deter vehicle ownership with development of public transport systems. As show in Figure 3.8.6, the share of public transport will continuously decrease with economic growth if the government does nothing. While some U.S. cities are recently trying to increase the share of public transport to reduce externalities of private mode of transports, a limited number of cities have succeeded to regain a share of public transport. Once car ownership and a share of private mode of transport increases, it is difficult to reverse it due to the captive characteristics of car users.

With the decrease of travel speeds on the roads due to the abovementioned severe traffic congestion, the travel time of buses will increase. This might accelerate the shift to private modes of transport. It is highly expected to break this vicious circle though provision of convenient, fast and high capacity public transport modes.



Source: Morichi, S and Acharya, S.R. (eds.) (2012) Transport Development in Asian Megacities -A New Perspective-, Springer

Figure 3.8.5 Vehicle Ownership and GRP per Capita of Cities in U.S., E.U. and Asian Cities



Source: Hanaoka, S. (2014) " International Experiences in Urban Transport Policies and Financial Options for Urban Transport Projects" presented for CoMTrans Special Seminar on Sustainable Urban Transport Development on 21st January, 2014

Figure 3.8.6 Public Transport Mode Share and Timing of Transit Investment

(3) Provision of Sufficient Capacity for Increasing Transport Demand

Travel speeds on the road network appear low in the peak periods as described in Subsection 3.4.7. It is noteworthy that the capacity of public transit is much higher than that of private motorised modes of transport. As high economic growth is expected, all major corridors, especially high demand corridors such as Malabe, Kandy, Galle, Negombo and High Level corridor should have public transit systems.

(4) Provision of Affordable Transport Means for the Poverty Group

The Home Visit Survey indicates that travel characteristics vary significantly according to income level. The modal share of Group C household members depends on non-motorised modes of transport and public modes of transport such as buses and the railway. It is expected to provide affordable public transport for them in addition to non-motorised transport.

Expenditure for transport in a household budget is limited; for instance, about 50% of Group C, of which monthly income is less than Rs. 40,000, spend less than Rs. 4,000 per month.

(5) Lack of Transport Facilities for the Physically Handicapped

At present barrier free facilities such as elevators and escalators are not yet provided at railway stations and bus terminals. Thus it is not convenient for physically handicapped people to use public transport. It is required to provide such facilities to support them to travel as normal people in the city.

(6) Environmental Friendly Transport System

The result of ambient air quality monitoring for PM10 conducted at Colombo Fort Station from 2006 to 2009 shows that PM10 occasionally exceeded the national air quality standard (100ug/m3). The exceedance was observed mainly during the period from November to February.

In Sri Lanka, the transport sector contributed more than 50% of the CO_2 emissions in 2010. Road transport contributes 94 percent of CO_2 emissions produced by the transport sector. Since it is expected that CO_2 emissions will grow in accordance with the increase in vehicle ownership, the environmental policy for the promotion of lower emission vehicles such as electric cars and hybrid cars should be supported to control CO_2 emissions. At the same time, the promotion of public transport should also be taken into account for reduction of CO_2 emissions.

(7) Transport System to Promote Health

Transport facilities for walking and bicycles have not had attention paid to it for a long time. Walking and bicycling has become popular since these modes are environmentally friendly and good for health. Walking is the most basic means for travel; therefore, the walking environment should be improved and developed in the future. Development of a pedestrian network separated from car traffic is good from the viewpoint of safety and good health overall.

Furthermore, improvement in the walking environment would support the promotion of public transport use since when people use buses and the railways, they usually access the railway station and bus stops on foot.

(8) Problems regarding Traffic Safety

The number of traffic accidents has been increasing from 2009 to present in the Western Province. Fatalities involved in traffic accidents are pedestrian (43%) and motorcycles/mopeds (29%). About 75% of pedestrian fatalities are in the age group over 40 years old. Special attention should be paid for protection of older people from a traffic safety point of view. About 70% of traffic accidents occurred at road sections between intersections. This implies a lack of sidewalks on arterial roads. This suggests the necessity of developing more sidewalks and pedestrian facilities to protect people from traffic accidents. Regarding the causes of traffic accidents 80% are from human factors such as aggressive/negligent driving and speeding. To reduce this kind of dangerous driving practices, driving education might be effective.