KANDY CITY TRANSPORT STUDY

DRAFT FINAL REPORT

University of Moratuwa
in association with University of Peradeniya
Sri Lanka

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1 Introduction

1.1 Background

With regard to the Road Development Authority (RDA)'s intent for solving the traffic problem within the Kandy City area, the Department of Transport and Logistics Management of the University of Moratuwa was invited to investigate and make recommendations. As requested by the RDA, the Department of Transport and Logistics Management of the University of Moratuwa proposed to undertake the study in association with the University of Peradeniya. Thus the project inception was on 24th November 2010 and the Inception Report had been submitted on 8th March 2011. As per the Terms of Reference, the aforesaid Inception Report was submitted by the University of Moratuwa in association with the University of Peradeniya.

With its unique topography and features, Kandy is a city where there are many constraints for any expansion of its transport infrastructure. As this project clings complex tasks including land use re-planning, public transport re-planning, transport and traffic studies as well as highway planning, early meetings were held with key stakeholders representing the Kandy Municipal Council, Police, Provincial Authorities, Urban Development Authority and other key stakeholders for consultation. It was evident from those discussions that an integrated solution that includes urban development, public transport including railways and buses, school transport, traffic circulation and management have to be considered.

In this context the intended study will focus on many diverse matters including Kandy City's land use, travel and traffic generations and attractions, inter modal interchanges, public transport terminals, bus routing, parking areas, traffic circulation systems, intersections, crossings and other infrastructure facilities for investigating solutions with respect to the Kandy City's traffic problem.

The study will also assess the adequacy and efficiency of existing transport services in terms of public and para-transit as well as requirements of the goods movements with a view of recommending improvements in terms of technology and operation. Moreover the study will cover all modes of passenger transport including non-motorised travel as well as goods transport.

1.2 Scope of Work

The Terms of Reference for the Study includes the following work components:

A. Transport Infrastructure Mapping and Inventory
B. Land Use Study and identification of transport requirements
C. Identification of Transport Supply parameters
D. Transport and Traffic Demand and Operations Survey
    (a) Origin- Destination Survey
        i. City Centre
        ii. City Boundary
    (b) Origin- Destination Survey

i. City Centre
ii. City Boundary

(c) Manual Classified Counts

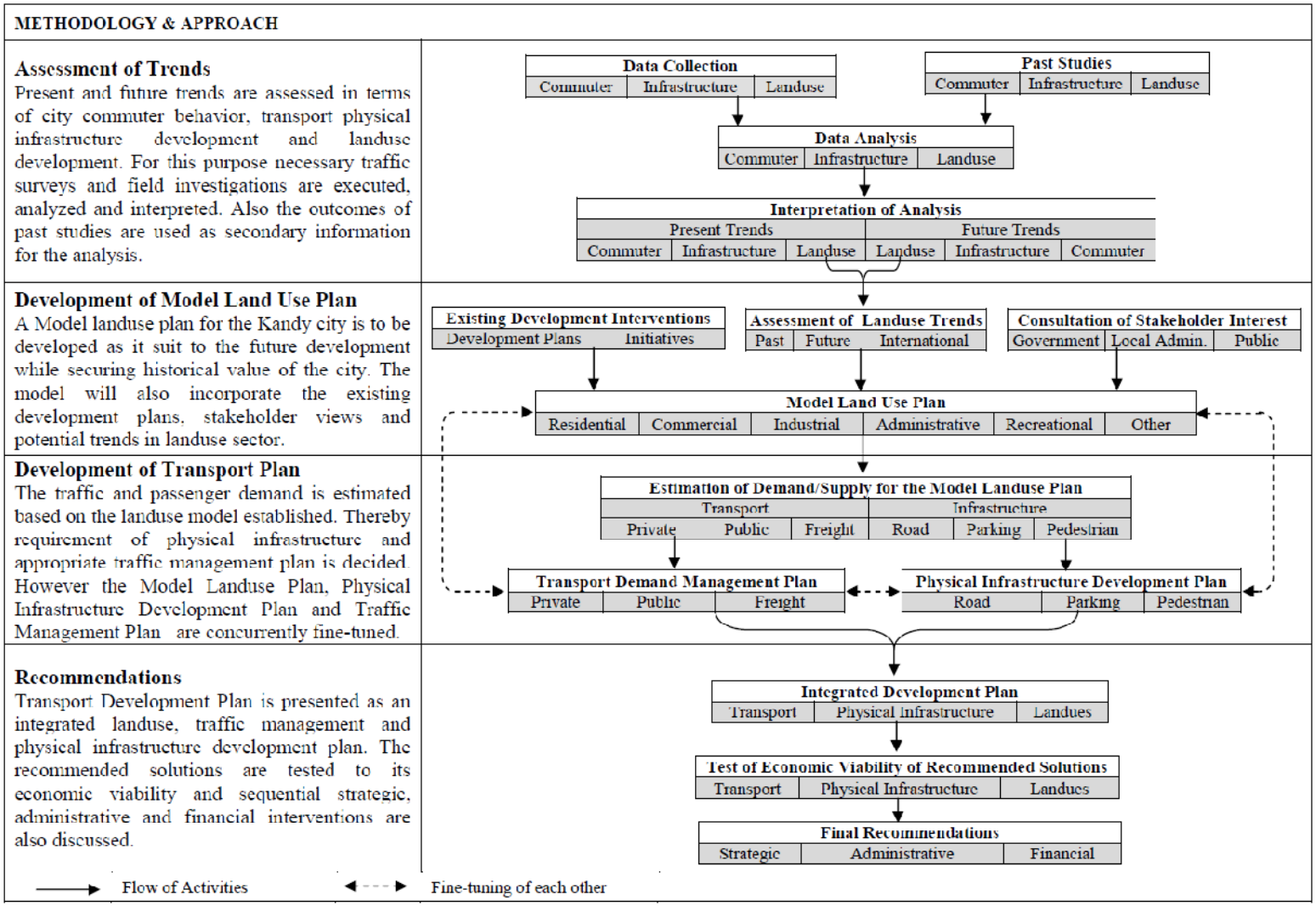
iii. City Centre
iv. City Boundary

(d) Pedestrian Survey
(e) Schools Traffic Survey
(f) Parking Survey
(g) Public Transport Survey
(h) Goods Vehicle Survey
(i) Trip Attraction and Generation Survey
(j) Travel Time and Journey Time Survey
(k) Accident Survey
(l) Tourist Traffic and its variations

E. Transport and Traffic Data Analysis
F. Identification and Assessment of Future Development Plans
G. Forecasting of Future Transport Demands
H. Identification of Improvements to Transport Supply Side
   (a) New Roads
   (b) New Public Transport Terminals
   (c) Parking Facilities
   (d) Traffic Circulation Improvements
   (e) New Public Transport Services
   (f) New Transport Technology
   (g) Land Use Planning & Regulation
   (h) Traffic Regulations
I. Assessment of Measures to Manage Transport Demand
   (a) Shifting of travel to more space efficient modes
   (b) Demand Spreading
   (c) Congestion Pricing
   (e) Parking Management
   (f) Pedestrian Management
   (g) Management of Tourism Related Traffic and its variations
J. Relocation of Activities
K. Calculation of Costs and Benefits for 20 Selected Interventions including use of TransPlan demand estimation software for traffic flow calculation, congestion costing and estimation of Benefit Cost Analysis and Multi Criteria Analysis of options.
L. Conclusions and Recommendations

This Final Report includes all aspects of the above ToR except for special consideration of tourist traffic which was beyond the scope of this study as the composition of tourists in the general transport system was minimal. However considerations of tourists' requirements have been considered under several areas. This report is also accompanied by a video setting out the key components of this study and its findings produced under this study as an addendum to the ToR.

1.3 Methodology



1.4 Work Plan

The project progress has been deviated by two months against the original work plan given below. The project started with traffic surveys in early November 2010 as originally scheduled but the persistent rain that prevailed in Kandy held off the completion of field work for over six weeks.

No	Activity	Nov 2010	Dec 2010	Jan 2011	Feb 2011	Mar 2011	Apr 2011	May 2011
1	Stakeholder Discussions/ Preliminaries/Inception Report							
2	Map Studies							
3	Surveys							
4	Data Analysis							
5	Interim Report/Stakeholder Meeting							
6	Appraisals							
7	Draft Final Report							
8	Final Report							

Moreover with the agreement of the RDA, a Saturday traffic survey and the production of a Video as a study output had also been added to the study. The revised Work Plan is given below.

No	Activity	Nov 2010 to April 2011	May 2011	June 2011	July 2011
1	Stakeholder Discussions/ Preliminaries/Inception Report				
2	Map Studies				
3	Surveys				
4	Data Analysis				
5	Interim Report/Stakeholder Meeting				
6	Video Production				
7	Appraisals				
8	Draft Final Report				
9	Final Report				

1.5 Study Team

The names of the members of the Study Team that undertook this project are as follows:

Team Leader/Principal Consultant	Prof. Amal S. Kumarage
Transport Planner/Economist	Prof. Amal S. Kumarage Eng. Janaka Weerawardana Dr IMS Sathyaprasad
Traffic Surveys	Dr. IMS Sathyaprasad Eng. Janaka Weerawardana
Urban Planner	Prof. Harsha Munasinghe
Infrastructure Planners	Dr.Tissa U Liyanage Eng. SN Bentotage Eng. SB Wijekoon
Road Safety Specialist	Dr.Jayalath Edirisinghe
Project Manager	Eng. Ranil Shanaka Sugathadasa
Video Production	Dananjaya Suriyaarachchi Asiri Senasinghe Nishantha Kahawita

2 Study Area

2.1 Kandy City Profile

Kandy city is located at N7 17 37 E80 38 25 at an elevation of 500 m above mean sea level and 116 km from Colombo, Sri Lanka's the commercial capital. The city is located on a mountainous terrain surrounded by the Mahaweli River by 3 sides and the other side by the Hantane range of hills all of which creates natural transport barriers to reach the city from outside.

It was King Wimaladharmasuriya (1591-1604) who built a safe capital city in Kandy by taking into account those geographical constraints in 1592 to protect the Kingdom from the European powers that encroached the coastal areas at that time. In the year 1603, he also built the Temple of Tooth at the centre of the city which is recognized as a most venerable place of worship for Buddhists even at present. However the city after many years of resistance was fallen to the British in 1815 and after which it had been functioning mostly as an administrative centre for the upcountry especially to support the plantation industry in the surrounding areas. At present Kandy is the capital of the Central Province and has well developed commercial and service industry considered second only to Colombo and is also a national transport node. The city was declared as one of the 704 cultural heritage sites in the world by the UNESCO in 1988 and is thus a popular destination for both foreign and local tourists. Map 2-1 in Volume II shows the Kandy city and its environ.

2.2 Study Area

In order to address the transport issues in Kandy city, it is necessary to define a study area to include the areas affected by prevailing transport problem and/or where possible solutions for such problems could be implemented. Due to increasing business activities and transport constraints such as access and parking, the Central Business District (CBD) of Kandy located at the core of its municipal area is continuously expanding its size by the migration of activities that were once confined to the CBD to the surrounding areas. Even at present several commercial, administrative, educational, cultural activities have relocated to other parts of the municipal area especially along the major roads. Typical urban sprawl is taking place with residential areas being pushed towards the periphery which increases the demand for commuting and consequently the demand for new roads and improved transport systems to access Kandy City.

The inability to provide the required supply of road space as required by the activities brought on by the urban sprawl has made the major access roads to the city congested during peak hours. It has also led to diversion of traffic trying to avoid such congestion to roads in residential areas thus lowering quality of residential life especially in terms of noise, and dust pollution as well as deterioration in air quality. Issues of safety and availability of parking and heavy traffic levels are observable throughout the municipal area. Such evidence indicates that the problem of transport deficiency in Kandy city has spread over the whole municipal area and hence the entire area has to be investigated and addressed in developing a sustainable solution. Thus the study considers the Kandy Municipal Area which extends from Peradeniya to Katugastota and also to Thennekumbura and Hantane. However in order to limit the intended study to an area that has a functional identity, the areas occupied by the University of Peradeniya as well as the Botanical Gardens have been excluded and the southern boundary of the

study area has been established at Gatembe junction. Thus all of Peradeniya is excluded from the study area. Similarly at Katugastota also, the boundary has been demarkated along the river and does not include any part on the left bank of the river. At Thennekumbura also the boundary has been established at the Thennekumbura Bridge. As such the study area for the project closely follows the Kandy Municipal Council but excludes the Peradeniya area and the Botanical Garden and the University of Peradeniya.

Based on the orientation of the road network and the land use formations within the city, the study area is further defined as falling within two rings. The inner ring is the Central Business District (CBD) and the outer ring is considered the Study Area (SA). The CBD is separately identified as it includes several traffic attractors and generators including a number of popular schools, General Hospital, Sacred Temple of the Tooth Relic, Commercial and Administrative services. Map 2-2 in Volume II shows the CBD and SA of Kandy City.

Additionally an extended study area has been considered encircling the city centre up to 16-20 km radius for the purpose of developing a network of outer bypass roads and alternative satellite cities for the Kandy city. Therefore the influence of solutions proposed for mitigating transport problems in the SA is spread up to the Extended Study Area (ESA) shown in Map 2-3 of Volume II.

2.3 Demography & Economy

The Study Area falls within the area of the Four Gravets Divisional Secretariat. However it excludes the areas such as Peradeniya, Navayalatenna, Eriyagama, Hindagala, Mahakanda and Gurudeniya. The population estimated for the Study Area is 130,000 adjusted from the population of 149,680 for Four Gravets DSD as per census of 2001.

The Kandy Four Gravets DSD records the highest population density in the Central Province with an estimated 2,537 persons per sq. km. and it becomes six times the provincial density of 422 persons per sq. km. and eight times the nation-wide density of 307 sq. km. Its racial composition is made up of 70.5% Sri Lankan Moors, 13.9% Sri Lankan Tamils 8.6%, Indian Tamil 4.8% and 2.3% others. Its religious profile is made up as 73.3% Buddhist, 10.5% Hindu, 13.6% Muslim and 2.6% Catholic /Christian

The City of Kandy leads the economic activity of the Central Province which is around 9.6% of the national GDP and had recorded a per capita income of Rs 175,000 in 2009. It however has recorded a lower GDP growth rate of 8.1% compared to the national average of 9.4% in 2009. As per the Household Income and Expenditure Survey 2006/07, the Poverty Head Count Index for the province is around 22.3%, exceeding the national average of 15.2%.

2.4 Urban Profile of the City of Kandy

The World Heritage City of Kandy is a unique testimony to a particular evolution of urban life. This last seat of the Sinhalese dynasty marks a turning point in Sri Lanka's town planning with a well-demarcated city plan, a distinctive composition of diverse activities in a dense urban landscape, and a built fabric of unique architectural character. Its center is dominated by the Royal palace that also accommodates the Sacred Temple of Tooth Relic, an extensive man-made water body, grid-iron street

layout, and pre-colonial and colonial architecture, composing the unique identity. The Study Area for this study falls within the Kandy Urban Development Area (KUDA), declared by the Urban Development Authority (UDA Law No 41 of 1978 Gazette Extraordinary No 26/8). KUDA, a dense and diversified urban center, has been administered as a municipality since 1939.

KUDA can be approached from four directions via seven roads and expands over an area of 26.45 sq. km. The city center, at 400-650 MSL, is an elevated basin surrounded by hills. The main reason for shifting the Seat of the King and the Tooth Relic to Kandy was the protection provided by the hills and water bodies. The city evolved in to a major service and commercial center during the colonial occupation from 1815-1945 and the post-colonial era saw the addition of administrative, leisure and secular functions to the city. Having evolved for the last 600 years, Kandy is a major cultural, commercial, administrative, and transport center, and one of the most revered cities in the world. Kandy's major challenge is sustaining the heritage values and living society, and its particular diversity and density. Kandy is a major center for tourism with several star class hotels, smaller hotels and many other lodging facilities. Enlisting of Kandy on the UNESCO World Heritage List did enhance tourist arrivals.

Arbitrarily evolved land use/ activity pattern has turned the city into becoming unlivable and inaccessible. KUDA is inhabited by a little under two hundred thousand population, and attracts over three hundred thousand day visitors. The change of uses in historic buildings and urban quarters has been resulted by the demands of the visitors rather than the residents. Traffic congestion, air pollution, restricted accessibility, and social exclusion are among the indicators of degrading livability of the city. The uncontrolled land use is a major cause for the deteriorated livability of KUDA, an instructive case to examine the possibility of adopting sustainable urban development in terms of accessibility.

Figure 2-1: Uncontrolled Land Use on Colombo Street

The Sacred Area, designated by the Gazette Extraordinary No 301 (1984), is the best-preserved urban space in the city. It is reserved for the functions of the Temple Tooth Relic. This well-conserved central part of the city is accessible to the public and appears to have regained its splendor after the Central Cultural Fund removed all incompatible activities to other locations. The social inclusion of this space is such that the Sacred Temple of Tooth Relic means Kandy for many. The tourists who visit Kandy would plan the temple as their major destination, and most of the development decisions are derived from the disposition of the temple too. Development planning protects and conserves the temple square as the core urban space of the city. By treating the other urban quarters as those

reinforcing the existence of the distinctive urban order, in which the top spot is reserved for the Temple square. The historic built forms that surround the temple square signify the importance of the sacred temple through their architecture and designated activities.

Figure 2-2: Manor Houses in Kandy in 1815[1]

The next most important area in the urban order is the historic quarter with the grid-iron street layout. This witnesses to pre-colonial, colonial and post-colonial urban development, and was originally dedicated to the officials of the Royal Court and to perform their duties to the Royal Court. A map drawn in 1815 shows the location of 18 Manor houses that existed in this quarter (Figure 2-2). The colonial era added Queen's Hotel and a few other administrative buildings to this urban quarter, strengthening its image as the most significant living/ working space. Among the features of the inner city are architectural forms that abut the street, the plot division pattern, and the street layout. The residential function of the urban quarter has completely deteriorated today, and residences have been readopted for diverse commercial activities such as banks, financial institutions, departmental stores, etc. Many residences have been replaced too. The street layout is preserved along with several

[1] (Source: *World Heritage City of Kandy,* Colombo: Central Cultural Fund, 1999, p.7 cited in *Study on Kandy Traffic* Final Report prepared by The Asia Foundation & Global Vision Centre for Knowledge Advancement, Kandy 2008.

architectural edifices, but the plot division pattern is mostly distorted due to the transformation of a new activity pattern.

The urban quarter dominated by infrastructure facilities and the service sector, accommodates the Railway Station, Bus Stations, a multi-level car park, and commercial activities such as banks, hotels, financial establishments, restaurants, etc. The particular land use has turned this quarter into the service segment of the city that also provides the link to suburbs and other cities. Most of the spaces in this quarter attract diverse users and some spaces even do function as multi-purpose spaces. This quarter is accessed by almost all the visitors to the city and thus remains the busiest. Furthermore, this quarter, with the Bus Station and Railway Station, is more likely the generator of traffic and a transit space. The most significant historic feature of this quarter is the prison complex. This dead and enclosed urban space glimpses of the historicity of the city as well as the need for designing a correct land use for the inner city to become a place of life. This urban quarter with two types of land use; open and closed, does not follow the urban order of diversity and density, and an activity pattern that has not evolved with the evolution of the urban society.

More sedate urban space around the lake is another urban quarter that is occupied by religious and leisure activities. The most striking urban space is the street that runs around the lake. The official residence of the chief incumbent of the Malwatta chapter and several religious buildings and hotels demand this street to be a calmer and quiet space. But today it is heavily used by vehicles. The functions along the street do not attract traffic but the improper traffic planning, forcing vehicles to pass through, seems to have cost the tranquility of the urban quarter.

Rest of the city is filled with diverse types of functions that have evolved with the transformation of city life. Administrative facilities such as Kandy Municipal Council, Central Province Council Office, Government Agent's Office, amenities such as schools, hospitals, health care facilities and infrastructure facilities within KUDA show more of improper-management of space utilization than creating of an urban diversity (Munasinghe, H. 'Development of Kandy as a Cultural Diversity', ***Daily News*** 19 August 2004). The urban quarter that is dominated by the entry road from west is the best example for this complicated nature of land use and activity pattern of KUDA. This quarter is mostly occupied by small and medium scale commercial establishments and amenities such as healthcare and education. There is a less congested urban quarter on the North-west of KUDA. The official residence of the chief incumbent of Asgiriya chapter, temple, schools, and the international cricket stadium dominate this urban quarter. Among the most notable problems in this area in terms of urban landscape is a run-down housing area that is occupied by the blue-collar service community.

2.5 Urban Development Plans for Kandy

Development plan of the Urban Development Authority proposes to develop the city quarters as zones of mixed-development, and detail out the *scale* of functions in terms of floor area. The plan clearly changes the scale of the functions but not the types of functions. This is on one hand a good move to keep the city live but on the other it is possible to foresee the continuity of the mismatch between land use/ activity pattern and the city image. Also, this will not help easing the traffic in the inner city. For example, the current mixed-use in the city quarters, in which one experiences the inappropriate land use that also create most of the traffic problems would continue under the disguise of mixed-use. The scale will only manage their expansion and not the integration of similar functions in the future. The plan does not intervene to replace the inappropriate functions with more fitting ones, in terms of city

image or easing traffic. Compartmentalization of the city as a result of this hinders potential economic growth in Kandy. The plan is not specific in terms of identifying particular dominating functions for each quarter while keeping them as quarters of mixed-land use.

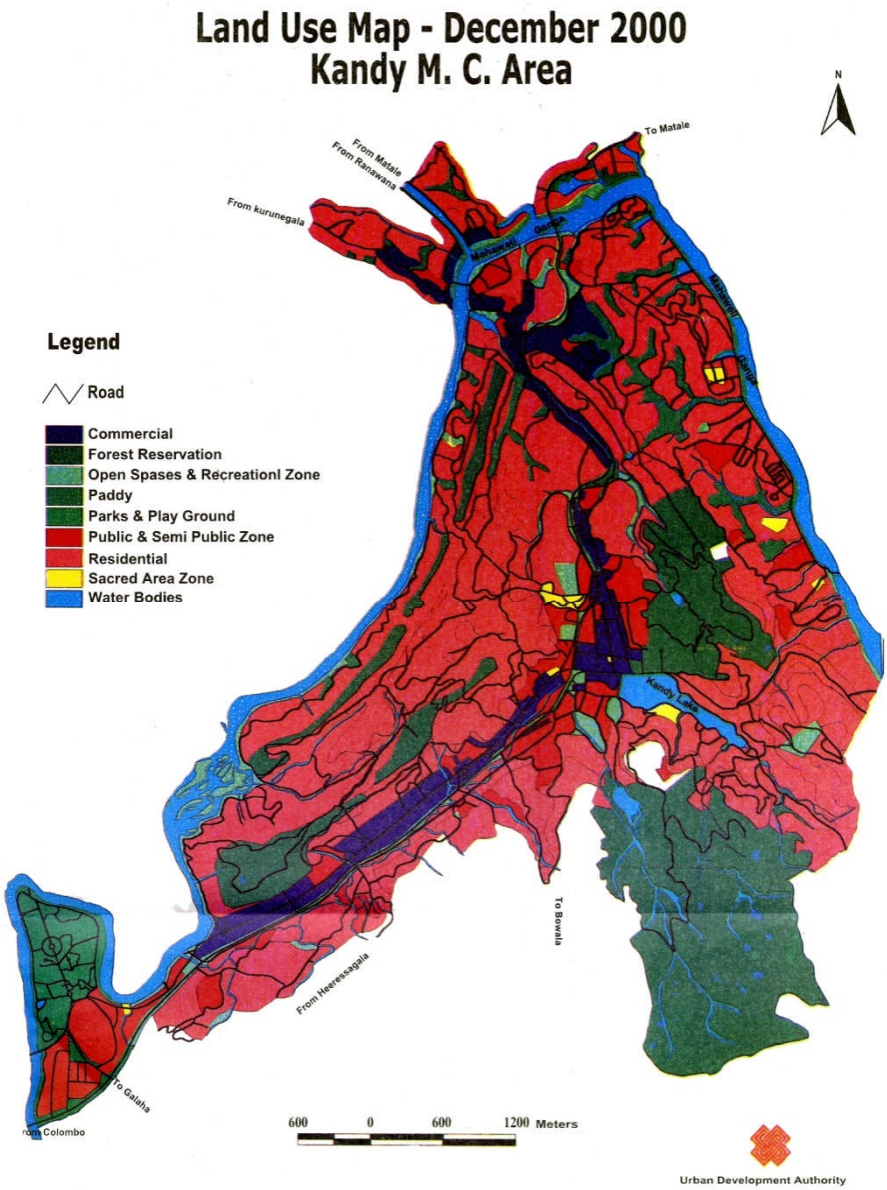


Figure 2-3: Land Use Plan[2] (UDA)

2.6 Transport Networks in Study Area

The Kandy Study Area is served by a number of transport networks. These are discussed as follows:

[2] Source: Kandy development Plan, Urban Development Authority

2.6.1 Road Network

The main road network that provides access to Kandy City consists of the Kandy-Colombo (A01) Road, Kandy-Kurunegala (A10) Road, Kandy - Jaffna (A09) Road, Kandy – Mahiyangana – Padiyatalawa (A26) Road Raja Mawatha (B413) and Peradeniya - Badulla-Chenkalady (A05) Road. Of these, three roads, A01, A09, and A26, provide direct connections to the CBD and carry large volumes of traffic to the SA as well as to the CBD. The A05 Road also serves both the SA and the Kandy City by merging with the A01 at Peradeniya. The CBD is served by these main roads in a radial manner as shown in Volume II Map 2-4. Due to the geographical constraints imposed by the Mahaweli River and the Hantane mountain range, there are no circular or orbital road links between the radial roads with adequate capacity and flow speed that can be served as popular by passes in the SA or the CBD.

There are several important nodes in the national road network in the periphery of the SA namely the Gatembe Junction (duplicate for A1/A5) at the southern most point, Katugastota (A9/A10) at the northern-most point, and Thennekumbura (B26/B413) at the eastern-most point. The road distance between the above nodes when travelling through the city center is shown in Table 2-1. The distance between these nodes averages around 9 km. This section is a part of the national road network and indeed an important node in the national network. Thus a significant proportion of traffic passes through the Study Area given that these important nodes in the national network are found within the SA.

Table 2-1: Distance through City Centre between Nodes (km)

End Node	Gatembe	Katugastota	Thennekumbura
Gatembe	-	8.9	9.3
Katugastota	8.9	-	8.9
Thennekumbura	9.3	8.9	-

The currently established alternative routes available for travel between the above three nodes without travelling through the CBD are shown in Table 2-2.

Table 2-2: Alternative By-pass Routes between Main Nodes

Node Connections	Attentive Routes
Gatembe - Katugastota	Guhagoda Road (7.2 km), a substandard 2-lane, Asphalt Concrete surfaced road in good condition.
Katugastota - Boowelikada	Dharmasoka Mawatha, via Nittawela of intermediate lane width in good condition.
	Dutugemunu Mawatha/ Mawilmada Road of single lane width needs substantial improvements.
Boowelikada - Gatembe	No attractive routes available due to the adverse terrain and geography.

There are four major crossings of the Mahaweli River at Peradeniya, Gatembe, Katugastota and Thennekumbura. Furthermore, there are two minor river crossings at Polgolla and Lewella. The total number of lanes for crossing of the Mahaweli River in Kandy Study Area over these six bridges is 12.

There are around 80 km of municipal roads within the Study Area, and most of them are sinle lane roads. There are four major railway level crossings in the study area, at Gatembe, Heerassagala junction; SWRD Bandaranayake Mawatha and at Mahaiyawa.

2.6.2 Rail Network

The Main line was extended to Kandy in 1867 and the Matale Line was established in 1880. These lines were built and initially used to transport coffee and tea from the plantations of the hill country. Throughout the elapsed 144 years, no significant infrastructure improvement has taken place in the rail services to Kandy. The two lines, the Main Line approaching the city from the southwest and the Matale line from the north, continue to operate although the freight load carried by rail has gradually declined following the nation-wide trend. As of now, these lines are mainly providing passenger rail access to Kandy city, both for intercity travel as well for urban commuters. The railway is well positioned to cater for Kandy urban commuters as it connects many of the suburban centres such as Peradeniya, Kadugannawa, Gampola, Katugastota, Watthegama and Matale as shown in Table 2-3. The speed of the main line averages just under 30 km/hr while the Matale line manages a speed around 20 km/hr.

Table 2-3: Rail Accessibility to Kandy from Major Nodes in the Urban Catchment

From Station	Distance (km)	Travel Time (min)	No of Stations/ Sub Stations/ Halts	3rd Class Fare (Rs.)	No. of Trains (Per day)	No. of Trains (During Morning Peak)
Kadugannawa	15.2	36	4/ 1/ 4	15.00	7	1
Gampola	18.0	40	3/ 1/ 8	20.00	6	2
Peradeniya	5.9	12	2/ 1/ 3	10.00	15	3
Matale	27.0	83	5/ 6/ 9	25.00	6	2

2.6.2.1 Stations

Kandy railway station is located next to the main bus station at Goods Shed road making it highly favourable for rail-bus integration, even though this is not happening. There are in addition to the Kandy Railway Station four halts and one substation, located within the study area.

Peradeniya → Sarasavi Uyana → Rajawatta→ Randles Halt→ Suduhumpola→ KANDY→ Asgiriya Halt→, Mahaiyawa → Mawilmada → Katugastota

Another substation, a halt and two other stations are located immediately outside the study area. Total length of railway from Peradeniya to Katugastota is approximately 11 km making the average station spacing around 1.2 km which makes it suitable for a commuter service. The rail track, from Gatembe to Katugastota through Kandy, closely follows several major trip attractors such as popular schools, commercial and employment centres.

Owing to the local traffic congestions and increased travel times on the national roads, long-distance rail transport from Kandy has shown some promise in the recent past, especially with the introduction of intercity train services to Colombo. The average travel times of 160 minutes for intercity trains and 190 minutes for normal trains are still very attractive compared to travel times of buses, which can vary between 180 minutes for intercity luxury buses and 210 minutes for normal buses. However, the modal share carried by rail services is much less when compared to road-based transport.

There are around 20 train movements per day summarised as follows.

- Kandy to Matale – 6 Nos. (one from Colombo Fort and one from Peradeniya)
- Kandy to Polgahawela – 3 Nos.
- Kandy to Badulla - 1 Nos.
- Kandy to Colombo Fort – 4 Nos. (including 1 Matale train).
- Kandy to Galle – 1 Nos.
- Kandy (from Matale) to Peradeniya – 2 Nos.
- Kandy to Nawalapitiya – 2 Nos.
- Kandy to Rambukkana – 1 Nos.
- Kandy (from Fort) to Hatton – 1 Nos.

Map 2-5 of Volume II shows railway network and all stations in Study Area including sub stations and halts.

2.6.3 Bus Transport

Both intra-provincial and inter-provincial bus services serve the City of Kandy making it a national and regional hub for public transport. As reported by the Central Province Road Passenger Transport Authority, there are 152 intra-provincial routes (bound to 124 destinations) with 1,103 private buses and 64 inter-provincial routes (bound to 45 destinations) with 776 private buses. Additionally there are Sri Lanka Transport Board owned buses plying through the same routes. Of all these services entering the SA, only 15 inter-provincial services with 110 buses run through the CBD. All the other services including Sri Lanka Transport Board buses terminate in Kandy town. It is especially noted that none of the local or provincial services run through the CBD. A detailed list of such services by origin and destination and number of permits for private buses issued for each service is given in Appendix 2-1.

2.6.3.1 Terminals

Public passenger buses terminate at 3 major terminals located at Good shed, Clock Tower Junction and Torrington with an approximate parking of around 400 buses at a given time. All inter-provincial buses start at Good Shed bus terminal except air-conditioned services to Colombo which starts at a location close to the Clock Tower junction. The Good shed bus stand is the starting point for most of the provincial services serving towns within Kandy district as well as towns in Matale and Nuwara Eliya districts. The other bus stand at Torrington is allocated for short distance services circulating within the Study Area or extending just outside. The bus stand at Clock Tower junction is the second biggest and is generally allocated for the routes serving provincial centres in the Kandy district. Furthermore, it is the starting point for several local services such as to Heerassagala, Bowalawatta, Anniwatta and Polgolla etc. and also a passenger boarding point for the buses bound to northern and eastern routes from Good shed bus stand. The distribution of the operational private bus fleet at three terminals by destination is summarised in Table 2-4.

Table 2-4: Destinations served by Private Bus Services Operating at Each Terminal

Bus Stand	Number of Destinations served	
	Intra- Provincial	Inter-Provincial
Good shed	62	42
Clock Tower	33	1 (AC-Colombo)
Torrington	12	None

Generally all three bus stands in Kandy dispatch around 4,800 buses per day with an average occupancy rate of 42 passengers per bus at both the SA and CBD cordons. Depending on the city entry/exit corridor and dedicated bus stand all bus services fit into prominent 9 different major circuits.

2.7 Major Traffic Attractors

The major attractors can be categorised under six types; Public Offices, Commercial Institutions (public and private), Social and Recreational Institutions, Hospitals and Health Institutions, Transport Terminals and Parking, and Schools and Educational Institutions. The major public offices include the Divisional Secretariat, Kandy Municipal Council, and institutions such as the Department of Education, Ceylon Electricity Board, National Water Supply and Drainage Board, General Post Office etc.

The major traffic attractors in the CBD are summarised below.

- Schools — 23 Schools (Major)
- Bus Terminals — Good Shed, Clock Tower, Torrington
- Hospitals — Kandy General Hospital
- Railway Stations — Kandy
- Administrative Buildings — Kachcheri, UDA, RDA, Telecom, CEB, many other buildings
- Commercial Complexes — Kandy City Centre
- Cultural/Religious — Temple of Tooth, Archaeological Sites
- Sports Facilities — Asgiriya, Bogambara Grounds

2.8 Vehicle Ownership

The annual vehicle licensing data for each of the DS Divisions in the Kandy District for the year 2006 are given in Table 2-5. This shows that the Four Gravets DSD has the highest number of vehicles in the district exceeding 20,000 of which nearly half are cars and vans.

Table 2-5: Annual Vehicle Licensing for Kandy District, 2006

District Secretariat	Car	Motor Bike	Three Wheeler	Bus	Dual Purpose	Lorry	Land Vehicle	Total
Patha Hewaheta	116	803	776	94	341	381	12	2523
Udapalatha	676	1458	1257	204	718	822	65	5200
Ganga Ihala Korale	152	748	600	94	229	297	11	2131
Pasbage Korale	138	435	549	20	321	301	7	1771
Medadumbara	140	581	444	73	218	281	28	1765
Ududumbara	20	248	177	28	47	114	17	651
Galagedera	150	906	384	83	257	247	34	2061
Pujapitiya	267	1317	676	87	446	399		3192
Akurana	401	1305	583	69	714	604	14	3690
Patha Dumbara	707	1576	1109	57	812	731	39	5031
Panwila	30	235	175	20	78	77	9	624
Harispattuwa	915	2229	1119	66	711	791	63	5894
Yatinuwara	1137	2432	1542	190	873	1050	95	7319
Mahanuwara Four Gravets	**6247**	**4930**	**3086**	**543**	**3403**	**2067**	**224**	**20500**
Kundasale	1181	3601	2025	417	1311	1469	476	10480
Udunuwara	731	1890	1476	90	732	890	31	5840
Minipe	54	1104	314	30	125	236	275	2138
Doluwa	92	557	483	14	162	198	17	1523
Delthota	22	178	220	23	137	193	1	774
Hatharaliyadda	69	704	591	12	89	134	24	1623

2.9 Previous Transport Studies in Study Area

The prevailing traffic problem in the Kandy city has led to many studies carried out by the Road Development Authority, Urban Development Authority and University of Peradeniya. However publications were available on the research carried out by Jayatilake (2003) and The Asia Foundation and a Non-Governmental Organisation, Global Vision (2008).

Jayatilake (2003) measured, 33,260 vehicles (12 hour count) entering the Kandy city. Nearly 50% of them were found to be cars and vans. Two thirds of this volume was found to enter the city from outskirts. Remarkably, around 15~20% of them were heading beyond the CBD to other destinations.

The 16 hour vehicle count carried out in July 2007, as presented in Global Vision Report (2008), was found to be 46,651 (16 hour count). The split of vehicle types of this survey in the in-bound direction is shown below.

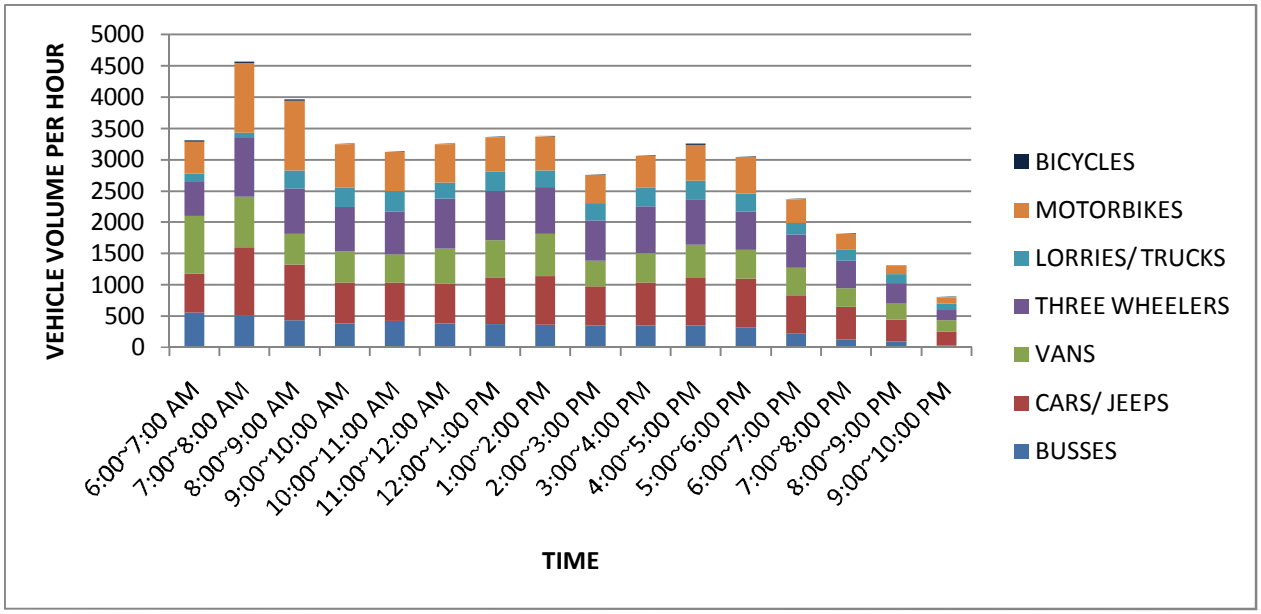


Figure 2-4: In-Bound Traffic to Kandy by Time Slot and Vehicle Type[3]

As Jayatilake (2003) found, that around 250,000 enter to the city limits daily and that nearly 168,000 (67%) of them were bus commuters while 81,000 were using private vehicles. Thus the day-time population on any given day exceeds 350,000. The Global Vision (2008) states that of all types of vehicles found within the city in any daytime, only 10% are buses. But those buses are important as they carry 67% of the commuters to the city.

The Global Vision study has identified several locations of traffic problems especially on A9 up to Katugastota and within the CBD especially near bus terminals but it has not ventured to provide any demand management measures recommending only capacity improvement methods. Jayatilake (2003) makes reference to the poor supply of rail infrastructure. The suggested improvements for railways include improvements of the existing lines as well as a new line connecting Pallekele. The other recommendations include

- Widening of A9 Katugastota Road to 4 lanes
- Improvements of by-pass roads, such as Wattarantenna, Mapananawathura and Asgiriya.
- Use of Dharmasoka Mawatha and Rajaphilla Mawatha for diversion
- Use of William Gopallawa Mawatha for diversion.

Of these, widening of A9 is an approved project, while the increased use of Dharmasoka Mawatha and William Gopallawa Mawatha has occurred.

As reported by Global Vision (2007), the hourly demand for parking of vehicles within the CBD on a working day varies from 1,000 to 3,250 vehicles for a given working day. However the survey date seems to be during the school holidays and therefore the demand could be much higher during a school day. Despite the considerable number of parking spaces (862) available in the Municipal Central Car Park, the maximum utilisation was reported as 323. The parking related problems are reported as:

[3] Source: Global Vision Report, 2008

- Under utilisation of the KMC car park and excess demand for on-street parking
- Haphazard parking of school vans causing congestion and inconvenience to residents in school neighbourhoods
- Unregulated three wheeler parking
- Congestion in the city bus stations
- Inadequate parking at public and private institutions (hospitals, channelling centres, schools, secretariats, post office, police station etc.)

Over the years Kandy city centre has been recognised as an area pressed with parking needs. This is due to the limited city area and the fact that Kandy city and surrounding areas have regularly had high vehicle ownership rates.[4] Chronic congestion in city streets, mainly due to the roadside parking, prompted Kandy Municipal Council to go ahead with the multi-storied parking facility in the city centre in 2002. On-street parking supply in the Kandy CBD was estimated at 825 vehicles in the CBD area, on 55 road links. In addition, there have been a number of off-street parks, operated by commercial establishments, mainly to cover their own parking requirements and sometimes for customer parking as well. Parking provision at these parks within the CBD totalled 1,740 spaces. There are few off-street parks that provide a total of 960 public parking spaces, operated by KMC and private entities. Of these, 850 are provided at the Kandy city multi-storied car park. The total parking supply within Kandy CBD is estimated at 3,225 spaces.

[4] Feasibility Report of the Kandy Multi-Storied Car Park, DCL (2001)

3 Data Collection

3.1 Field Visits & Discussions

The first field visit to Kandy for problem identification was made on 7th September 2010 which was attended by Ms. Namalie Siyambalapitiya, Deputy Director and a number of RDA engineers from Kandy. The study team was represented by Prof. Amal S. Kumarage, Dr. I. M. S. Sathyaprasad, Mr. S. B. Wijekoon, Dr. Jayalath Edirisinghe, Mr. S. N. Bentotage, Mr. Ranil Sugathadasa, A number of core issues that needed attention were identified during the meetings with stakeholders that included the Kandy Municipal Council, Police, UDA and RDA Provincial Office.

The second field visit for problem identification was made on 25th February 2011 which was attended by Mr G. Bandara, Director Planning, Ms. Namalie Siyambalapitiya, Deputy Director and Mr. Dimuthu Fernando of the RDA. The study team was represented by Prof. Amal S. Kumarage, Dr. I. M. S. Sathyaprasad, Mr. Ranil Sugathadasa, Dr. Tissa Liyanage and Mr. Janaka Weerawardana. Whilst a number of core issues that needed attention were identified, it was also decided to conduct a limited survey on a Saturday as it transpired that Saturday's have a remarkable congestion pattern. It was also decided to amend the Terms of Reference to undertake the production of a video for public awareness as a project of this nature needs public support and many issues are difficult to communicate in printed media or at meetings.

The third field visit was carried out on 24th and 25th April 2011 where detailed observations on identified problems had been completed. Meetings were also held with the RDA Provincial Director and other senior officials, Director of UDA, Engineers of the Sri Lanka Railways. An inspection of the railway around Kandy City area was also completed during this field visit.

Monthly meetings of consultants for reviewing progress and brainstorming had been conducted throughout the study period switching between Peradeniya and Moratuwa University premises. Representatives of the client were also invited for those gatherings in addition to the consultants of the two universities.

3.2 Field Data Collection

With the intention of obtaining the present transport characteristics, transport surveys had been conducted during the month of November 2010. The University of Peradeniya carried out this field data collection conforming to the data collection formats used by the University of Moratuwa. More than 90% of traffic surveys were completed in November 2010 and the balance surveys were conducted during the January/February 2011 as it was necessary to avoid the school vacation during December 2010.

The field surveys included the following survey types and respective field data collection forms are given in Appendix 3-1.

1. Manual Classified Count
2. Roadside Origin Destination Surveys (Passenger Vehicles)
3. Roadside Origin Destination Surveys (Goods Vehicles)
4. Roadside Origin Destination Surveys (School Vans)

5. Manual Classified Turning Movement Counts
6. Bus Passenger Counts
7. Bus & Rail Passenger Interview Survey
8. Pedestrian Interview Survey
9. Trip Generation and Attraction Survey
10. Accident Survey

A second set of selected surveys representing a Saturday were carried out on 7th May 2011.

3.3 Description of Surveys

The traffic surveys were planned on the basis of assigned cordons, areas and corridors/roads. The magnitude and characteristics of the traffic entering the SA was surveyed at the Study Area Cordon while the same parameters for the CBD entries were surveyed at the CBD cordon. The traffic movements and commuter behaviour inside the CBD area were surveyed through several turning movement counts and interview surveys conducted inside the CBD. Traffic surveys were also conducted on three selected by-pass roads namely Dharmasoka Mawatha, Anniwatta Road and Peradeniya-Katugastota (Guhagoda) Road to determine the nature of the traffic moving within the SA but not entering the CBD area.

3.3.1 Study Area Cordon Surveys

Manual Classified Counts, Bus Passenger Counts and Roadside Origin Destination Surveys for the passenger vehicles, goods vehicles and the school vans was carried out at selected locations of SA Cordon on 9 and 10th November 2010 . The Roadside Origin Destination Surveys were carried out for a 13 hour period in the outbound direction starting from 0600 hrs while the Classified Traffic Counts and Bus Passenger Counts were carried out over a 24 hour period in both directions. Seven major entry points at the Study Area Cordon were selected and surveyed within a single day to ensure the consistency of traffic flow measurements. The representative corridors and locations selected for surveys are listed below and also shown in Map 3-1 of Volume II.

- Sirimavo Bandaranayke Mw.(Gatembe Junction)
- William Gopallawa Mawatha (Gatembe Junction)
- Katugastota Road (Katugastota Bridge)
- Polgolla Road (Polgolla Dam)
- Sirimalwatta Road (Lewella Bridge)
- Hewaheta Road (Thennekumbura)
- Ampitiya Road (In front of Devon Hotel)

For all origin-destination surveys, randomly selected vehicles were stopped and interviewed while maintaining a minimum sample size of 5% for each category of vehicle. The number of vehicles interviewed under each category is tabulated in Table 3-1 on a corridor basis.

Table 3-1: Interview for Origin Destination at Study Area Cordon

Access Corridor	Sample Size of Interviews (Numbers)		
	Passenger Vehicles	Goods Vehicles	School Vans
Sirimavo Bandaranayake Mawatha	242	130	84
William Gopallawa Mawatha	369	204	32
Katugastota Road	287	153	42
Polgolla Road	190	Not done	36
Sirimalwatta Road	212	102	26
Hewaheta Road	158	110	27
Ampitiya Road	152	106	36

Respective survey forms are given in Appendix 3-1 and the detailed schedule of the field surveys is given in Appendix 3-2.

3.3.2 Central Business District Cordon Surveys

Similar surveys were executed at the Study Area Cordon and also repeated for the four major entry corridors to the CBD but limiting to 13 hour period starting from 0600hrs on 11th November 2010. Although William Gopallawa Mawatha is classified as a major road to the CBD, only 13 hour traffic count was done eliminating the OD survey, owing to adequate space at the cordon point to facilitate an O-D survey. For the remaining five minor entry corridors, only the traffic flows have been estimated by using 13 hour Manual Classified Traffic Counts or Turning Movement Counts conducted at the vicinity of the entry point. The representative corridors and locations selected for surveys on the CBD cordon are given below and shown in Map 3-1 of Volume II.

Selected Major Roads:

- DS Senanayaka Mawatha (In front of Vidyartha College)
- Adahana Maluwa Road (In front of Mahaiyawa Cemetery)
- Sri Sangaraja Mawatha. (Mosque Junction)
- Sirimavo Bandaranayake Mawatha(Good shed Junction)
- William Gopallawa Mawatha (Keppetipola Junction)

Selected Minor Roads:

- Sri Pushpadana Mawatha (In front of SLBC)
- George E de Silva Mawatha (In front of Cultural Centre)
- Rajaphilla Mawatha (In front of YMBA)
- Wariyapola Sri Sumangala Mawatha (In front of Police Training College)
- Dr. Nihal Karunaratne Mawatha (Ehelepola junction)

Similar to the study area cordon, a minimum sample size of 5% was maintained for origin-destination surveys of passenger vehicles, goods vehicles and school vans. The number of vehicles interviewed at each location under each category of vehicle is tabulated in Table 3-2.

Table 3-2: Interviews for Origin Destination at CBD Cordon

Access Corridor	Sample Size of Interviews (Numbers)		
	Passenger Vehicles	Goods Vehicles	School Vans
DS Senanayaka Mawatha	450	192	16
Adahana Maluwa Road	440	112	21
Sri Sangaraja Mawatha	340	163	73
Sirimavo Bandaranayake Mawatha	302	102	22

Respective survey forms are given in Appendix 3-1 and the detailed schedule of the field surveys is given in Appendix 3-2.

3.3.3 By-pass Surveys

With the intention of quantifying and investigating the nature of the traffic by-passing the CBD, Manual Classified Traffic Counts and the Roadside Origin Destination Surveys for Passenger Vehicles, Goods Vehicles and School Vans were conducted at the following selected by-pass roads in one direction for 13 hours on 26th November 2010.

- Dharmasoka Mawatha (Aruppola)
- Anniwatta Road (Anniwatta)
- Guhagoda Road (Guhagoda)

For the origin- destination surveys, randomly selected vehicles were interviewed maintaining a minimum sample size of 5% for each vehicle category. The number of vehicles interviewed at each location under each vehicle category is tabulated in Table 3-3.

Table 3-3: Interviews for Origin Destination at By-pass Roads

Bypass Road	Sample Size of Interviews (Numbers)		
	Passenger Vehicles	Goods Vehicles	School Vans
Dharmasoka Mawatha	238	141	20
Anniwatta Road	260	60	14
Guhagoda Road	174	144	20

The Map 3-1 of Volume II shows the locations selected for the above surveys. The respective survey forms are given in Appendix 3-1 and the detailed schedule is given in Appendix 3-2.

3.3.4 Junction Movements and Links Flow within CBD

For the purpose of investigating the internal traffic circulation pattern as well as the traffic at junctions and links, several Turning Movement Surveys were carried out at 14 junctions located within the CBD and another 3 junctions just outside CBD as listed below. All of these Turning Movements Counts (TMC) were done as Manual Classified Traffic Counts over a 13 hour period starting from 0600hrs. Survey was conducted on the 11th, 24th and 26th November 2010 by grouping close-by junctions to a single day. The locations of junctions within CBD are shown in Map 3-2 while the locations of junctions outside CBD are shown in Map 3-1 of Volume II.

- Heerassagala Junction on WGM
- Heerassagala Junction on SBM
- Station Junction
- Bus Stand Junction
- Keppetipola Junction
- Ehelepola Junction
- Police Junction
- Clock Tower Junction
- Raja Veediya -Kotugodalla Veediya Junction
- Queens Hotel Junction
- Mosque Junction
- PTS Junction
- Lake Round Junction
- Good shed Junction
- Municipal Junction
- Ampitiya Road Junction
- Yatinuwara Veediya-Colombo Street Junction

Respective survey forms are given in Appendix 3-1 and the detailed schedule is given in Appendix 3-2.

3.3.5 Pedestrian Surveys

With the intention of investigating pedestrian walkway capacities and the travel pattern of pedestrians, several congested road links within CBD were selected for Pedestrian Counts and Interview Surveys. Such selected road links for the survey are listed below.

- Dalada Veediya (Link between Kotugodalla Veediya & Yatinuwara Veediya)
- DS Senanayaka Veediya (Link between Kumara Veediya & Raja Veediya)
- Colombo Street (Link between Kotugodalla Veediya & DS Senanayaka Veediya)
- Kotugodalla Veediya (Link between Dalada Veediya & Colombo Street)
- Sangaraja Mawatha (Link between Mosque junction & Queens Hotel junction)
- Sirimavo Bandaranayake Mw.(Link between High School junction & Police junction)
- SWRD Bandaranayake Mw.(Link between Bus stand junction & Keppetipola junction)
- William Gopallawa Mw.(Link between General Hospital & Rail station junction)
- Yatinuwara Veediya (Link between Dalada Veediya & Colombo Street)

Passengers walking in both directions along both sidewalks were counted during the period 0700-1800 hrs and some of them interviewed. At the same time, two-way counts of pedestrian road crossings of each road link were also noted. The number of interviews completed at each location is given in Table 3-4.

Table 3-4: Interviews of Pedestrians

Terminal	Number of Interviews
Dalada Veediya	323
DS Senanayaka Veediya	224
Colombo Street	311
Kotugodalla Veediya	324
Sangaraja Mawatha	297
Sirimavo Bandaranayake Mw.	420
SWRD Bandaranayake Mw.	356
William Gopallawa Mw.	323
Yatinuwara Veediya	300

The survey was conducted on 25th January 2011 at all locations by using the survey forms given in Appendix 3-1.

3.3.6 Bus & Rail Passenger Interviews

Bus and rail passenger interviews were conducted at the major bus terminals at Good Shed, Clock Tower and Torrington and also at the Kandy Railway Station. During the bus passenger interviews, only the passengers waiting for a bus were interviewed. Boarding counts were conducted for buses leaving these terminals. At the railway station, only passenger interviews were conducted as the count of passengers was obtainable from the daily ticket and monthly season ticket sales. The number of interviews held at each location is given in Table 3-5.

Table 3-5: Interviews for Bus & Rail Passengers

Terminal	Number of Interviews
Good Shed Bus Stand	1930
Clock Tower Bus Stand	573
Torrington Bus Stand	212
Kandy Railway Station	229

The survey was conducted on 1st December 2010 during the time period 0600 hrs to 1800 hrs at all the above locations using the survey forms given in Appendix 3-1

3.3.7 Parking Survey

Parking survey was conducted with two sub-surveys. Initially, parking locations in CBD was identified under a parking inventory survey conducted on 6th December 2010. It was conducted covering on-street and off-street parking locations connected to 54 road links in CBD. Parking durations of such identified locations was investigated during parking patrol survey conducted on 7th and 8th December 2010.

3.3.8 Trip Generation & Attraction Survey

Several major trip attractors and generators were identified within the CBD and trip end counts and interviews were conducted at each of these locations. The selection of such trip attractors/generators was done in a manner that they represented different categories of land use activities related to commercial, administrative, educational, tourism and religious etc. The trip attractors and generators selected were as follows,

- Dalada Maligawa
- District Secretariat
- Hospital
- Market
- Municipal Car Park
- Consultation Channel Centre
- Trinity College
- Food City

The number of interviews completed at each location is given in Table 3-6

Table 3-6: Interviews of Bus & Rail Passenger Interviews

Terminal	Number of Interviews
Dalada Maligawa	104
District Secretariat	84
Hospital	103
Market	139
Municipal Car Park	165
Consultation Channel Centre	71
Trinity College	53
Food City	60

Both surveys were conducted simultaneously during 0600-1800 hrs on 25th February 2011 at entry gates of each location by using the forms given in Appendix 3-1

3.3.9 Saturday Surveys

In addition to aforementioned surveys, several representative surveys had been conducted on Saturday 7th Mat 2011 at the CBD cordon taking into account the differences of activities during a weekday and a weekend within the city. The same survey forms that have been used for the previous set of surveys were used for these surveys as well. Short descriptions of the selected Saturday surveys are given below.

3.3.9.1 CBD Cordon Surveys

The same locations that have been considered for the weekday surveys at the CBD cordon were re-surveyed on Saturday with Classified Manual Vehicle Counts, Passenger Vehicle Origin-Destination Surveys and Bus Surveys. All those surveys were conducted during 0600 to 1700 hrs maintaining the same 13 hour duration as in the previous surveys. The list of those survey points is as follows:

- DS Senanayaka Mawatha (In front of Vidyartha College)
- Adahana Maluwa Road (In front of Mahaiyawa Cemetery)
- Sri Sangaraja Mawatha. (Mosque Junction)
- Sirimavo Bandaranayake Mawatha(In front of High School)
- William Gopallawa Mawatha (In front of Hospital)

The Manual Classified Vehicle Count and Bus Surveys were conducted only for the city inbound traffic while Total Vehicle Count was conducted only for the outbound direction. Passenger Vehicle Origin Destination Survey was also carried out for the inbound direction and the following samples sizes obtained.

Table 3-7: Interviews for Passenger Vehicle Origin Destination (Saturday)

Access Corridor	Number of Interviews
DS Senanayaka Mawatha	360
Adahana Maluwa Road	372
Sri Sangaraja Mawatha	359
Sirimavo Bandaranayake Mawatha	239
William Gopallawa Mawatha	287

3.3.9.2 Pedestrian Surveys

The pedestrian surveys similar to those conducted on weekdays were carried out on a Saturday on the following road links:

- Dalada Veediya (Link between Kotugodalla Veediya & Yatinuwara Veediya)
- DS Senanayaka Veediya (Link between Kumara Veediya & Raja Veediya)
- Kotugodalla Veediya (Link between Dalada Veediya & Colombo Street)
- Yatinuwara Veediya (Link between Dalada Veediya & Colombo Street)
- SWRD Bandaranayake Mw.(Link between Bus stand junction & Keppetipola junction)

Passengers walking in either direction along the sidewalks were counted during the period 0700-1800 hrs and interviews were conducted during the same time. At the same time, all road crossings of each road links were also recorded.

3.3.10 Road Inventory Data Collection

In addition to the aforementioned surveys, measurement of the travel time on road links and preparation of road and parking inventories have been undertaken to have secondary supportive information for the data analysis. Under this survey road geometry and roadside land use data were also collected for 157 road links with 79.1 km covering almost total road length in Study Area.

3.3.11 Road Safety

Data related to road traffic accidents for a 3 year period from October 2007 to September 2010 had been collected from the records available at the Kandy Police Station. Those have been summarised in an Excel sheet paying special attention to basic information and characteristics of the road traffic accidents. To indentify the spatial distribution of accident, the accident data locations were entered into a software that has been developed for this purpose.

As commonly known, accidents categorised under “Property Damage” and “Minor injuries” are either not reported in full due to prevailing insurance schemes in the country. According to the available information, even if property damage and minor injuries are reported, such reports are beyond reasonable accuracy. Therefore, accidents categorised as “Fatal” and “Grievous injuries” were extracted from the total collection and considered for further studies.

4 Data Analysis

This section discusses the analysis of the data collected under this project.

4.1 Cordon and By-pass Flows

By processing the MCCs and Bus Passenger Surveys the total traffic in terms of vehicles and passengers at each location has been estimated. These have also been aggregated for each cordon and are reported as follows:

4.1.1 Study Area Cordon

There are approximately 112,000 vehicles crossing the SA Cordon daily in both directions on a weekday. It means that 56,000 vehicles enter the SA every day. A total of 318,000 people enter the SA by road in these vehicles. Table 4-1 provides a summary of the vehicle and passenger flow at the SA Cordon by vehicle type.

Table 4-1: Vehicle & Passenger Flow at SA Cordon by Vehicle Type (2way-24 hours)

Vehicle Type	2-way, 24 Hour Flow			
	Vehicles		Passengers	
	Nos.	%	Nos.	%
Cycles	513	0.5%	513	0.1%
Motor Bike	24,682	22.0%	32,260	5.1%
3-Wheeler	24,203	21.6%	34,673	5.4%
Car/ Jeep/Pickups	25,614	22.8%	53,957	8.5%
Pax. Van	11,469	10.2%	36,854	5.8%
School Van	1,837	1.6%	33,534	5.3%
Non Route Bus	954	0.9%	14,310	2.2%
Route Bus	9,602	8.6%	403,674	63.4%
Delivery Van	2,434	2.2%	4,836	0.8%
Light Goods (other)	2,984	2.7%	5,918	0.9%
Medium Goods (2Axle)	6,990	6.2%	14,300	2.2%
Heavy Goods	676	0.6%	1,380	0.2%
Multi Axle	61	0.1%	122	0.0%
Tractors	105	0.1%	155	0.0%
Carts	46	0.0%	0	0.0%
Total	**112,170**		**636,485**	

All categories of private vehicles jointly carry only about 19% of passengers even though they contribute to around 65% of the traffic flow on roads at the SA cordon. On the other hand, although route buses make up only 8.5% of traffic flow, they carry 63.4% of passenger share. This is comparable with the share of bus passengers at the Colombo Municipal Cordon which is 62.5%. It is noticeable that school vans also carry 5.3% of passengers, with other forms of para-transit also carrying 8% and goods vehicles also carrying around 4% of the passengers. Presumably due to the hilly terrain, use of bicycles is extremely low at around 0.1%.

The number of buses entering the city assumed as one half of the reported bi-directional flow translates to approximately 4,800 trips carrying 200,000 passengers. At the same time there are a little

less than 1,000 school vans entering the SA carrying over 16,000 passengers. The goods vehicles make up around 5,500 entries. The balance of nearly 45,000 private vehicles that dominates the traffic flow carries around 100,000 passengers in to the city.

Table 4-2 gives the vehicular traffic and passenger flow by corridor. It can be seen that the south-western approach from Peradeniya (Gatembe) direction brings around 21,000 vehicles per day, while both the northern approach at Katugastota and the eastern approach at Thennekumbura brings around 17,000 vehicles per day. The passenger flows are also distributed proportionately.

Table 4-2: Vehicle & Passenger Flows at SA Cordon by Major Corridor

Corridor	2-way, 24 Hour Flow			
	Vehicles		Passengers	
	Nos.	%	Nos.	%
Sirimavo Bandaranayaka Mw.	20,486	18.3%	127,581	20.0%
William Goppalawa Mw.	21,306	19.0%	125,284	19.7%
Katugastota Road	34,317	30.6%	217,678	34.2%
Polgolla Road	4,051	3.6%	8,310	1.3%
Sirimalwatta Road	4,282	3.8%	11,644	1.8%
Hewaheta Road	19,447	17.3%	103,958	16.3%
Ampitiya Road	8,281	7.4%	42,030	6.6%
Total	**112,170**		**636,485**	

The variation of the combined traffic flow at the Study Area boundary in 15 minute intervals on a weekday is shown in Figure 4-1. It indicates that the sharpest peak for inbound trips occurs between 0630-0645 hrs and followed by another rise between 0800 to 0815 hrs. The sharpest peak for the outbound trips is during the period of 0730-0745 hrs followed by several local peaks as the day goes on.

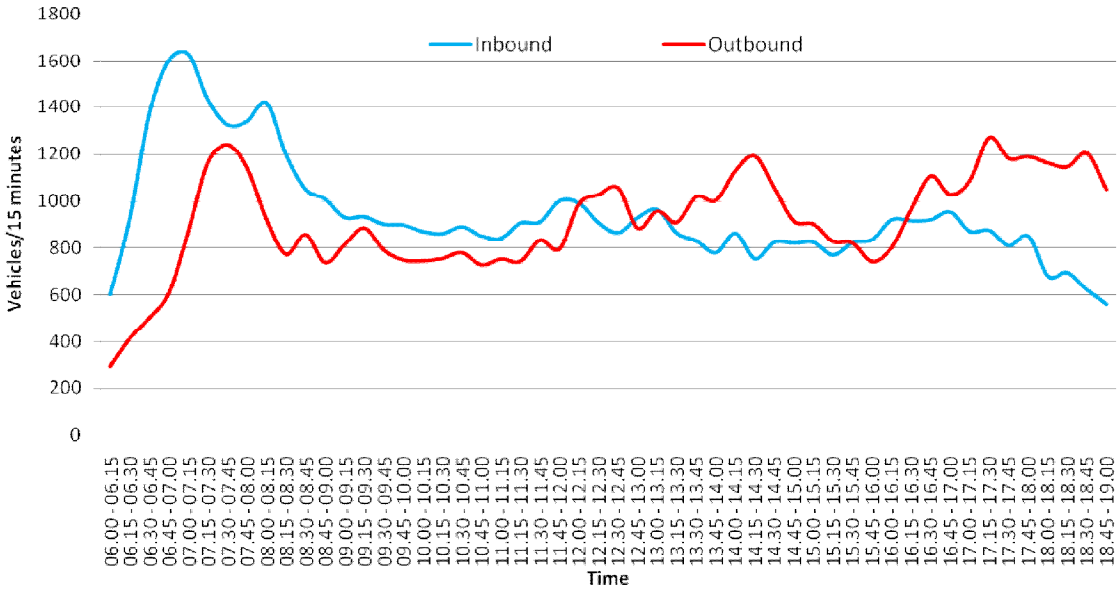


Figure 4-1: Variation of Traffic Flow Rate at Study Area Cordon (12 hours)

This implies that the busiest time on a weekday is between 0630 and 0815 hrs. This is made up of three traffic movements presumably:

- In bound school traffic
- Traffic outbound after dropping children at school
- Traffic In bound to work

Moreover it can also be concluded that the traffic levels are fairly consistent throughout the day thereafter, tailing off only after 1900 hrs with directional split being very much equal at all times. This is typical of a small urban area where trips are bi-directional and does not indicate the uni-directionality observed in traffic peaks in Colombo.

4.1.2 CBD Cordon

The influence of city centre activities is generally reflected by vehicle and passenger flow at the CBD cordon. Further the nature of such activities changes from a weekday to a weekend day, consequently the travel characteristics of city commuters also changes accordingly. Hence it was pre-decided to study vehicle and passenger flow characteristics at CBD cordon on a weekday and a Saturday separately.

4.1.2.1 Weekday Flow Analysis

On a weekday the vehicular traffic levels at the CBD cordon increases from the CBD flows by about 30% to reach around 150,000 vehicles in both directions of travel. This means that an additional 18,000 vehicle trips enter the CBD when compared to the SA cordon. Table 4-3 summarize the vehicular traffic and passenger flow at CBD Cordon by vehicle type.

Table 4-3: Weekday Vehicle & Passenger Flow at CBD Cordon by Vehicle Type

Vehicle Type	2-way, 24 Hour. Flow			
	Vehicles		Passengers	
	Nos.	%	Nos.	%
Cycles	231	0.2%	231	0.0%
Motor Bike	22,509	15.0%	32,071	4.2%
3-Wheeler	43,497	29.0%	59,254	7.8%
Car/ Jeep/Pickups	37,278	24.9%	81,130	10.6%
Pax. Van	16,915	11.3%	60,505	7.9%
School Van	3,198	2.1%	57,424	7.5%
Non Route Bus	1,103	0.7%	16,544	2.2%
Empty Bus	2,255	1.5%	0	0.0%
Route Bus	10,182	6.8%	427,608	56.1%
Delivery Van	3,044	2.0%	6,836	0.9%
Light Goods (other)	2,693	1.8%	6,059	0.8%
Medium Goods (2Axle)	6,311	4.2%	13,578	1.8%
Heavy Goods	516	0.3%	878	0.1%
Multi Axle	63	0.0%	125	0.0%
Tractors	117	0.1%	259	0.0%
Carts	6	0.0%	0	0.0%
Total	**149,918**		**762,502**	

By comparison to the flows at the SA cordon, it can be seen that this increase is mostly due to an increase of 10,000 three wheeler trips and 6,000 passenger car/jeep/pickup trips. The other significant increase is in school vans from less than 1,000 to 1,600. The increase in other vehicles namely buses and goods vehicles are somewhat proportional though marginal. The following conclusions can be drawn from these:

- There is no major reduction in traffic between the SA cordon and the CBD indicating that the CBD is a strong core with the peripheral areas being mostly generator land uses.
- The bus transport volumes runs steady between corridors further consolidating this view indicating a strong bus node in the CBD.
- Three-wheeler traffic volume has increased sharply indicating it as a preferred mode of transport closer to the CBD, possibly due to restricted parking and short travel distances. It could also be due to high load factors on buses and lack of short distance city service bus services.
- Also it appears that many private vehicles are used for several trips to the CBD presumably due to lack of parking and proximity between residences, schools and offices.

Table 4-4: Increase in Weekday Vehicle & Passenger Flow between Cordons by Vehicle Type

Vehicle Type	Increase at CBD over SA (2-way, 24 Hour)			
	Vehicles		Passengers	
	Nos.	%	Nos.	%
Cycles	-282	-0.7%	-282	-0.2%
Motor Bike	-2,173	-5.8%	-189	-0.1%
3-Wheeler	19,294	51.1%	24,582	19.5%
Car/ Jeep/Pickups	11,664	30.9%	27,173	21.6%
Pax. Van	5,446	14.4%	23,650	18.8%
School Van	1,361	3.6%	23,890	19.0%
Non Route Bus	149	0.4%	2,234	1.8%
Empty Bus	2,255	6.0%	0	0.0%
Route Bus	580	1.5%	23,934	19.0%
Delivery Van	610	1.6%	2,001	1.6%
Light Goods (other)	-291	-0.8%	141	0.1%
Medium Goods (2Axle)	-679	-1.8%	-722	-0.6%
Heavy Goods	-160	-0.4%	-501	-0.4%
Multi Axle	2	0.0%	3	0.0%
Tractors	12	0.0%	104	0.1%
Carts	-40	-0.1%	0	0.0%
Total	**37,748**		**126,017**	

However it should be noted that due to the CBD area being quite small, some trips that cross the CBD may be recorded as a double entry thereby inflating the CBD volumes of actual trips made. This would be particular applicable to school vans which may be serving several schools and thereby crossing the CBD boundary twice or more times in one trip. Thus the passenger in-flow which is recorded at 380,000 at the CBD cordon indicating an increase of around 60,000 more passenger trips compared to the SA cordon may not represent actual trips. An exact estimate of this cannot be made. However given that passenger OD surveys indicate nearly 50% transfers it is possible that this may

only be around 30,000 trips. As such it may be concluded that while 320,000 trips enter the Study Area around 350,000 enter the CBD. In other words, over 90% of the trips entering the CBD originate from outside the Study Area and the city limits. Table 4-5 indicate traffic and passenger flow details by corridor.

Table 4-5: Weekday Vehicle & Passenger at CBD Cordon (Corridor Basis)

Corridor	2-way, 24 Hour Flow			
	Vehicles		Passengers	
	Nos.	%	Nos.	%
Sangaraja Mw.	28,828	19.2%	163,728	21.5%
William Goppalawa Mw.	28,830	19.2%	132,871	17.4%
Sirimavo Bandaranayake Mw.	20,109	13.4%	136,915	18.0%
Adahana Maluwa Road	20,171	13.5%	45,759	6.0%
DS Senanayaka Mw.	18,865	12.6%	194,580	25.5%
Wariyapola Sri Sumangala Mw.	7,003	4.7%	21,673	2.8%
George E de Silva Mw.	6,606	4.4%	21,550	2.8%
Rajapillah Mw.	5,641	3.8%	15,291	2.0%
Dr. Nihal Karunaratne Mw.	10,470	7.0%	22,143	2.9%
Sri Pushpadana Mw.	3,395	2.3%	7,993	1.0%
Total	**149,918**		**762,502**	

Figure 4-2 shows the profile of the traffic flow per 15 minute period for both directions at the CBD cordon on a weekday. It indicates that the sharpest peak for inbound trips is from 0645 to 0700 hrs and for outbound it is from 0700 to 0715 hrs. Both inbound and outbound traffic flows show several local peaks when the day goes on. The work trip peak in the morning seems flatter than at the SA cordon and lasts from 0745 till 0845 hrs. It is very similar to the flow variations at the SA cordon and shows an equal directional split from 0900 to 1630 hrs. Detailed traffic and passenger flows for both cordons are given in Appendix 4-1.

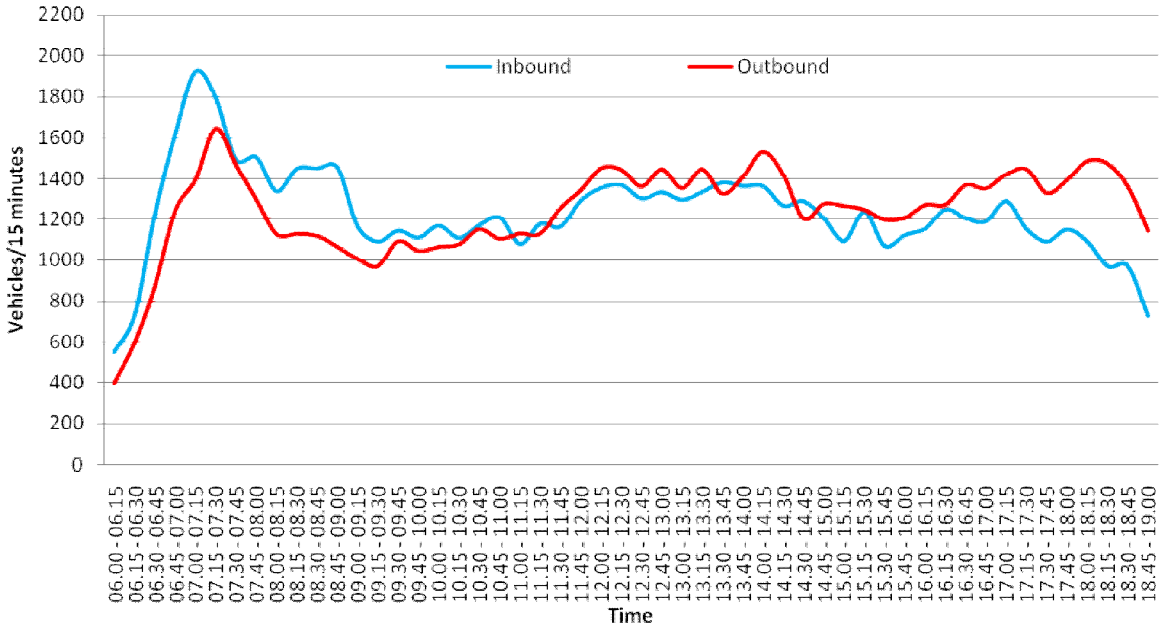


Figure 4-2: Variation of Traffic Flow Rate at CBD cordon on a Weekday (Major 3 Roads only)

4.1.2.2 Saturday Flow Analysis

Traffic counts conducted on major five entry corridors to CBD shows only marginal variations in vehicle and passenger flow on a Saturday compared to a weekday. Analysis on Saturday traffic counts indicate that all five major corridors carry daily two way flow of 114,761 vehicles with 694,874 passengers while the corresponding weekday flows are 116,803 vehicles and 694,873 passengers respectively. Table 4-6 compares the variation of vehicle and passenger counts on a weekday and Saturday by vehicle type.

Table 4-6: Comparison of Vehicle and Passenger Flow at CBD on a Weekday and Saturday

Vehicle Type	2-Way, 24 Hour. Flow (Nos.)					
	Vehicles			Passengers		
	Weekday	Saturday	Reduction in Saturday	Weekday	Saturday	Reduction in Saturday
Cycles	187	140	47	187	140	47
Motor Bike	18,835	21,471	-2,636	26,837	33,566	-6,730
3-Wheeler	31,395	27,035	4,360	42,767	43,333	-567
Car/ Jeep/Pickups	28,367	33,415	-5,049	61,734	84,477	-22,743
Pax. Van	12,867	12,917	-50	46,024	61,708	-15,684
School Van	2,012	0	2,012	36,135	0	36,135
Non Route Bus	954	1,064	-110	14,310	15,956	-1,646
Route Bus	10,916	10,469	447	421,325	439,049	-17,724
Delivery Van	2,945	2,180	765	6,614	3,856	2,757
Light Goods (other)	2,213	1,378	835	4,980	3,039	1,941
Medium Goods (2Axle)	5,505	3,569	1,936	11,844	7,661	4,183
Heavy Goods	441	902	-460	751	1,637	-886
Multi Axle	57	157	-100	115	315	-200
Tractors	104	60	44	231	136	95
Carts	3	4	-1	0	0	0
Total	**116,803**	**114,761**	**2,042**	**673,853**	**694,874**	**-21,021**

This shows that there is only 2% reduction of vehicles on a Saturday and should be considered as equal to a weekday. However the composition of the traffic is different. The school vans are absent, three wheeler numbers have dropped while private passenger vehicles show a significant increase. However the number of people arriving in these vehicles has increased by around 3%. Non-route buses have increased by about 10% on a Saturday indicating an increase presumably due to local tours. Meanwhile, the number of public buses deployed on the major entry corridors remains unchanged though carrying around 17,000 more passengers compared to a weekday. In terms of goods vehicles, it is observed that all light and medium sized goods vehicles have reduced while heavy goods vehicles including have increased by more than 100 percent.

Figure 4-3 shows the profile of the traffic flow for both inbound and outbound directions at the CBD cordon on a Saturday. It indicates that there are neither inbound nor outbound traffic flow peaks on a Saturday as observed on weekdays. It is seen that both the inbound and outbound traffic flows progressively increase in the morning up to around 0815 hours and remain steady through most of the day before dropping after 1800 hrs. This profile is totally different from the one prevailing during weekday illustrated in Figure 4-2

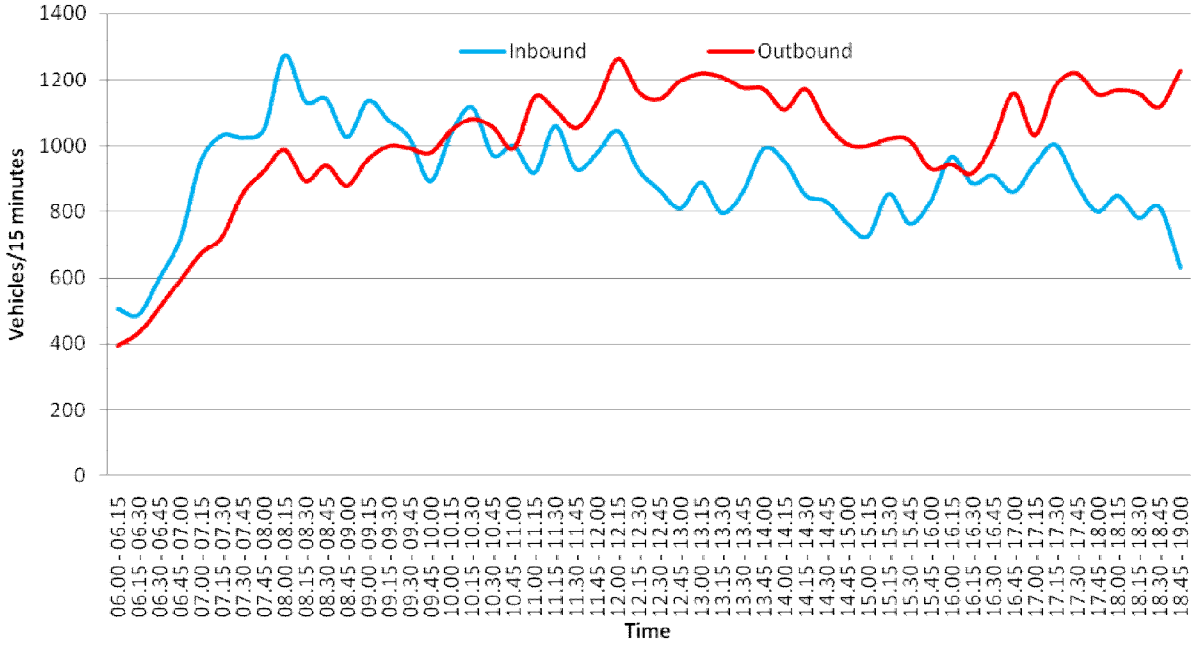


Figure 4-3: Variation of Traffic Flow Rate at CBD Cordon on a Saturday

4.1.3 By-pass Roads

Certain combinations of roads located within Kandy Municipal area and also just outside of it forms by-pass to the CBD. However most of such combinations cannot be effectively used as bypass roads due to the bad horizontal and vertical alignments at the hilly terrain.

Alternate #1: By-pass at the Periphery of the Study Area

- **Guhagoda Road:** Is a north-south oriented linkage to the west of the city. It connects Gatembe/ Peradeniya to Katugastota. Unlike other by-passes to CBD, this road is located entirely outside the SA on the left bank of the Mahaweli River. This road is frequently used by the vehicle travelling north-south direction arriving at Peradeniya on A1 or A5 and cutting across to Katugastota to travel on A9 or A10 or vice versa. This is demonstrated by the fact that it carries around 11,000 ADT with 28,000 passengers. But it does not have a significant bus transport service.

- There is no proper east-west linkage to the north of the city that connects the major road junctions of Thennekumbura to Katugastota. However the road connecting Digana, Madawala and Thennekumbura is currently the most widely used serving as an outer-by pass.

- There is no connection to the east of the city that connects Gatembe/Peradeniya to Thennekumbura due to the Hantane mountain range.

Alternate #2: By-pass of CBD within Study Area

- **Anniwatta by-pass:** This by-pass provides north-south connection between Sirimavo Bandaranayake Mawatha at Gatembe (close to Sri Pushpadana Purana Viharaya) to Adahana

Maluwa Road at Mahaiyawa (close to General Cemetery) through the combination of Deveni Rajasinghe Mawatha, George E de Silva Mawatha, Anniwatta Road, Bahirawakanda Lane, Dammadissi Mawatha and AA Dharmasena Mawatha. This by-pass also extends up to Nittawela on Katugastota Road at its northern end via Mapanawathura Road, but less traffic is using this additional section due to its poor alignment and surface conditions. Intermittently the by-pass provides access to different places of the CBD area via George E de Silva Mawatha and Bahirawakanda Road, Sri Pushpadana Road and Wariyapola Sri Sumangala Mawatha. Apart from diverting traffic from city centre, this connection also provides access to high-density residential areas in the western part of the Study Area. This by-pass carries around 5,200 ADT and 11,000 passengers. It is served only by an infrequent bus service.

- **Dharmasoka Mawatha:** This road is a inner by-pass for north-east directional traffic between Lewella and Nittawela connecting Lewella Road and Katugastota Road respectively. Like Anniwatta by-pass it also serves high-density residential areas on the north-eastern side of the Kandy Municipal area. This road carries 12,000 ADT and over 28,000 passengers including a bus service that carries around 12.5% of the passengers.

Table 4-7: Average Daily Traffic & Passenger on bypass Road

Vehicle Type	Vehicle & Passenger Flows (2-way, 24 Hours)															
	Anniwatta Road				Dharmasoka Mw.				Guhagoda Road				All CBD Bypasses			
	Vehicles		Passengers		Vehicles		Passengers		Vehicles		Passengers		Vehicles		Passengers	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Cycles	1	0.0%	1	0.0%	16	0.1%	16	0.1%	58	0.5%	58	0.2%	75	0.3%	75	0.1%
Motor Bike	509	9.7%	662	5.9%	2,400	19.6%	3,360	11.8%	2,406	22.1%	3,369	12.5%	5,315	18.7%	7,390	11.1%
3-Wheeler	1,390	26.4%	1,806	16.2%	3,493	28.6%	4,890	17.2%	2,360	21.7%	3,069	11.4%	7,243	25.5%	9,765	14.7%
Car/ Jeep/Pickups	2,283	43.4%	4,566	40.9%	3,137	25.7%	6,587	23.2%	2,365	21.7%	5,204	19.3%	7,785	27.4%	16,357	24.6%
Pax. Van	647	12.3%	1,423	12.7%	1,599	13.1%	3,839	13.5%	1,584	14.5%	3,642	13.5%	3,830	13.5%	8,904	13.4%
School Van	73	1.4%	878	7.9%	168	1.4%	2,020	7.1%	67	0.6%	806	3.0%	309	1.1%	3,704	5.6%
Non Route Bus	48	0.9%	476	4.3%	53	0.4%	530	1.9%	122	1.1%	1,223	4.5%	223	0.8%	2,229	3.4%
Route Bus	18	0.3%	526	4.7%	118	1.0%	3,544	12.5%	127	1.2%	3,824	14.2%	263	0.9%	7,894	11.9%
Delivery Van	55	1.0%	164	1.5%	118	1.0%	296	1.0%	7	0.1%	18	0.1%	180	0.6%	478	0.7%
Light Goods	103	2.0%	298	2.7%	234	1.9%	679	2.4%	448	4.1%	1,298	4.8%	785	2.8%	2,275	3.4%
Medium Goods	122	2.3%	353	3.2%	635	5.2%	1,906	6.7%	979	9.0%	3,330	12.4%	1,736	6.1%	5,589	8.4%
Heavy Goods	6	0.1%	17	0.2%	200	1.6%	619	2.2%	329	3.0%	987	3.7%	535	1.9%	1,623	2.4%
Multi Axle	0	0.0%	0	0.0%	35	0.3%	70	0.2%	39	0.4%	82	0.3%	74	0.3%	152	0.2%
Tractors	4	0.1%	8	0.1%	10	0.1%	20	0.1%	6	0.1%	12	0.0%	20	0.1%	40	0.1%
Carts	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total	**5,257**		**11,178**		**12,217**		**28,376**		**10,898**		**26,922**		**28,373**		**66,476**	

4.2 Junction and Link Flows

There are about 50 junctions within the selected CBD area connecting about 50 road links. Of these, l 14 junctions within CBD and 3 junctions just outside CBD were identified and surveyed for their turning movements. Table 4-8 presents a summary of the total vehicle Turning Movement Counts (TMC) for the respective junctions the individual detailed of which are shown on Map 4-1 in Volume II.

Table 4-8: Total Vehicle Movements at Selected Major Junctions

Map Ref. No.	Location	Average Daily Traffic	
		Vehicles	PCUs
TM01	Good Shed Junction	22,279	23,832
TM02	Station Junction	32,687	36,172
TM03	Bus Stand Junction	34,573	41,466
TM04	Ahelepola Junction	25,573	27,943
TM05	Keppetipola Junction	30,834	35,761
TM06	Police Junction	35,207	33,498
TM07	Clock Tower Junction	42,449	45,436
TM08	Lake Round Junction	40,939	43,967
TM09	Queens Hotel Junction	27,295	29,075
TM10	YatinuwaraVeediya-Colombo Street Junction	20,610	20,940
TM11	Raja Veediya-KotugodallaVeediya Junction	13,960	12,065
TM12	Municipal Junction	34,296	35,655
TM13	Mosque Junction	17,012	17,908
TM14	PTS Junction	24,088	21,852
TM15	Ampitiya Road Junction	28,454	30,457
TM16	Heerassagala Junction (WGM)	28,291	29,747
TM17	Heerassagala Junction (SBM)	22,434	23,243

The Clock Tower Junction and Lake Round Junction have the highest junction flows of over 40,000 vehicles per day. In addition, the Police Station Junction, Bus Stand Junction and Municipal council Junction are also highlight as having around 35,000 vehicle movements per day. However it is observed that the junctions within the central road grid such as the Mosque Junction and Raja Veediya-Kotugodalla Veediya Junction records movements of less than 20,000 vehicles per day while all other junctions average between 20,000 to 35,000 vehicles per day.

Table 4-9 summarizes the traffic flow details for several important links within the city that connect these junction the details of which are provided on Map 4-1 in Volume II.

Table 4-9: Flows on Selected Major Links

Road/Street	Link (Start and End Nodes)	Average Daily Traffic	
		Vehicles	PCUs
Dalada Veediya	Clock Tower Junction & Yatinuwara Veediya	29,422	31,244
DS Senanayaka Veediya	Municipal Junction & Raja Veediya Junction	22,769	22,875
Colombo Street	Kotugodella Veediya & DS senanayaka Veediya	3,960	3,455
Kotugodella Veediya	Raja Veediya & Colombo Street	10,458	8,998
Sangaraja Mawatha	Lake Round Junction & Queens Hotel Junction	18,284	20,226
Sirimavo Bandaranayaka Mw.	High School Junction & Police junction	24,687	23,784
Adahana Maluwa Road	Police Junction & Mapanawatura Junction	20,343	18,726
SWRD Banadaranayaka Mw.	Bus stand junction & Keppetipola junction	30,297	35,024
Wiliam Goppalawa Mw.	General Hospital & Rail station junction	28,874	30,626
Yatinuwara Veediya	Dalada Veediya & Colombo Street	13,369	14,769

Three selected links on SWRD Bandaranayake Mawatha, William Gopallawa Mawatha and Dalada Veediya have the highest flows of around 30,000 vehicles per day as they are two-way roads that connect the main corridors. Road links such as Colombo Street and Kotugodalla Veediya, located within the central grid that do not have through traffic and are not served by buses record lower traffic flows of 10,000 vehicles per day or less while most other links have between 20,000 to 30,000 vehicles per day on the major links and between 10,000 to 20,000 vehicles per day on the minor roads.

4.3 Private Vehicles

Since motorcycle, three-wheelers, passenger cars (car/jeep/pickups) and passenger vans are mainly used for personal travel they are grouped into one category as private passenger vehicles and analysed together. These private vehicles account for 76.6% of the vehicular flow or 85,968 vehicles at the SA cordon, increasing to 120,199 vehicles with a share of 80.2% at the CBD cordon when measured in both directions of travel over a 24 hour period.

4.3.1 Origin Destination Analysis

Origin Destination surveys were conducted at all major entry points to the Study Area and also the CBD to study the travel pattern of passenger vehicle on a weekday and on a Saturday.

4.3.1.1 Weekday Analysis

Table 4-10 and Table 4-11 provide a summary of weekday passenger vehicle OD analysis for SA and CBD cordons respectively.

Table 4-10: Percentage Distribution of Trip Ends of Passenger Vehicles (SA Cordon)

Trip Ends	Kandy CBD	KMC (excl. CBD)	Rest of Kandy District	Matale District	Nuwara Eliya District	Western Province	Southern Province	Northern Province	Eastern Province	North Western Province	North Central Province	Uva Province	Sabaragamuwa Province
Kandy **CBD**													
KMC **(excl. CBD)**	8.4	1.9											
Rest of Kandy District	43.1	20.8	10.2										
Matale District	1.5	0.6	0.9										
Nuwara Eliya District	1.2	0.3	0.9	0.2									
Western Province	1.3	0.3	1.0	0.3									
Southern Province	0.1		0.1										
Northern Province			0.1			0.1							
Eastern Province	0.1		0.1			0.2							
North Western Province	0.9	0.2	0.4		0.1	0.1							
North Central Province	0.6		0.1										
Uva Province	0.2	0.1	0.4			0.1				0.1			
Sabaragamuwa Province	2.1		0.3	0.2	0.2					0.3		0.1	
Trip Ends per Zone (%)	***59.5***	***24.2***	***14.4***	***0.7***	***0.3***	***0.5***	***0.0***	***0.0***	***0.0***	***0.4***	***0.0***	***0.1***	***0.0***

Table 4-11: Percentage Distribution of Trip Ends of Passenger Vehicles (CBD Cordon)

Trip Ends	Kandy CBD	KMC (excl. CBD	Rest of Kandy District	Matale District	Nuwara Eliya District	Western Province	Southern Province	Northern Province	Eastern Province	North Western Province	North Central Province	Uva Province	Sabaragamuwa Province
Kandy CBD													
KMC (excl. CBD)	26.5	3.9											
Rest of Kandy District	37.3	9.8	7.2										
Matale District	2.4	0.4	0.7										
Nuwara Eliya District	0.8	0.3	0.7	0.2									
Western Province	1.4	0.5	0.7		0.1								
Southern Province	0.2		0.1		0.1								
Northern Province													
Eastern Province	0.1	0.1	0.1	0.1		0.1							
North Western Province	1.9	0.3	0.7		0.3	0.1							
North Central Province	0.4	0.3	0.1		0.1	0.1							
Uva Province	0.1	0.1	0.3							0.1			
Sabaragamuwa Province	0.4	0.4	0.6	0.1						0.1			
Trip Ends per Zone (%)	***71.5***	***16.2***	***11.1***	***0.3***	***0.6***	***0.2***	***0.0***	***0.0***	***0.0***	***0.1***	***0.0***	***0.0***	***0.0***

Passenger vehicle OD surveys conducted on a weekday at the SA cordon reveals that 59.5% of trips entering the SA cordon have their trip ends within the CBD. Furthermore of such trips, around 72.4% have the other trip end outside the SA but within the Kandy District. Another 24.2% of trips entering the SA, have their trip ends in the Study Area (excluding CBD area) with 86% of them are having their other trip end outside the SA but within Kandy District. The remaining 16.3% of vehicles entering the SA do not terminate within the SA but cross both the SA and CBD areas to terminate outside.

This shows that around 51,000 passenger vehicular trips have one trip end within the CBD area. Since 65,000 trips ends are estimated within the SA, around 14,000 or just over 20% of trips entering SA have both their trip ends outside the SA. This shows that the area within the SA but outside the CBD has poor trip attraction and serves mostly as a residential zone. The good news is that unlike in Colombo, the areas just outside the CBD have mostly remained as residential and urbanisation has been confined to the major road corridors. The primary reason for this could be the terrain and narrow access lanes in this area which is not favourable for commercial development.

Beside these trips entering the CBD along the major arteries, there are around 20,000 vehicle trips arriving through minor corridors such as Ampitiya Road, Rajaphilla Mawatha, etc. Along with an estimated 10,000 trips generated on to the major roads between the two cordons, it can be assessed that there are around 30,000 vehicle trips having origins within the SA. When compared to the estimated 27,500 households in the SA, it roughly translates to around 1 vehicle trip originating per household.

As estimated through OD analysis around 16.3% of all private vehicles crossing the Study Area cordon i.e. around 14,000 cross the CBD. These trips are having two alternative routes within the Study Area as some of them go through the CBD while others by-pass the CBD. Table 4-12 and 4-13 provides the OD distribution of the private passenger vehicles using Anniwatta Road and Dharmasoka Mawatha respectively.

Table 4-12: Percentage Distribution of Trip Ends of Passenger Vehicles (Anniwatta Rd.)

Trip Ends	Kandy CBD	KMC (excl. CBD)	Rest of Kandy District	Matale District	Nuwara Eliya District	Western Province	Southern Province	Northern Province	Eastern Province	North Western Province	North Central Province	Uva Province	Sabaragamuwa Province
Kandy CBD													
KMC (excl. CBD)	40.6	31.4											
Rest of Kandy District	5.4	15.9	1.7										
Matale District		1.3											
Nuwara Eliya District													
Western Province				0.4									
Southern Province				0.4									
Northern Province													
Eastern Province													
North Western Province		0.4	0.4										
North Central Province		0.8											
Uva Province													
Sabaragamuwa Province	0.4	0.8											
Trip Ends per Zone (%)	***46.4***	***50.6***	***2.1***	***0.8***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

Table 4-13: Percentage Distribution of Trip Ends of Passenger Vehicles (Dharmasoka Mw.)

Trip Ends	Kandy CBD	KMC (excl. CBD)	Rest of Kandy District	Matale District	Nuwara Eliya District	Western Province	Southern Province	Northern Province	Eastern Province	North Western Province	North Central Province	Uva Province	Sabaragamuwa Province
Kandy CBD													
KMC (excl. CBD)	27.6	6.6											
Rest of Kandy District	27.2	19.7	11.4										
Matale District	0.4	0.9	2.2										
Nuwara Eliya District	0.4	0.4	0.9										
Western Province													
Southern Province													
Northern Province													
Eastern Province	0.4												
North Western Province			0.4										
North Central Province													
Uva Province	0.4												
Sabaragamuwa Province		0.4	0.4										
Trip Ends per Zone (%)	***56.6***	***28.1***	***15.4***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

Of the 14,000 trips that have both trip ends outside the SA, their paths may be traced as follows:

- Anniwatta By-Pass – around 100 vehicles
- Dharmasoka By-Pass – around 1,800 vehicles
- Through CBD– around 12,200 vehicles

It can then be concluded that the two by-passes within the SA are not effective as the majority of passenger vehicle trips continue through the CBD presumably due to better road conditions and travel at low traffic times such as night time where using by-passes do not give a time saving.
On the other hand Guhagoda Road carries 11,000 vehicles and has much better road condition than the by-passes within the SA. Similarly the east-west by-pass at the SA boundary from Thennekumbura to Katugastota via Dharmasoka Mawatha carries around 12,000 vehicles. As such it may be concluded that well developed by-passes will be used if made available.

Saturday Analysis

Table 4-14 provides an analyzed summary of passenger vehicle OD survey conducted on Saturday for CBD cordon.

Table 4-14: Percentage Distribution of Trip Ends of Passenger Vehicles on a Saturday (CBD Cordon)

Trip Ends	Kandy CBD	KMC (excl. CBD)	Rest of Kandy District	Matale District	Nuwara Eliya District	Western Province	Southern Province	Northern Province	Eastern Province	North Western Province	North Central Province	Uva Province	Sabaragamuwa Province
Kandy CBD													
KMC (excl. CBD)	19.1	3.5											
Rest of Kandy District	35.2	8.7	11.1										
Matale District	1.7	0.2	1.0										
Nuwara Eliya District	0.9	0.5	1.1	0.4									
Western Province	2.6	0.4	2.8	0.3	0.3								
Southern Province	0.2	0.1	0.3	0.1									
Northern Province						0.1							
Eastern Province	0.3	0.0	0.2		0.1	0.1							
North Western Province	1.9	0.1	0.6		0.1								
North Central Province	0.3		0.3		0.1								
Uva Province	0.2	0.0	0.6	0.2		0.4				0.0			
Sabaragamuwa Province	1.9	0.6	0.9	0.1	0.5							0.1	
Trip Ends per Zone (%)	***64.3***	***14.1***	***18.8***	***1.1***	***1.1***	***0.6***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.1***	***0.0***

As shown above, 64.3 % of all private vehicles entries at the CBD cordon on a Saturday, making up around 61,000 trips terminate within the CBD. This is a reduction of around 4,000 vehicles from a weekday. However, it is also seen that private vehicles arriving from outside the Study Area and terminating in the CBD increase by around 2,000 on a Saturday, thus demonstrating that the actual reduction of private vehicles trips made by those living within the Study Area to the CBD is around 6,000 on Saturday.

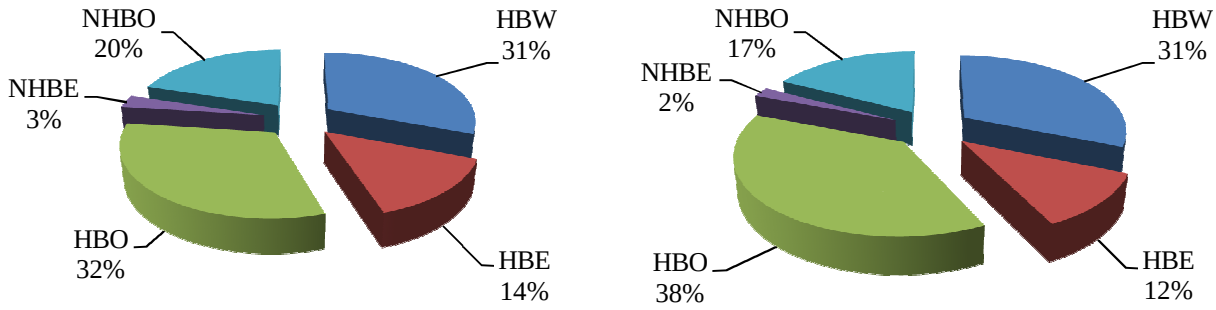
Saturday survey shows that there are around 34,000 private vehicle trips passing through the CBD which is about 8,000 higher when compared to a weekday of which 12,000 trips are for trips made between two locations outside Kandy District. Thus a substantial amount of traffic in Kandy CBD area is made up of vehicles passing through the city.

4.3.2 Trip Purposes of Private Vehicles

The trip purpose of private vehicle users was observed under five different categories:

- Home-based work trips (HBW): *Trips between home and workplaces*
- Home-based education trips (HBE): *Trips between home and school / educational institute*
- Home-based other trips (HBO): *Trips between home and places other than work or school/educational institute*
- Non- home based education trips (NHBE): *Trips from school/educational institute to destinations or other than home*
- None-home based other trips (NHBO): *All other trips.*

Figure 4-4 illustrates the trip purpose distribution at the two cordons on a weekday.



Study Area Cordon CBD Cordon

Figure 4-4: Trip Purpose Distribution on a Weekday

Home-based work and home-based educational trips make up around 31% and 13% of all trips on average at both cordons. Generally home-based education trips represent school trip on a weekday. Analysis also show that home-based other trips dominate at both cordons, accounting for 31%and 38% of passenger vehicle flow at SA and CBD cordons respectively.

Trip purpose distribution on a Saturday completely differs to the one on a weekday although both days records nearly equal number of vehicle and passenger movements. Figure 4-5 compares the trip purpose distribution at the CBD cordon on a weekday and on a Saturday. This shows that home-based work trips have reduced from 31 to 20 percent, while home based educational trips have also reduced from 12 to 8 percent. However home-based other trips for shopping, recreational and activities has increases significantly from 38 to 50 percent.

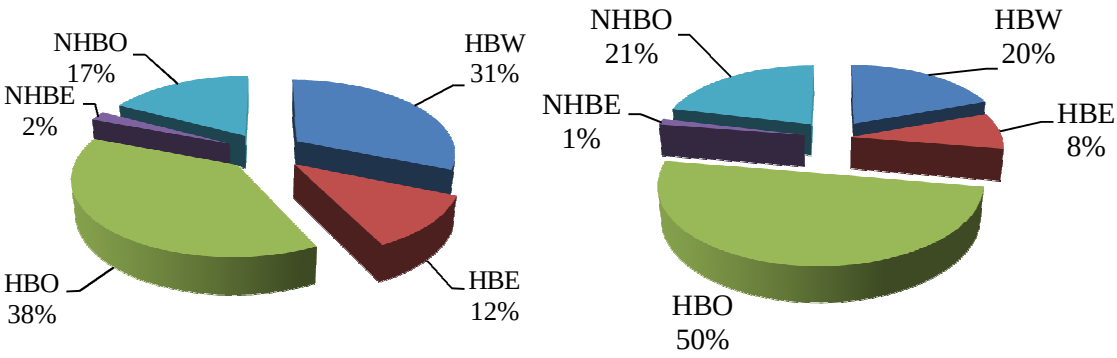


Figure 4-5: Trip Purpose Distribution at CBD Cordon on a Weekday and Saturday

Figure 4-6 shows the variation of the trip purposes by time during a weekday for all private vehicle trips crossing the CBD boundary on the three major arteries namely; Sirimavo Bandaranayake Mawatha, Katugastota Road, Sri Sangaraja Mawatha. The school trips and work trips have their respective peaks. It is observed that presumably due to the available road capacity being taken up during this time, the home-based other trips commence just after the morning work trip peak and return just before the evening work trips. The Non-home based trips on the other hand are spread out during the day starting from around 10 AM and continue till around 3 PM. This could be for business engagements such as meetings and also for some executives going home for lunch, picking up children etc.

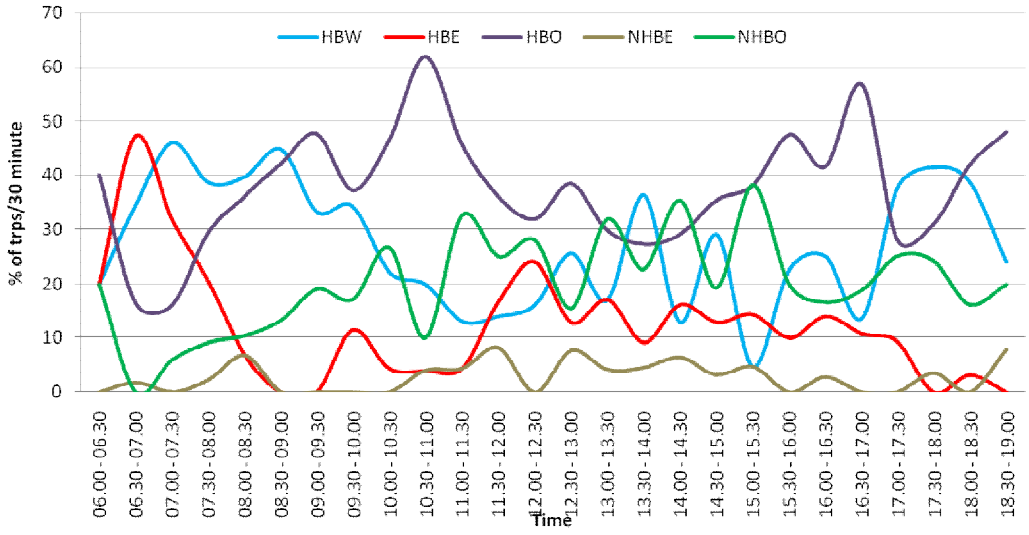
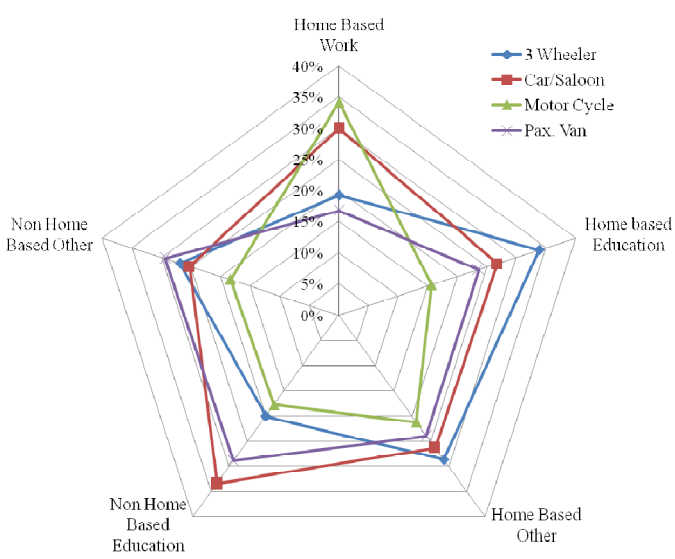


Figure 4-6: Frequency of Trip Purposes (City entries on Major Roads)

The types of private passenger vehicles used for different trip purposes during weekdays have been shown in Figure 4-7. This shows that at the CBD cordon, the use of passenger cars (cars/jeeps/pickups) increase significantly for home-based work trips and home-based education (school) trips. This is presumably because of the short distances involved and difficulties in parking so that they make more than one trip. On the other hand the use of motor cycles at the CBD cordon shows a decrease for these trip purposes, presumably because children from motor cycle owning households are sent by school vans which show an increase at the CBD cordon.

Study Area Cordon



CBD Cordon

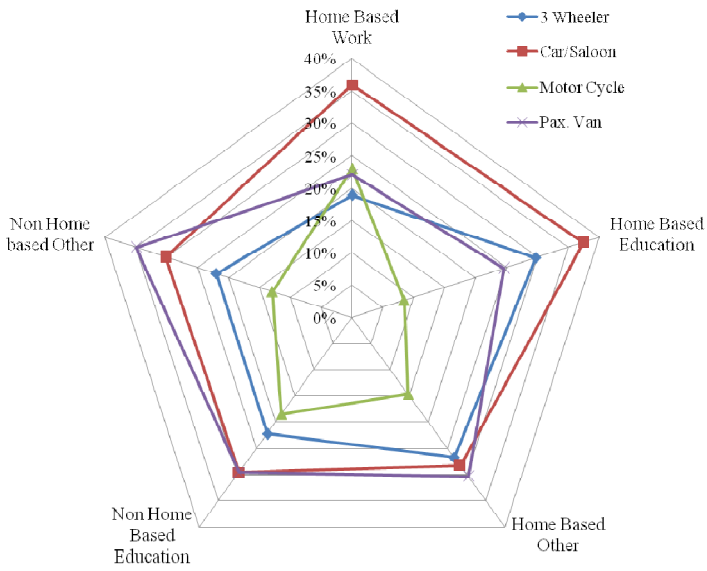
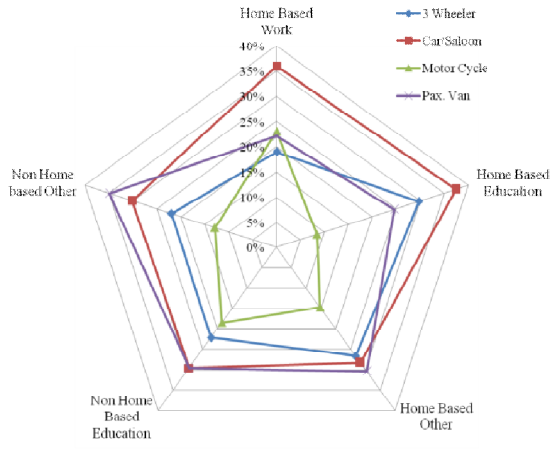


Figure 4-7: Trip Purpose of Private Vehicle Types at SA and CBD Cordons

Private passenger vehicle utilization for different trip purposes by vehicle type is shown in Figure 4-8. Home-based other trips which is the single largest trip category is more or less produced in equal categorise through all four categories of private vehicles i.e. three wheelers, motor cycles, cars and passenger vans. Home-based Educational trips are dominated by passenger cars showing 40-45% share. However in absolute terms educational trips are few in numbers accounting only for 14% of total private vehicle flow. Due to the increase of short distance travels within city limits, three wheelers contribute more for non-home based other trips with about 45%.

Weekday



Saturday

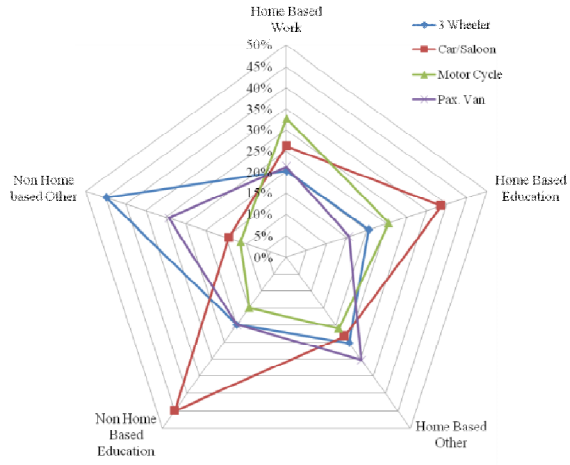


Figure 4-8: Private Vehicles by Trip Purposes at the CBD Cordon on a Weekday and Saturday

4.3.2.1 Occupancy Rates for Private Vehicles

The occupancy rates for private passenger vehicles calculated using the roadside interviews conducted at the two cordons are shown in Table 4-15. It clearly indicates that the highest occupancy rates are towads the CBD and on Saturday.

Table 4-15: Average Passenger Occupancy by Corridor

Vehicle Type	Occupancy Rate (Passenger per vehicle)				
	Weekday				Saturday
	SA Cordon (Outbound)		CBD Cordon (Inbound)		CBD Cordon (Inbound)
	Peak Hour	Daily Average	Peak Hour	Daily Average	Daily Average
Motor Bike	1.1	1.3	1.5	1.4	1.6
3-Wheeler	1.0	1.4	1.7	1.4	1.6
Car/ Jeep/Pickups	1.8	2.1	2.6	2.2	2.6
Passenger Vans	4.2	3.2	3.4	3.6	4.5
All Private Vehicles	**2.5**	**1.8**	**2.5**	**1.9**	**2.9**

4.4 Goods Vehicles

A total of 13,250 goods vehicles were observed crossing the SA cordon (2-way, 24 hour) which was 11.8% of total traffic flow at that cordon. The Medium Goods Vehicles (two-axle 8 tonnes) represent 52% of total goods vehicle flow, Light Goods 22.5%, Delivery Vans 18.4% and Heavy Goods Vehicles including containers and tippers 5.1% . The CBD cordon is 12,744 and the distribution by type of vehicle remains constant.

4.4.1 Origin-Destination Analysis

The OD analysis given in Table 4-16 indicates that 37.6% of goods vehicles going through the Study Area have both their origins and destinations outside the Study Area. In fact 4.6% are found to be totally external to Kandy District. At the CBD cordon (Table 4-17) the percentage drops to around 28% indicating that only a small percentage take the by-pass roads.

Table 4-16: Percentage Distribution of Trip Ends of Goods Vehicles (SA Cordon)

Trip Ends	Kandy CBD	KMC (excl. CBD)	Rest of Kandy District	Matale District	Nuwara Eliya District	Western Province	Southern Province	Northern Province	Eastern Province	North Western Province	North Central Province	Uva Province	Sabaragamuwa Province
Kandy CBD													
KMC (excl. CBD)	4.0	0.3											
Rest of Kandy District	26.5	15.7	12.6										
Matale District	0.5	0.2	2.3										
Nuwara Eliya District	3.0	0.2	4.3	0.3									
Western Province	2.3	0.6	3.7	0.6	0.6								
Southern Province	0.3		0.0										
Northern Province			0.2										
Eastern Province		0.1	0.4			0.3							
North Western Province	1.9	0.7	2.1	0.1	0.1	0.3		0.2					
North Central Province	0.3	0.2	0.3										
Uva Province	3.3	0.1	5.0		0.1	1.9							
Sabaragamuwa Province	1.7	0.2	2.3	0.1						0.1		0.1	
Trip Ends per Zone (%)	***44.0***	***18.4***	***33.0***	***1.0***	***0.8***	***2.5***	***0.0***	***0.2***	***0.0***	***0.1***	***0.0***	***0.1***	***0.0***

Table 4-17: Percentage Distribution of Trip Ends of Goods Vehicles at CBD Cordon

Trip Ends	Kandy CBD	KMC (excl. CBD)	Rest of Kandy District	Matale District	Nuwara Eliya District	Western Province	Southern Province	Northern Province	Eastern Province	North Western Province	North Central Province	Uva Province	Sabaragamuwa Province
Kandy CBD													
KMC (excl. CBD)	13.3	1.4											
Rest of Kandy District	33.7	10.7	8.8										
Matale District	2.5	0.2	1.2										
Nuwara Eliya District	0.3		1.3										
Western Province	2.6	1.2	3.4	0.1	0.5	0.5							
Southern Province			0.0										
Northern Province			0.3										
Eastern Province	0.5				0.6	0.2							
North Western Province	2.1	0.6	0.4										
North Central Province	1.4	0.2	1.1			0.1	0.4						
Uva Province	0.2	0.3	1.6	0.4	0.5	2.3				0.7			
Sabaragamuwa Province	0.3	0.5	1.8						0.2	0.2	0.1	1.6	
Trip Ends per Zone (%)	***56.9***	***15.0***	***20.0***	***0.5***	***1.6***	***3.0***	***0.4***	***0.0***	***0.2***	***0.9***	***0.1***	***1.6***	***0.0***

Table 4-18, illustrates the commodities carried by goods vehicles. It is seen that 1/4 to 1/3 of all goods vehicle movements are empty trips. Consumables, Building Materials and Industrial Products dominate the commodities types carried across the city. Of this, special consideration is made of the movements of around 2,500 trucks carrying building materials. Of this nearly one half or around 1,100 movements are heavily loaded vehicles from outside the Study Area to destination beyond Kandy but passing through both the CBD and the SA. Considering that such a vehicle may have a Passenger Car Equivalence of around 5 Units (PCUs) in typical road condition and terrain found in study area, this translates to an effective impact of around 5,000 PCUs or 3% impact of the CBD and

4% impact at the SA cordon. There are an estimated 225 tippers carrying sand from Mahiyangana passing the study area daily.

Table 4-18: Distribution of Commodities Carried by Goods Vehicles at Cordons

Commodity Type	% of Vehices by Commodity Type	
	CBD Cordon	SA Cordon
Floor	1.4%	0.4%
Other Foodstuff	14.2%	14.9%
Tea/Rub/Coconut	1.4%	1.1%
Paddy Rice	0.7%	0.7%
Vegetable	3.5%	3.2%
Other Agri.product	2.6%	1.3%
Livestock	0.5%	0.6%
Fish/Dry Fish	0.7%	1.7%
Forestry Product	1.9%	1.3%
Petroleum	1.2%	0.8%
Chemicals	1.6%	2.0%
Steel	0.9%	1.5%
Rubber Product	1.4%	1.7%
Other Industrial Product	14.2%	12.9%
Motor Vehicles	2.3%	0.4%
Fertilizer	0.7%	0.3%
Building Materials	14.2%	19.8%
Personal	1.9%	3.9%
Empty Containers	1.2%	4.5%
Empty	33.6%	27.0%
Number of Goods Veh.	**12,744**	**13,250**

4.5 Public Transport

Kandy is a provincial and national node for bus transport. It is also a terminal for train services to Colombo and Matara. It is also a terminal for local services from Matale and Nawalapitiya.

4.5.1 Bus Service

A total of 9,602 buses were observed to carry 403,674 passengers across the SA cordon. Passenger carried by these route buses accounts for a share of 63.4% of total road passenger flow at the cordon even though route buses represents only 8.6% of traffic flow.

A slight increase of buses and passengers can be observed at CBD cordon mainly due to the addition of local services in-between the two cordons. CBD cordon records 10,182 buses with 427,628 passengers in the two-way 24 hour count. The average occupancy rate of buses at CBD cordon is 42.1 and 40.4 for SA cordon. During peak periods this increases to an unacceptable 49.1 at CBD cordon and even more unacceptable 56.7 passengers per bus at SA cordon. The peak demand for outbound buses is from 1730 to 1830 hrs for CBD cordon and 1630 to 1600 hrs for the SA cordons where the occupancy rates increase to 50.1 and 55.0 respectively. The Figure 4-9 provides a better illustration of passenger occupancy rates of buses at the two cordons in terms of load factors indicating the most unsatisfactory operational conditions of buses.

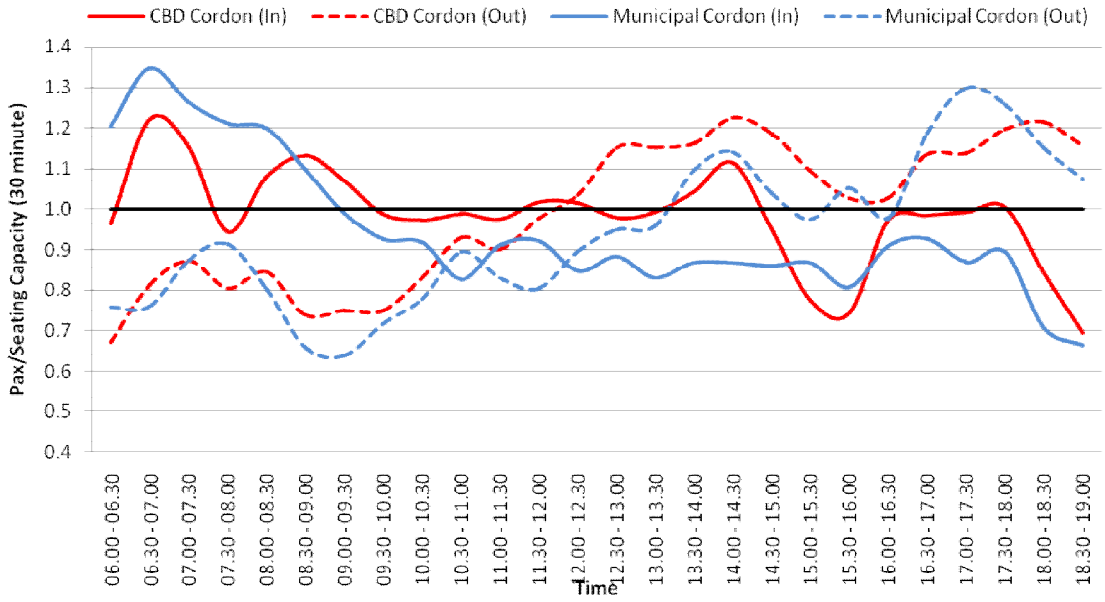


Figure 4-9: Load Factor Variation of Public Buses at Two Cordons

4.5.1.1 Origin Destination Analysis

With the purpose of investigating passenger travel characteristic, Origin-Destination Surveys were conducted at the three major bus stands at Good shed, Clock Tower Junction and Torrington. The results indicating percentage distribution of origin and destinations of passengers that buses at these terminals are given in Table 4-19.

Table 4-19: Percentage Distribution of Trip Ends of Bus Passengers at 3 Terminals

Trip Ends	Kandy CBD	KMC (excl. CBD)	Patha Hewaheta DSD	Udapalatha DSD	Ganga Ihala Korale DSD	Pasbage Korale DSD	Medadumbura DSD	Ududumbura DSD	Galagedara DSD	Pujapitiya DSD	Akurana DSD	Patha Dumbara DSD	Panwila DSD	Harispaththuwa/Katugastota DSD	Pilimathalawa/Yatinuwara DSD	Kundasale DSD	Udunuwara DSD	Minipe DSD	Doluwa DSD	Delthota DSD	Hatharaliyedda DSD	Matale District	Nuwara Eliya District	Rest of the country
Kandy CBD	0.4																							
KMC (excl. CBD)	4.9	2.3																						
Patha Hewaheta DSD	1.9	0.7																						
Udapalatha DSD	0.7	0.3	0.2																					
Ganga Ihala Korale DSD	0.2	0.0																						
Pasbage Korale DSD	0.5	0.0																						
Medadumbura DSD	0.7	0.3																						
Ududumbura DSD	0.1																							
Galagedara DSD	0.2	0.3	0.0																					
Pujapitiya DSD	1.0	0.2	0.0	0.0		0.0	0.1		0.0															
Akurana DSD	0.2	0.2		0.1		0.0																		
Patha Dumbara DSD	2.1	0.6	0.2	0.2		0.0	0.1			0.1	0.1													
Panwila DSD																								
Harispaththuwa/Katugastota DSD	3.4	0.9	0.2	0.3			0.1	0.0	0.1	0.0		0.1												
Pilimathalawa/Yatinuwara DSD	9.2	2.8	0.6	0.1		0.1	0.2		0.4	0.3	0.2	0.6	0.1	1.0	0.0									
Kundasale DSD	5.7	1.2	0.2	0.3		0.1			0.1	0.1		0.4	0.0	0.2	1.8									
Udunuwara DSD	2.8	1.0	0.3	0.2		0.0	0.1		0.1		0.0	0.1		0.4	0.4	0.4								
Minipe DSD	0.0	0.1				0.0									0.1									
Doluwa DSD	0.2	0.0												0.1			0.0							
Delthota DSD	0.8	0.1												0.2										
Hatharaliyedda DSD	0.4	0.2												0.0	0.1	0.0								
Matale District	0.9	0.3	0.0	0.1		0.1						0.0			0.3	0.2	0.2			0.0				
Nuwara Eliya District	2.6	0.9	0.1	0.5		0.0			0.2	0.0		0.1		0.4	0.8	0.2	0.3			0.1		0.1		
Rest of the Country	8.3	2.8	1.4	1.3	0.0	0.3	0.3	0.0	0.3	0.5	0.4	0.9	0.1	2.0	3.6	2.5	0.9	0.1	0.1	0.5	0.0	1.9	2.3	3.0
Trip Ends per Zone (%)	**47.2**	**15.1**	**3.2**	**2.9**	**0.0**	**0.7**	**0.8**	**0.1**	**1.1**	**1.1**	**0.7**	**2.4**	**0.1**	**4.4**	**7.2**	**3.3**	**1.4**	**0.1**	**0.1**	**0.6**	**0.0**	**2.0**	**2.3**	**3.0**

It is shown that 47.2% of the passenger boardings at these terminals (approximately 200,000) have one end of their trip in the Kandy CBD. Of these trips, the major origins are in order, Pilimatalawa, Yatinuwara and Kundasale which are areas that have a demand to satisfy a service frequency of more than one bus every 5 minutes and followed by Harispattuwa, Katugastota, Udunuwera and Pathadumbara DSDs which have adequate passengers to satisfy a frequency of at least one bus every 10 minutes.

Of passengers boarding the long distance inter provincial buses, approximately 18,000 passengers have their origins in the CBD and maybe presumed to be able to access the terminal by walking. However, around 52,000 passengers appear to arrive by a connecting bus. Thus inter-provincial passengers amount to 1/3rd of all passenger boardings, highlighting the importance of Kandy bus terminals in the national bus network.

With respect to the passengers boarding the intra-provincial (local) buses, it can be seen that around 50,000 passengers also arrive by a connecting bus comparable to those that can access the terminals by walking which is around 80,000. At 0.4% of trips made within the study area, it indicates that buses are not used for short distance travel, possibly due to:

- Transfers between terminals been inconvenient
- Buses having high load factors within the city
- Lack of bus services on smaller roads

Around 50% of passengers have both their trip ends outside the SA. This means around 100,000 passengers arrive in the CBD just in order to transfer from one bus to another. Services to Nuwara Eliya district and Matale district are also available at minimum frequencies of 10 minutes and 20 minutes respectively. Outside of Central Province, the Western, North Western, North Central and Uva provinces have the highest bus passenger travel shares with average frequencies of 10 minutes for Western and North Western and 30 minutes for Uva and North Central.

4.5.1.2 Trips Purposes

Figure 4-10 shows the trip purpose distribution of bus passengers based at the 3 bus terminals. It can be seen that the home-based work trip percentage is comparable to private transport, whereas in the case of home-based school trips it is higher in buses. However use of buses for non-home based trips is lower. This means that of the 320,000 people entering the Study Area, around 30% do so for jobs. This translates to around 100,000 persons.

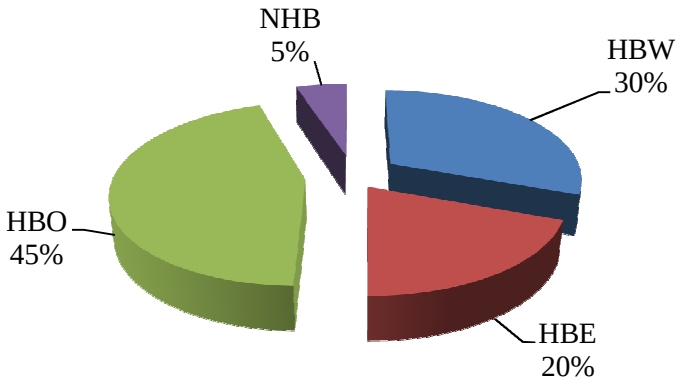


Figure 4-10: Trip Purposes of Bus Passengers

4.5.1.3 Modes used to access Terminals

As shown in Figure 4-11, over 65% of bus passengers or around 135,000 at the terminals use another bus to reach the terminal and just over 30% or 60,000 passengers who access the terminals by walking. However since the three terminals are placed far apart from each other, many of the bus passengers were forced to become unwitting and reluctant pedestrians. Only 0.3% or around 600 passengers seem to be transferring from the railway underlying the poor integration despite the Good Shed terminal is located adjacent to the Kandy Railway station.

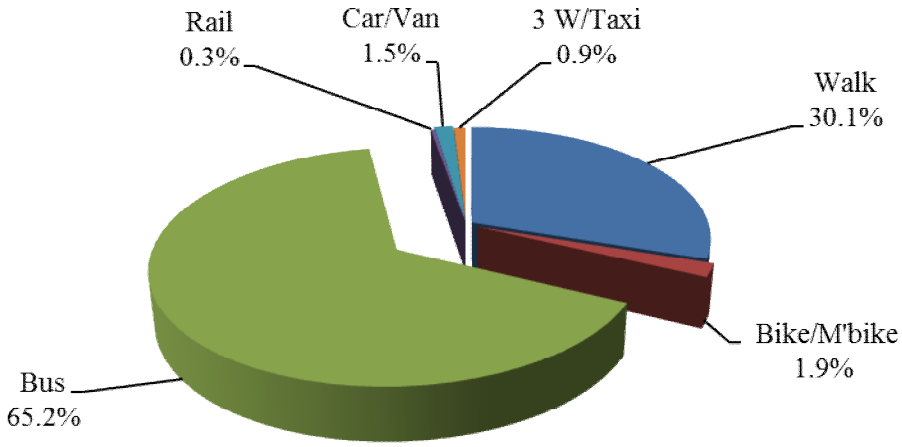


Figure 4-11: Terminal Access of Bus Passengers

4.5.2 School Van Services

There are interestingly high 40,000 school trips estimated at the CBD carried by bus. There are a further 28,000 school trips observed by school vans crossing the boundary and private vehicles may be estimated to carry around 5,000 students in equal number of trips. School vans as they may cross the CBD twice may be further revised downwards to around 20,000 and passenger cars also to around 4,000. Thus surveys indicate that the school transport of around 64,000 students and staff daily is s significant part of the passenger movements in the Study Area making up around 20% of the passenger movements.

4.5.3 Railway Services

The Sri Lanka Railway reports that the Kandy Railway station has processed 1,045,152 passengers in 2010. This can be translated to around 3,000 passengers arriving by railway every day making it less than 1% of the traffic load of the CBD. The origin-destination surveys show that over 50% of these passengers are from out of province using long distance trains. From those using short distance trains, stations such as Peradeniya, Gampola, Kadugannawa, Katugastota and Watthegama each of which attracts only around 100 trips a day. Given that the railway operates 20 trains a day this is well below par and indicates an under performance of the railway even when compared with Colombo.

4.6 Pedestrians

The pedestrian counts were conducted at several locations within the CBD area by identifying the CBD area in to four zones, i.e. northern, eastern, southern and south-western. The flows observed on seven roads representing these areas are shown below:

Table 4-20: Summary of Pedestrian Flows

Road/Street	Maximum Flow per Hour	Time of Peak
Dalada Veediya	7,500	Between 1000 to 1300 hrs
DS Senanayaka Veediya	2,300	Intermittently from 8000 hrs to 1400 hrs
Colombo Street	2,700	Between 1000 to 1400 hrs
Sri Sangaraja Mawatha	1,200	Between 0800 to 0900 hrs
Sirimavo Bandaranayake Mw	2,900	Between 1400 to 1800 hrs
SWRD Bandaranayake Mw	4,700	Between 1200 to 1700 hrs
William Gopallawa Mw	3,400	Between 0800 to 1700 hrs

Apart from Dalada Veediya which is the main shopping area, the pedestrian flows can be seen to be concentrated around the Good Shed bus terminal and the Clock Tower bus terminal clearly underlying the source of this pedestrian flow. The Table 4-21 shows that even elsewhere in the city, most pedestrian trips are either to or from the bus terminals indicating the pervasive nature of the problem that the bus terminals are poorly located and the routing of buses is ineffective. In most cases the capacity of walkways for pedestrian space available was inadequate for the peak flow.

Table 4-21: Analysis of Pedestrian Origins and Destinations

Origin Zone					Observed on	Destination Zone				
North	East	South	South -West	Same Road		Same Road	South-West	South	East	North
54%	6%	4%	14%	19%	**Colombo Street**	29%	9%	0%	5%	56%
17%	17%	33%	14%	17%	**Dalada Veediya**	18%	30%	30%	8%	12%
7%	23%	3%	7%	50%	**D S Senanayaka Mw.**	52%	5%	6%	16%	14%
10%	31%	12%	18%	21%	**Sangaraja Mw.**	42%	22%	11%	16%	4%
0%	0%	6%	27%	67%	**William Gopallawa Mw.**	37%	60%	3%	0%	0%

North Zone Roads	East Zone Roads	South Zone Roads	Southwest Zone Roads
• **Colombo Street** • Deva Veediya • **D S Senanayaka Veediya** • Kotugodalla Veediya • Pushpadana Mawatha • Raja Veediya • Thilak Ratnayake Mawatha • Yatinuwara Veediya	• Anagarika Dharmapala Mawatha • **Dalada Veediya** • Mahamaya Mawatha • **Sangaraja Mawatha** • Dalada Maligawa	• Ehelepola Kumarihami Mawatha • Keppetipola Mawatha • Mosque Road • Prison Road • Rajaphilla Mawatha • Sri Wickrama Rajasinghe Mawatha	• Sirimavo Bandaranayake Mawatha • S W R D Bandaranayake Mawatha • **William Gopallawa Mawatha** • Bus Terminals • Railway Station • Hospital

As a world heritage city, the Sacred Temple of Tooth and many other cultural centres, attracts many local and foreign tourists especially during the festive season in August every year. Accurate counts of these are not available but estimates indicate it may range from 60,000 to 160,000 (http://www.kandycity.org/kmc/services.html).

However, this study finds that there are over 200,000 bus passengers who arrive daily to the CBD almost all of whom become pedestrians. The poor integration of transport modes and the facilities available for pedestrians are obvious reasons for the incessant pedestrian flows throughout the city which also causes traffic congestion in many parts of the city.

4.7 School Transport

School traffic has been always very prominent in Kandy due to the large number of schools located within the Kandy Municipal Area. According to the records with the Kandy Zonal Office of the Department of Education, in 2011 there were 87,014 students enrolled at 117 schools in the Kandy educational zone. Of them, 63,415 students were at 39 schools located within the Kandy Municipal limits. This excludes three of the major private schools; Trinity College, Hillwood College and Good Shepherd's Convent. There are twenty-three major schools, including the above three, with at least 500 students each, located within the study area with a total student population of 63,387 and 2,875 teachers. These numbers are very significant when the land area and population of the study area are taken in to consideration.

The number of students recorded by Jayatilake (2003) in 29 schools in 2001 is 60,185 students and 2,607 teachers. This indicates that school enrolment in Kandy has increased only marginally by just 5% over 10 years. The locations of these schools are shown in the Map 4-2 of Volume II with the diameter of the circles indicative of the student population at each school.

As shown in the map, it is possible to identify five clusters of schools with respect to their geographical locations and the main access routes; named as Western, Central, Southern, Eastern and Northern Clusters. A summary of these clusters is given in the Table 4-22 below.

Table 4-22: Composition of School Clusters[5]

Cluster	No. of Schools	Students		Teachers.	
		Nos.	%	Nos.	%
Western	8	22,803	36	908	32
Central	8	20,716	33	1,031	36
Southern	2	2,819	4	200	7
Eastern	3	10,586	17	456	16
Northern	2	6,463	10	280	10
Total	**23**	**63,387**	**100**	**2,875**	**100**

[5] Source: Department of Education

4.7.1 Modes of Transport

Variations of the modal shares of school trips during the recent past at schools located in Kandy are shown in the Table 4-23 below. It is observed that there is a marked decline of using school buses and an associated increase in use of private vehicles. These modal ratios were obtained using samples of 20,000 students in 1998[6] and 8,000 students in 2010.[7] Obviously, the use of public buses is prominent in provincial schools as opposed to national schools, whereas the use of private vehicles and schools vans are comparatively low. Modal share of railway was estimated in a more recent study using a much smaller sample (650) and was found to be only 0.5%[8].

Table 4-23: Modal Split of School Trips in Kandy

Mode	Percentage Modal Share		
	National Schools		Provincial Schools
	1998	2010	2010
School Vans	34	32	27
School Buses	13	8	4
Public Buses	36	35	49
Private Vehicles	11	18	12

Taking into consideration the present modal split, peak-time vehicle occupancy rates found from the OD surveys and appropriate passenger car equivalency factors it was found that 16% of the students who travel by private vehicles contribute to 55% of school traffic. For school vans and public buses these rates stand at; 31% students contributing 13% and 40% students contributing 4% respectively.

4.7.2 School Vans

There are an estimated 1,000 school vans transporting students to Kandy. Approximately 850 school vans were registered at the Central Provincial RPTA in 2010, however, there are vans transporting students to Kandy that are not registered at RPTA. The school van flows at major entry points to the SA cordon showed a total of 1,837 school van movements (two-way) or 918 school vans in a day across the municipal boundary. School van flow across the SA cordon and their destinations are shown in the Table 4-24 below, and are shown graphically in Appendix 4-2.

[6] *Pushparajah et.at. (1999) in 'A comparative study of school vans vs. school buses – Traffic engineering and energy implications', Undergraduate research project, University of Peradeniya*
[7] *Kamalasena et.al. (2010) in 'Modeling school trip mode choice in Kandy suburbs', Undergraduate research project, University of Peradeniya*
[8] *Wijesinghe et.al. (2011) in 'Effect of parental attitudes in school trip mode choice – a case study in Kandy', Undergraduate research project, University of Peradeniya*

Table 4-24: School Van Flow (two-way) at SA Cordon

Entry Point	Cluster of Destination					
	Western	**Central**	**Southern**	**Eastern**	**Northern**	**All Clusters**
Gatembe – SBM	313	145	22	116	13	618*
Gatembe WGM	20	51	15	66	0	214*
Ampitiya	37	18	34	40	6	135
Thennekumbura	82	111	15	56	33	311*
Lewella	14	27	2	19	2	64
Polgolla	21	29	6	14	18	101*
Katugastota	47	158	9	52	116	394[9]
All Entry Points	**534**	**539**	**103**	**363**	**188**	**1837**

It is also observed that there are a considerable number of vans serving more than one cluster. Only 47% of the vans serve a single cluster. There are 36% serving two clusters, 15% serving three clusters and 2% more than three clusters. Serving multiple clusters cause certain amount of congestion as these vehicles have to pass through the CBD several times during peak periods.

4.7.3 Contribution of Rail in School Transport

Although eighteen out of twenty three major schools in the study area, or the clusters Western, Central and Northern representing 79% of school children, are located in a ribbon of easy walking distance from the Peradeniya – Kandy – Katugastota rail track, it is observed that only 0.5% of school children are using the train as the school transport mode presently.

4.8 Parking

Demand for roadside parking, particularly in the grid-city area of the CBD, seems to surpass the available capacity. Parking spaces in streets such as DS Senanayaka Veediya, Yatinuwara Veediya, Kotugodalla Veediya, Colombo street etc. get filled up as early as 8:30 AM and the Parking utilisation curves for these streets show a persistent over-utilisation of capacity until as late as 6:00 p.m., in some cases the actual parking exceeds 150% of the legal parking capacity of the link.

Daily parking load (eleven-hour: 7:00 AM – 6:00 PM.) of the 55 road links in the CBD in which roadside parking is allowed was 14,667 vehicles. Of these, motorcycles, three-wheelers and car/jeep have representation of 22%, 30% and 24% respectively, followed by 15% vans, 6% buses and 5% goods vehicles. However, the compositions of the parked vehicles vary with location. Thus parking of buses, goods vehicles and vans is not an unusually large problem when compared to other vehicles, except in some locations within the CBD. It is noted that three wheelers make up 30% of the demand for parking. As such nearly 5,000 three wheelers were found parked over the 11 hour period- no doubt many three wheelers would have been counted twice.

Average parking durations observed in the different streets in Kandy CBD has varied from less than 30 minutes to 105 minutes. In some streets the 85th percentile parking durations were almost four

[9] *Note: Totals may not match due to destinations outside the selected clusters. When one van serves more than one cluster, they are distributed to the destinations accordingly.*

hours. Average 85th percentile parking duration for the CBD was 90 minutes. Deva Veediya, D.S. Senanayaka Veediya, and Kande Veediya had relatively longer parking durations, with 85th percentile

parking durations above two hours. This is presumed to be due to the practise of traders in this area parking their own vehicles throughout the day in close proximity to their shops. Yatinuwara Veediya and Rajaphilla Mawatha show shorter parking durations with 85th percentile parking durations around 30 minutes. It is interesting to note here that, in many streets, the median parking durations were around 30 minutes even when the average parking durations were high, suggesting a reasonable number of vehicles with very long parking durations. Out of the total 825 parking spaces available in CBD, 118 spaces or 14.3 % were occupied for durations greater than 8 hours, which is a good sign. However, the average parking turnover for the 11-hour period remained at only 17.8 minutes, due to a large proportion of very short-duration parkers. Characteristic of some selected major roadside parking locations are given in the Table 4-25 below.

Table 4-25: Parking Characteristics of Selected Roads in Kandy CBD

Street	Parking Capacity	Peak Utilization (%)	Parking Composition (%)				Parking Duration (Hrs)		
			3 Wheeler	Motor Bike	Car/Van/ Jeep	LGV	Average	Median	85th Percentile
Colombo Street	169	121	37	21	29	9	1.09	0.50	1.43
Kotugodalla St	135	134	29	37	31	3	1.17	0.50	1.57
D.S. Senanayaka St	76	167	32	35	29	3	1.21	0.50	1.64
Raja Veediya	70	109	27	18	45	6	1.29	0.50	1.92
Haras Veediya	65	78	24	33	32	11	1.31	0.50	1.46

4.8.1 Off-Street Parking

The provision of off-street parking in Kandy is dominated by the Kandy City multi-storied car park that is presently managed by the KMC. This facility has space for 850 vehicles. Average daily parking load at KMC car park was 2,476 with a daily turnover rate of 2.9 per space. Contrary to roadside parking, around 66% of the vehicles parked at the KMC car park belonged to the car/ jeep category, followed by 23% vans. Percentages of motorcycles, three-wheelers and goods vehicles were as low as 4%, 5% and 2% respectively. It is observed that the peak parking utilisation does not exceed 90% during a 15 day period in April~May 2011. On Sundays the peak utilisation dropped as low as 36%.

It is observed that, although the parking utilisation at roadside parking was above 100% almost everywhere, the utilisation of the Kandy city car park was only 70% to 80%. This even was after arranging to park idling school vans at a concessionary rate of Rs. 1000.00 per month. According to the records, 100-110 school vans are presently parked at the car park as per this arrangement. One reason for the under utilisation of the facility, and the practice of long-duration parking in the roadside, may be the parking fares structure at car park, that does not permit any concession to long-duration parkers as against the roadside parkers.

4.9 Road Characteristics

The highway database consists of more than 150 road links constituting 63 roads in Kandy CBD including cross sectional dimensions, on street parking spaces available, road frontage land use, road geometry, and travel time etc. The total length of roads in the CDB is nearly 80 km of which 5.18 km are one way links.

The Map 4-3 in Volume II gives the traffic flow arrangement in the CBD. An inventory of roads is given in Appendix 4-3. This shows a list of these 63 roads in the CBD of which is given the geometric conditions and the observed travel times both during off peak and peak periods.

4.9.1 Travel Time Analysis

A total of 174 travel observations have been made on the 63 roads in the CBD network and the results are given in Appendix 4-4. The network speed during the peak period is calculated at 16.7 km/hr while the off peak speed is calculated at 25.7 km/hr. However the speeds on the busier roads are below this average, with peak period flows recording between 4 km/hr to 15 km/hr.

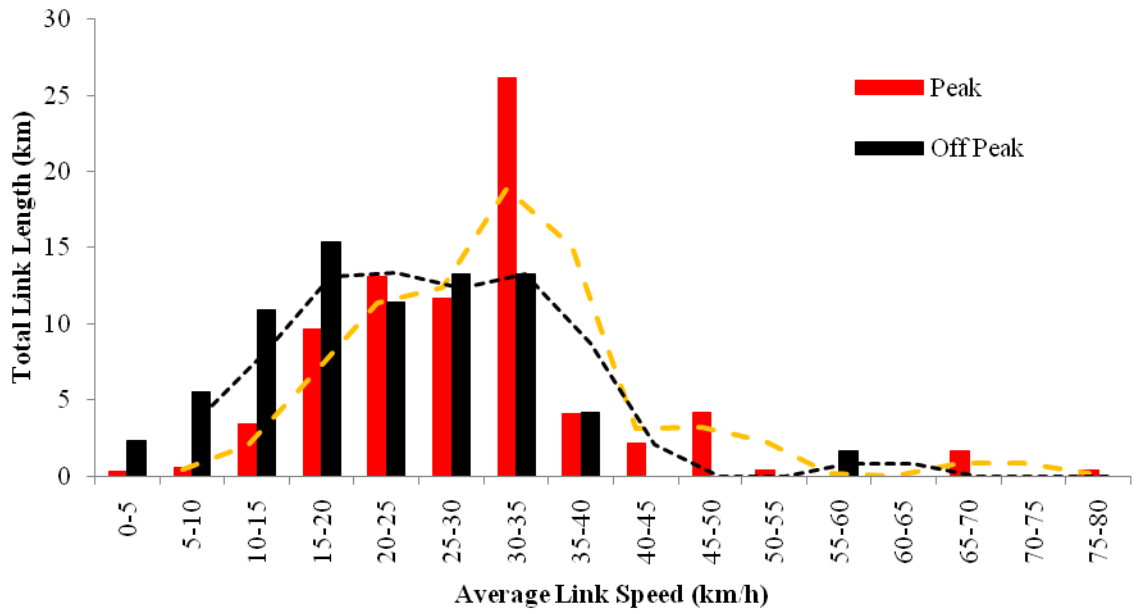


Figure 4-12: Travel Time Analysis in CBD Road Network

Table 4-26, gives the travel time and speeds of the most important roads in the Study Area. It is seen that the actual capacity (LOS) of some of the road links is much less than the calculated capacity (LOS). The examples are George E. de Silva Mawatha and Wariyapola Sri Sumangala Mw where the calculated LOS is B to C whereas the actual observed speeds are only 4 -14 km/h during peak periods and 16 -21 km/h during off peak hours. Poor traffic management seems to be a prevalent cause for this. Similar conditions can be found on most of the other roads, expect for SWRD Bandaranayake Mawatha, Katugastota Road, D. S. Senanayaka Veediya, and Sangaraja Mawatha. William Gopallawa Mawatha.

Table 4-26: Average Travel time and Speed during Peak and Off Peak Periods

No	Road Name	Length (km)	Average Travel Time (s)		Average Speed (km/h)	
			Peak	Off Peak	Peak	Off Peak
1	Wariyapola Sri Sumangala Mw.	0.763	755	176	4	16
2	SWRD Bandaranayake Mw.	1.132	819	191	5	21
3	Katugastota Road	2.928	1706	402	6	26
4	D.S. Senanayaka Veediya	1.162	459	167	9	25
5	Kotugodalla Veediya	0.601	199	146	11	15
6	Colombo Veediya	0.555	180	126	11	16
7	George E. de Silva Mw.	1.533	388	265	14	21
8	Sangaraja Mw.	1.957	443	249	16	28
9	Yatinuwara Veediya	0.585	124	68	17	31
10	Ampitiya Road	0.398	76	57	19	25
11	Sirimavo Bandaranayake Mw	5.312	1013	666	19	29
12	Dutugemunu Mw.	2.940	557	453	19	23
13	Matale Road	0.350	57	54	22	23
14	Dalada Veediya	0.799	128	99	22	29
15	Dharmasoka Mw.	3.043	485	358	23	31
16	Adahana Maluwa Road	1.090	164	137	24	29
17	William Gopallawa Mw.	3.655	484	326	27	40
18	Anagarika Dharmapala Mw.	1.180	145	136	29	31
19	Hewaheta Road	2.500	294	286	31	31
20	Guhagoda Road	7.200	800	741	32	35
21	Werra Madduma Bandara Mw.	1.020	87	76	42	48

It can be seen that of the major approaches, the approach from Gatembe is currently the most satisfactory with Sirimavo Bandaranayake Mawatha showing average speed of 19 km/hr and William Gopallawa Mw showing 27 km/hr. There are effectively four lanes of traffic volume among these two roads which meets the minimum requirements of the current demand. Besides, there is relatively less road side development on William Gopallawa Mawatha. However Katugastota Road is the worst performer as there are only two lanes and consequently the speed drops to just 6 km/hr during peak period. The eastern approach from Thennekumbura is also unsatisfactory showing speeds of only 16 km/hr during peak period hr. The roads outside the CBD area such as the Guhagoda Road, Hewaheta Road, and Ampitiya Road show much higher average speeds during peak period at around 30 km/hr. While the speed restraints on the major corridors are imposed by traffic levels, these speeds on the by-pass roads and other minor roads are imposed by poor geometry and restricted width.

4.9.2 Intersection Controls

Most intersections in the CBD and even in the Study Area are uncontrolled for traffic movements. Table 4-27 and the Map 4-4 of Volume II shows the types of control methods used for the major intersections. Even though a few intersections have been signalized in the 1990s, they are not utilized at present and are currently controlled by the police manually. Some intersections have been provided with roundabouts and channelized operations at present. All the other busy junctions are manually controlled by the police almost throughout the day and especially at peak periods.

Table 4-27: Traffic Control and Management at Important Intersections / Junctions

No	Intersection / Junction	Traffic Control Type
1	William Gopallawa Mw / Keppetipola Mawatha	Signalized Junctions (But manually controlled by police at present)
2	Sirimavo Bandaranayake Mw /Police Station Junction	
3	D.S. Senanayaka Veediya / Dalada Veediya (Queens Hotel Jn)	
4	D.S. Senanayaka / Kandy Veediya (KMC Jn)	
5	Sirimavo Bandaranayake Mw / William Gopallawa Mw	Roundabout
6	Sangaraja Mw / Ampitiya Road	
7	SWRD Bandaranayake Mw / Dalada Veediya	
8	Keppetipola Road / Ehelepola Kumarihami Mw	
9	Good shed / William Gopallawa Mw	Channelized Junctions
10	Rajaphilla Mw / Ehelepola Kumarihami Mawatha	
11	Heerassagala Road / Sirimavo Bandaranayake Mw	Police Controlled
12	Heerassagala Road / William Gopallawa Mw	
13	All Junctions in Sirimavo Bandaranayake MW	
14	George E de Silva Mw / Sirimavo Bandaranayake Mw	
15	Sirimavo Bandaranayake MW / SWRD Bandaranayake Mw	
16	Muslim Palliya Rd / Sangaraja Mw	
17	Sri Sumangala Mw / Adahana Maluwa Rd (Asgiriya Jn)	
18	Adahana Maluwa Road / Katugastota Road	

4.9.3 Roads Closed for Traffic

Furthermore Table 4-28 shows that a total length of 1.2 km of CBD roads that are closed for traffic for different reasons.

Table 4-28: Road Links Closed to Traffic at Present

No	Road Links (Closed to Traffic)	Length (m)
1	Raja Veediya	142
2	Deva Veediya	104
3	Dalada Veediya	308
4	Weera Madduma Bandara Mawatha	388
5	Anagarika Dharmapala Mawatha	230
Total		**1,172**

4.10 Traffic Generators

Most of the trip attractions in the Study Area shown in Map 4-5 of Volume II are concentrated within the CBD and along the three major access corridors to Kandy from the southwest (Sirimavo Bandaranayake Mawatha and William Gopallawa Mawatha), the north (Katugastota Road) and the east (Mahiyangana Road now diverted via Sangaraja Mawatha).

Estimated daily passenger attraction to several institutions representing above categories are as follows.

- Good Shed Bus Stand - Approximately 40,000
- Schools - Approximately 63,000
- General Hospital - Approximately 7,500
- Temple of Tooth - Approximately 6,000
- District Secretariat - Approximately 2,000
- Market - Approximately 25,000
- Kandy Consultation Centre - Approximately 2,500
- Food City - Approximately 2,500

4.11 Road Safety

There have been 36 fatal accidents and 149 grievous accidents in a period of 36 months in the Study Area making a total of 185.

Table 4-29: Summary of traffic accidents reported to Kandy Police station (2007 to 2010)

Type of Accident	2007/10 ~ 2010/12	2008/01 ~ 2008/12	2009/01 ~ 2009/12	2010/01 ~ 2010/09	Total
Fatal	3	12	7	14	36
Grievous	10	64	40	35	149
Non Grievous	24	209	135	206	574
Property Damage	45	370	244	273	932

4.11.1 Vehicle Involved in Accidents

The vehicle type of such accidents is shown in Table 4-30. This shows that buses are the most involved when considering that they make up around 25% of the fatal accidents even though they are only around 10% of the traffic flow. The high incident of mot cycle accidents is also a matter of concern.

Table 4-30: Vehicles involved in accidents by category

Vehicle Category	Number of Vehicles
Motor Bike	38
Van/Jeep	14
Car	29
Bus	56
Three wheeler	29
Tractor/Lorry	11
Bicycle	2
Not clear	6

4.11.2 Pedestrian Involved Accidents

The data also revealed that out of these 107 (58%) involved pedestrians. The majority of pedestrian related accidents have been recorded while walking alongside the road. There are also significant fatalities involved in crossing the road both at pedestrian crossings and away from crossings.

4.11.3 Accidents not involving pedestrians

Considering the accidents where pedestrians were not involved, it can be observed that of the vehicle only accidents, following is the distribution by primary reason for the accident.

Table 4-31: Reason for accidents

Reason for Accidents	Number of Accidents
Head on	18
Rear end	8
Side swipe	20
Hitting road side structure	5
Roll over/ without control	9
Reason not clear	18
Total	**60**

4.11.4 Location of Accidents

4.11.4.1 Fatal Accidents

The Map 4-6 of Volume II shows the locations of fatal accidents in the Study Area. It can be observed that of the 367 were recorded at the vicinity Good Shed bus stand. The majority of the remaining fatal accidents were observed to be on Sirimavo Bandaranayake and William Gopallawa Mawatha. There are only a few occurring within the CBD area. These are in the vicinity of the Good Shed and clock tower bus stand and railway terminal.

Analyzing reasons for majority of fatal accidents, it is clear that the conflict of pedestrian – bus conflict and haphazard way of moving buses is a reason to contribute for high number of fatal accidents at Good Shed bus stand. William Gopallawa Mawatha and Sirimavo Bandaranayake Mawatha have very poor segregation of pedestrians and vehicles leading to high accident rates.

An inspection of these roads shows that these roads have the combination of following factors that are primary reasons for the high incidence of fatal accidents:

- High traffic flow
- Heavy roadside development and more pedestrian activity
- Higher Speeds (especially in William Gopallawa Mawatha)
- Lack of centre median or any special road safety designs
- Absence of side walk facilities in most places

4.11.4.2 Grievous Accidents

On the other hand as shown in Map 4-8 of Volume II, the accidents classified as Grievous are spread more consistently across the entire Study Area.

This indicates that such accidents occur on the two roads that have heavy fatal accidents namely Sirimavo Bandaranayake Mawatha and William Gopallawa Mawatha and also on most roads within the CBD. There is a heavy concentration around the bus terminals as well as in some of the junctions of roads where moderate to high speeds are achieved. Sections of the A9 up to Katugastota as well as Lake Round Road, D.S. Senanayaka Veediya etc are commonly associated with grievous accidents. Most of these accidents involve pedestrians and motor cyclists. While pedestrian sidewalks are seen in these locations, they are not adequate at time of the day spilling users to the road itself. Moreover, pedestrians cross away from marked crossings. There are also no specific road safety measures to curb speeds or to ensure separation of conflicts at intersections. Most of the junctions are poorly designed paying less attention for the visibility, vehicle separation and proper guidance. Though the other types of accidents namely minor injury and damage only, are not mentioned, the situation is not different from above.

5 Issues & Conclusions

This chapter attempts to identify the main issues that are faced by Kandy City at present or would be of significant concern over the next few years. The study takes in to account that at present the Kandy City population considering the Four Gravets DSD area holds a population of around 130,000. The vehicle ownership in this area was recorded by end of 2006 at around 20,000 in the Four Gravets Area, thus showing that the Vehicle Ownership Ratio is 65 vehicles per 1000 population.

However, the number of people entering the City during a day is around 350,000 comprising around 90,000 for employment, over 60,000 for schools. It is observed that at this current level of transport activity Kandy City has advanced symptoms that the available road infrastructure will not be able to handle the increasing traffic levels satisfactorily. This is considered most significant given that due to the containment of the Kandy City between the Mahaweli Ganga and the Hantane mountains, the space available for expansion of current transport infrastructure or for new infrastructure will be limited and expensive.

5.1 Demand and Supply of Road Space

Traffic and Passenger Counts in 1998 (Jayatilake, 2003) estimates the entry of 30,000 vehicles including 4,800 buses at the SA Cordon. Over a period of 13 years the total vehicle entry level has increased to 56,000. This reflects a growth rate of 5% per annum or a doubling every 14 years. The corresponding figure for the number of passengers has also increased to 105,000 at the CBD and 215,000 making a total of 320,000 passengers. The current passenger flows at the CBD are 167,000 by private modes and 214,000 by bus. Thus it can be seen that bus flows have remained constant, while passengers arriving by private vehicles have increased by 60%. School vans do not show a significant change. Overall public transport share at the SA cordon has fallen from 67% in 1998 to 64% in 2011, signifying a reduction of around ¼ percentage every year.

Furthermore consideration has to be given to the increasing incomes and consequent motorisation. Given that at current levels of motorisation the public transport share is holding at around 60% is little though for comfort. It likely that there would be more demand for mobility, vehicle ownership and for increased used of vehicles all of which would result in an increase in demand for road space much higher than the economic growth rate.

In 2003, Kandy district had the highest vehicle ownership rates next to the Colombo district in the Car/ Van/ Jeep category whereas Four Gravets (Kadawath sathara) and Gangawata Korale DS division, that covers the Kandy city area, had the third highest vehicle ownership rate in the country at, 61 per 1,000 population, in the private vehicle category of Car/ Van/ Jeep after Colombo DSD at 147 and Nugegoda DSD at 76 vehicles per 1,000 population.

Currently the only restraint to increased vehicle flows to the Kandy City and congestion and availability of parking. However it can be seen that even with these restraints there is growth of 5% requiring doubling of road space every 14 years and possibly within 8-10 years if there is accelerated economic growth as expected. With personal incomes rising from average per capita of approximately 2000 USD to 5000 USD as forecasted over this period, most families will be able to own a three or four wheeled vehicle, and most would have the economic means to use it every day.

It is clear that widening approach roads would only lead to increase vehicle circulation within the centre, increased demand for parking. As such the primary solution has to begin with the long term sustainability of the traffic levels and what needs to be done to achieve it and retain it. In this respect the following issues and conclusions are discussed in detail in this chapter:

A. Conflicting Land Use
B. Inefficient Bus Transport Network
C. Underutilisation of the Railway Network
D. Excessive Pedestrian Activity in CBD
E. Connectivity to proposed Colombo-Kandy Alternative Highway
F. Traffic Congestion of Major and Minor Roads
G. Inadequate By-Pass roads for CBD and Kandy City area
H. Inappropriate Traffic Management Measures
I. Management of School Transport requirements
J. Road Safety and
K. Air Quality Issues

5.2 Conflicting Land Use

Emergence of Kandy of as well as its urban order had been forceful. The placing of the imposing Royal Palace against the Udawatta forest, annexing the temple for exhibition of the Tooth relic, and the colonial additions were all enforced urban patterns and activities that were not demanded by a living community. The evolution that resulted in terms of activity and land use has not been demanded by the social evolution but mostly by visitors. Queen's Hotel, Hotel Suisse and administrative functions of the colonial era and commercial establishments such as banks, hotels, restaurants, spare-parts shops, hardware shops, furniture stores, bakeries, food outlets of the post-colonial era had not been designed to cater the living community. Kandy became the commercial and administrative center for the central hills during the colonial era that established a plantation economy. This conversion is the most significant contribution to the creation of the current mismatch between land use/ activity patterns and citizens. It is noted that still Kandy remains the center for the hill country for commercial, cultural, amenities, leisure and entertainment. The development of conflicting land use has ejected residents and attracted more place-less activities, turning an unwanted zoning system to compartmentalize the city. This pushing the residents to the city edge has caused an urban sprawl, promoting residents to seek for modes of transport and space for parking in the city, their service center. The map 5-1 of Volume II shows the conflicting land use pattern prevailing in Kandy city

The inner city is one of the most instructive examples for the development of an activity pattern. The life in the inner city ends in the evening as there is no resident population in the night. Banks and other financial establishments, education and other amenities, and commercial activities have been accommodated in this urban quarter at the expense of habitable activities. It is noted that over 50% of the activities are used by outsiders, causing heavy traffic jams, air pollution, and ever-rising demand for space for parking and for service vehicles. The development plan of the Urban Development Authority proposes this quarter to be shaped in to a zone of mixed-development, and detail out the *scale* of functions in terms of floor area. The mismatch between land use/ activity pattern and the society may continue to strengthen the compartmentalization of the city, hindering potential economic

growth in Kandy. Furthermore, the deteriorating livability in Kandy may create a haunted city whereas it has high potentials to become an ecologically-sustainable living city.

The land use and activity pattern in and around the prison complex has been alarming in terms of accessibility to the city. The space is mostly occupied by vehicles and people are given a smaller portion of city space. Heavy movements of vehicles and uncontrolled movements of pedestrians have emerged from the existing land use pattern. The multi-story car park has been useful in terms of providing parking, but at the same time, the facility has aggravated the traffic situation by concentrating vehicular movement within a smaller urban space. Those who park their vehicles to use the facilities in the inner city find it difficult to use the pedestrian paths due to this traffic concentration. The proposal to add a convention center to the top most level of this facility would further hinder the accessibility to the city center as that facility may absorb and release heavy traffic on certain given times. A similar situation of traffic concentration is experienced around the schools and cinemas beyond this urban quarter.

There are many hardware stores, bakeries, wholesale stores, shopping warehouses and other similar activities accommodated in the central KUDA. They, demanding parking and access for heavy vehicles, contribute to traffic and air pollution, and further dismantle the user-friendliness of the city. The activities placed on Colombo Street attract users of from the city as well as from other cities. They need not to come to the city center if the facilities are provided elsewhere.

Figure 5-1: Inappropriate Land use & Road Utilization

Figure 5-2: Conflicts at Bus Stations

Schools and educational facilities are the next most inappropriate land use pattern in terms of the traffic congestions in the city. They attract thousands of vans, private cars, busses, contributing to the

air pollution in Kandy. Most interestingly, the pupils come from the city edges, suburbs, or from other cities. Since the schools are scattered all over the city, some of the vans do have to cross the center, causing much chaos. The administrative facilities and other secular functions are also scattered all over the city, and their transporters cross the city too. As such, most of the urban quarters in KUDA have become uncontrolled growth points. The zones have evolved spontaneously deforming city's diversity/ density composition and losing its livability.

The development plan enacted by UDA suggests mixed development zones without assessing the potentials of the existing zoning pattern. One may see that the said plan legitimizing those zones and their activity pattern without screening their impact on the livability of the city. The term mixed-development is not specified in terms of activities, their mixture, or the character.

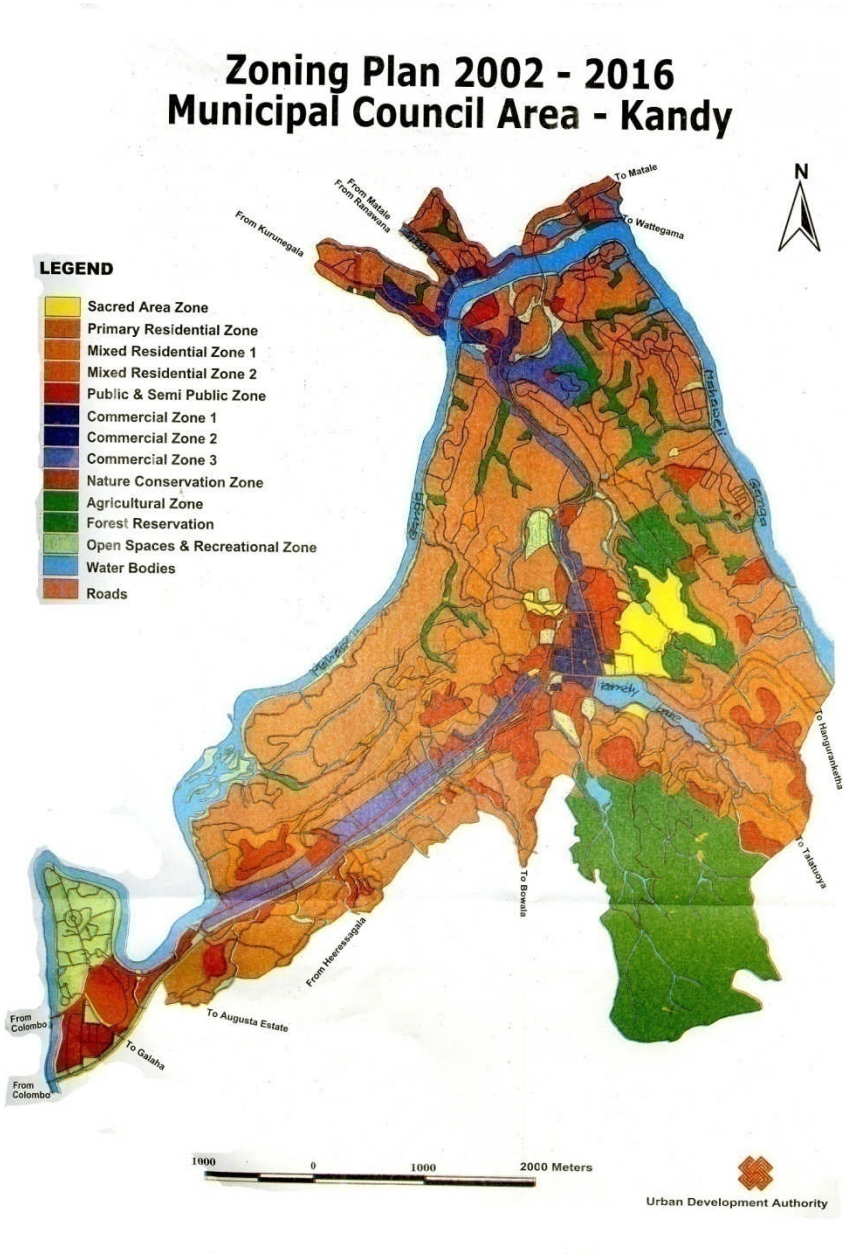


Figure 5-3: Proposed Zoning Plan by UDA[10]

[10] Source: Kandy Development Plan, Urban Development Authority

It is clear that the activity pattern in Kandy has not evolved in order to strengthen the image of the World Heritage City or to facilitate the public perception of the city as the major sacred Sri Lankan city for Buddhists. It has not been able to sustain the image of a living city as the public urban spaces are not accommodating diverse users. The current land use and activity pattern, which have evolved with a vision of a commercial hub at the expense of a cultural city, seem have distorted the image of the city.

Figure 5-4: City with less Ability to Contain

Figure 5-5: City Center Dominated by Vehicles

5.3 Inefficient Bus Operations

Buses provide the bulk of the transport requirement of the Kandy City currently carrying 64% of passengers at the SA Limit and 56% at the CBD. However, bus services are found to be vastly inefficient both from the service they render the passengers as well as integration with the city and meeting its transport requirements. Buses are also loosing passengers to private vehicles due to increasing affordability of private transport and non development of public transport.

The primary issues in bus operations are as follows:

5.3.1 Integration of Terminals

The three bus terminals together with the railway station are located in the south-western corner of the city. Even though they are reasonably close to each other there are neither proper pedestrian paths nor guidance for pedestrian to move between them.

Poor integration between short and long distance services is also an issue. At present all long distance services are allocated within Good Shed terminal which is served by only a few short distance services. Hence all passengers transferring to and from short distance buses have to walk from Torrington, Bogambara, Clock Tower etc. This requires the design of an integrated bus terminal. This quarter of the city has become the most congested with large flows of buses and pedestrians milling about and getting in each other's way, thus creating congested road condition for all vehicles entering and leaving the city from the southern approach.

5.3.2 One-way System

There is a one-way traffic system in force around the bus terminals. This causes buses to concentrate on a few roads increasing bus flows, making stopping difficult. As a result bus stops have been removed from many areas and currently apart from the 3 terminals there are only 8 legal bus stops within CBD limits. As a result, large numbers of passengers walk to terminals causing much disruption to traffic flows that head towards the bus terminals.

5.3.3 Termination of Services and Lack of Through Services

As discussed in Chapter 3, the termination of all local services and over 90% of inter-provincial services at the CBD has a twofold problem. In the first instance this contributes to large number of passenger transfers as well as creating large pedestrian flows as prospective passengers walk across town to the other terminals to catch a bus going away from the town centre. In the second instance, it causes the congregation of large number of buses in the town centre requiring circulation and parking. The large bus park at Bogambara which can accommodate around 150 buses has become an urban eyesore and this often overflows causing traffic congestion. Moreover, major approaches such as William Gopallawa Mawatha, Mahaiyawa road, Rajaphilla Mawatha, Ehelepola Mawatha, and Keppetipola Mawatha have become virtual bus parks. This requires the re-routing of buses such that there is through running and passengers do not have to alight and board again thus causing buses to stop, park, circulate, pick up passengers all activities that put pressure on the limited traffic circulatory space available in the CBD.

5.3.4 Design of Bus Terminal

None of the bus terminals in Kandy have been designed properly. Two of them are on-street terminals. For a bus terminal handling over 430,000 passenger boardings per day, this nothing short of a disgrace. The incessant turning, reversing, waiting often causes disruption and inconvenience to other road users, thus creating a disorderly scene around bus terminals. This also negatively impacts the urban quality of life including inconvenience to all road users. Besides these deficiencies, none of the terminals have well designed facilities for passengers such as waiting areas or sanitary requirements. The pedestrian walkways connecting the terminals have been poorly designed and often compete with vendors encroaching to pedestrian space.

5.3.5 Short Run Urban Routes

It was observed that most local bus services terminating in Kandy CBD are from the periphery of the study area. As such residential areas within the study area such as Aruppola, Watapaluwa, and Mawilmada are not served adequately by high frequency bus services. Some of these areas have narrow roads and hence three wheelers are the only form of public transport available. However, some roads should be developed to access these areas and new bus services operated to make all areas within Kandy City accessible to bus transport. Having a bus route within at least 500 metres of any residence should be a good guide for a city such as Kandy.

5.3.6 Developing Bus Services on By-Pass Roads

Several by-pass roads have now emerged as discussed in Chapter 3. However, none of these roads such as Guhagoda Road, Dharmasoka Mawatha, and Dutugemunu Road have appropriate bus services that would if developed divert traffic away from the city centre.

5.4 Underutilisation of the Railway Network

The railway carries less than 1% of the passengers arriving in Kandy City. This is an underutilisation of the available transport infrastructure. Given the limited availability for future expansion of road based transport, the railway should be preserved and developed as a significant player for Kandy's future transport scenario. In Colombo city, the railway carries around 10% of the daily passengers, while carrying around 20% during the peak and as much as 30% on some of the corridors that has higher level of service.

Kandy's railway line from Peradeniya to Katugastota in particular is well positioned to provide for good urban access. This line is located within walking distance to most f the major schools, city centre, bus terminals, commercial centre, tourist areas, general hospital, government offices etc. In other words the railway can be much better utilised if a reliable, high frequency service can be operated. The line requires to be double tracked and more stations with good integration with land access provided. A train service utilising power sets that provides a 10 minute frequency in either direction during the peak and a 15 minute frequency during the off peak can carry 10,000 passengers in the peak period and say 5,000 passengers per hour during off peak, thus taking around 70,000 passengers or approximately 20% of the total demand.

This will also provide an improvement to overall ease of mobility by proving railway as another choice for daily commuters, school children and even for tourists. It will also provide another mode of transport which will enable the city to function even if there is some disruption to road transport such as that forces closure of a road, public transport strike or similar event. Moreover, the possibility of extending the railway to the areas east of Kandy such as Digana and Pallekele to which there is currently no rail access could be investigated.

5.5 Excessive Pedestrian Activity in CBD

The excessive pedestrian traffic in Kandy causes inconvenience to those using it, as the infrastructure facilities are not available to accommodate such flows. Moreover the pedestrian flow causes

disruption to road traffic and also undermines the attractiveness of Kandy as a tourist destination and cultural and religious centre for which more serene and tranquil environments are preferred.

In order to de-congest pedestrian walkways the following issues have to be addressed:

- Setting up of an integrated bus terminal to eliminate walking between terminals
- Re-routing buses so that routes run through the town reducing the need to walk between terminal and end node of a trip
- Opening up of alleys and narrow streets as pedestrian walkways which may be developed as tourist walkways.

5.6 Connectivity to Proposed Colombo-Kandy Alternate Highway

The proposed Colombo-Kandy Alternate Highway (CKAH) is currently designed to approach the city from the western side close to Katugastota. The approach to Kandy city from Katugastota is currently the worst. Even if the present plan to widen it to four lanes from the bridge to the Asgiriya-by pass is completed, it is unlikely to be able to accommodate the increased flow that currently approaches mostly from Gatembe. It therefore considered necessary to provide for at least one other access preferably to the largely under developed western side of the Study Area by a new crossing of the Mahaweli Ganga.

5.7 Increasing Access to Areas Bounded by the Mahaweli Ganga

The lands bounded by the Mahaweli have poor access. The left bank of the Mahaweli Ganga which falls within the Kandy City Area is particularly under developed. The roads in these areas such as the Kuda Ratwatte Mawatha, Wattarantenna Road, Aruppola Lane, Dutugemunu Mawatha etc are in poor condition. There is no significant bus transport either. These are areas that can be further developed especially for residential access and for tourism development.

5.8 Traffic Congestion on Major Roads

The Levels of Service (LOS) for the main approaches to Kandy City are given in Table 5-1 below. The capacity of each link has been calculated using the road inventory data including cross sectional properties and activity types such as parking collected under this study.

Table 5-1: Existing Capacity and the LOS of the Major Roads

Name of Road	ADT Base Year (2011)	Carriageway Width (m)	Design Hr. Flow	No. of Lanes	Design Capacity (veh./hr)		V/C Ratio	LOS
					Capacity	%		
Adahana Maluwa Road	15,283	8.4 - 7.5	1,437	2	2132	0.76	0.67	E
D.S. Senanayake Veediya	18,940	8.7 - 10	1,780	2	2,132 - 2,632	0.76 -0.94	0.68 - 0.84	E
George E. de Silva Mawatha	5,255	5.7 - 6.4	494	2	1,289 - 2,211	0.46 - .79	0.22 - 0.38	B - C
Sangaraja Mawatha	25,638	8.40	2,410	2	2131	0.76	1.13	F
Sirimawo Bandaranayake Mw	18,383	9.50	1,728	2	2,027 - 2,632	0.72 - 0.94	0.66 - 0.85	E
Wariyapola Sri Sumangala Mw	5,540	6.60	521	2	1,526 - 2,421	0.55 - .86	0.22 - 0.34	B - C
William Gopallawa Mawatha	25,452	14.50	2,393	2 - 4	2,421 - 5,445	0.72 - 0.94	0.44 - 0.99	D - E

It is observed that the existing LOS of main links indicates that they are almost saturated with present day traffic levels for the design hour of the day. The main approach roads to city centre namely the, William Gopallawa Mawatha, Sirimavo Bandaranayake Mawatha, D.S Senanayaka Veediya (Katugastota Road), Sri Sangaraja Mawatha are at capacity showing LOS of "E" or below at present. Sri Sangaraja Mawatha which traverses the Lake has the worst LOS at present as it has only two lane capacities. This is due the Dalada Veediya being closed at present and all east bound traffic having to use this road. This causes a de-tour of approximately 2 km.

Some alternative north-south roads for Senanayaka Veediya such as Adahana Maluwa Road that carries around 15,000 ADT also show a LOS E for the peak hour. Some roads that are not major corridors such as Wariyapola Sri Sumangala Mawatha and George E De Silva Mawatha just outside the CBD are functioning much better at present with LOS of B to C.

It is thus clear that all approaches and specially the northern and eastern approaches have poor LOS and subject to recurring congestions especially during the peak period.

The effective capacity of the 32 road links in Kandy CBD area have been tested for ideal conditions and it was found that they all are significantly lower than the ideal situations. The reasons are the inadequate shoulder / walkway widths, narrow lane widths of most of these links of the main roads. Thus it is evident that most of the roads in the CBD are have to be re-engineered to accommodate the requirements of the different road users and with proper intersection control, channelization etc.

Table 5-2: Capacity Statistics of Road Links in CBD

Capacity	Links	%
Over 90%	8	25
90-80%	9	28
80-70%	15	47
Below 70%	0	0
TOTAL	32	100

5.9 Inadequate Bypass Arrangements for CBD and Kandy City

The heavy portion of traffic running through Kandy City and especially its CDB shows that the by-pass arrangements are not working adequately. As shown in the Map 2-4 of Volume II the bypass arrangements are required for traffic arriving at Gatembe, Katugastota and Thennekumbura to reach any of the other locations by passing the Kandy city and the CBD.

CBD By-pass

South to North: Adahana Maluwa By-Pass (Sirimavo Bandaranayake Mw to Katugastota Road): Currently used satisfactorily but steep incline near the Police Station makes it difficult for use of this by-pass by heavy goods vehicles. Otherwise the road is in satisfactory condition, even though it is at capacity during peak times. There are no public transport routes on this route.

South to East: There is no proper by-pass arrangement for this movement. Only one way flow from East to South is available from Sri Sangaraja Mawatha through Bogambara Stadium to William

Gopallawa Mawatha. Traffic running from South to East has to go through town area. Trucks use this route as well as public transport.

North to East: The Dharmasoka Road which connects the Katugastota Road to Boowelikada is a by-pass for the CDB for traffic in the north–east direction. This is currently in satisfactory condition but not suitable for goods transport. Not served by public transport

Recently a proposal has been made for a tunnel to connect Boowelikada to Bogambara area through the Hantane mountain range. This is a length of around 3 km. On inspection of the sites it was found that the Boowelikada end was on the Lewella Road and not conveniently accessible for traffic coming from the Thennekumbura side. A better location should be found to start the tunnel. The outlet at Bogambara is also a congested location and it is considered that it should be located a little distance away from the town centre, possibly with access to William Gopallawa Mw south of the Hospital which is the south most large generator on that road.

5.10 School Transport

Schools in Kandy attract students from places as far away as Matale, Kegalle, Gampola and Digana and the student population, as compared to the population in Kandy, is very significant. Morning school peak, which is higher than and slightly staggered from work peak even at the study area cordon, is almost equal to the average daytime inflow or approximately 800 vehicles per 15-min and is around 200 vehicles per 15-min higher than the work peak, as shown in Figure 4-6.

5.10.1 Congestion during School Peak Hours – Role of School Trip Modes

It was also obsereved that 65% of the school traffic is contributed by the 16% of students who travel to school by private transport means. This is very significant when compared with the fact that 47% of students who travel by buses (school and public) contributing only 9.2% to the school traffic and the contribution of 31% of students who travel by school vans towards the school traffic is only 14%. There are a further 6% of students who travel to school in hired three wheelers contributing 11% to the school traffic. In otherwords, a student travelling to school by private vehicles contribute 20 times more than a student who travels by bus. For school vans this is about 2 times and hired three wheelers 10 times.

Although the proportion of students travel to school by buses is still high at 47%, there seems to be a gradual decline in patronage, a reduction of 6% from 1998 to 2010,which is unwelcome. Similarly, there is a slight decline of 2% in usage of school vans too. There is an associated increase in the use of private vehicles, a 7% increase during the 12-year period, that gives an idea of the unfavourable trend we are in. It is therefore eveident from the above that some measures are needed to be taken to reverse this trend, or at least to arrest the current trend at manageable levels. That means, more bus-friendly and school-van-friendly measures are to be encouraged.

5.10.2 Issues Related to School Vans

Among some of the concerns of one of the most predominent modes of school transport, school vans, are the spread of the destinations they serve and the problem of van parking. School vans are naturally unregulated with respect to the destinations they serve, fares, routes they travel, loading and comfort conditions. In a recent study, it was found that a majority of parents send their children, especially the

students in primary classes and girls, by school vans as they provide door-to-door service, albeit costlier than public transport, whilst anticipated security and safety are other major concerns.

5.10.3 Spread of Service Areas of the School Vans

The origin – destination surveys carried out as a part of this study revealed that there are significant number of school vans, a 53%, serving more than a single school cluster and 17% serving more than two clusters. When a school van is serving more than one cluster, they have to travel through the city, especially when the clusters are not adjacent. There are 25% of school vans that serve clusters which are not adjacent. In such cases these vans cannot utilize the by-pass roads available and avoid congested areas. A regulation with respect to the service destinations, which can be in the form of an incentive to those vans that serve only a singe cluster, can help reduce the vehicle-kilometers travelled by school vans and the congestion caused by them.

5.10.4 Parking of School Vans

Roadside parking of school vans causes another disruption to traffic. This occurs in two ways; idle parking of school vans along minor or access roads and short-term parking near schools to pick up students at school closure times. In the mornings, dropping off students near schools creates a minor disruption to traffic. Over the last decade the practise of idle parking of school vans near schools has reduced mainly due to the police enforcement. However, this has only shifted the parking locations to further away from the major roads, into less congested minor and access roads, such as Wariapola Sri Sumangala mawata, Rajapihilla mawatha, Aniwatta road, Deveni Rajasinghe Mawatha etc. There also has started a practice of making these vans available for short-term hiring during the school times. Only a small proportion, about 10%, have opted to park at the Kandy City Centre car park even at the concessionary scheme that was introduced recently. Most of the schools have their entrances/ exits to the major roads and that prompts the school vans to wait-in along the major roads for the students at school closure times. It is required to recognise the importance of school vans as a school transport mode that uses road space fairly efficiently and to address their parking needs while minimising the adverse effects on the traffic circulation caused by roadside parking of school vans.

5.10.5 Underutilisation of Railway as a School Transport Mode

Although majority of major schools in Kandy, with the exception of those in Southern and Eastern clusters, are conveniently located in walking distance to the Peradeniya – Kandy – Katugastota rail track, railway has not attracted significant number of school trips owing to the problems in service provision such as service frequency, location of stations/ halts and punctuality. If a reasonable number of school trips are shifted to rail, congestion during morning school peak may be significantly reduced.

5.11 Road Safety

5.11.1 Intersection Improvements

As evident from the analysis of traffic accident information, it is very important to improve the conditions of junctions. Proper turning lanes, improving visibility, gradient at junctions are some

important areas to consider. Some of these junctions are blocked by vehicle parking and large size commercial holdings as well.

5.11.2 Segregation of Users

Heerassagala Junction on Sirimavo Bandaranayake Mawatha as well as William Gopallawa Mawatha, High school junction on Sirimavo Bandaranayake Mawatha, Good Shed bus stand, Queens Hotel junction, Entrance of Kandy Hospital, Railway junction, Clock Tower bus stand are some of the locations that can be identified as highly accident prone based on data. None of the above locations have a proper method to segregate different road user groups. A proper means of segregating vulnerable road users from vehicles also can improve safety particularly that of pedestrians. Out of 185 fatal and grievous accidents, 107 accidents were reported with pedestrians.

5.12 Air Quality

Kandy city is located in a flat valley surrounded by hills and mountains. This results in a very low mixing height for atmospheric air in the city. The atmosphere of the city has been observed to become hazy during periods of high traffic with the haziness persisting for long hours. During these periods of high traffic there is a drastic slowing down of vehicular speeds resulting in significant increases in the emission of local air pollutants, since fuel efficiency decreases with speed, especially under stop-go driving condition.

A study by Elangasinghe and Shanthini, (2008) from the University of Peradeniya has determined the atmospheric PM10 concentration in Kandy in relation to traffic intensity. PM10 is a mixture of materials that can include smoke, soot, dust, salts, acids, and metals and is known to be one of the most harmful air pollutants. When inhaled, these particles evade the respiratory system's natural defences and lodge deep in the lungs.

The PM10 concentrations recorded at 7 sites out of the 25 sites sampled were above 150 µg/m3, which is the daily average ambient standard imposed by the United States Environment Protection Agency (USEPA). Of these, 4 were within the boundaries of Kandy city and the other 3 were along the Kandy–Peradeniya, Kandy–Colombo and Kandy–Matale national highways. The highest PM10 concentration of 340 µg/m3 has been recorded at the 3-way junction at Katugastota situated along the A9. Their study shows that the average PM10 concentration exceeds 150 µg/m3 for traffic levels of 1,200 vehicles per hour. Currently all the major approaches carry traffic levels exceeding this level.

6 Recommended Solutions

This study will consider that the Kandy City should be a traffic constrained area given its cultural context as a Heritage City, its population density as well as its geographical and environmental setting. Accordingly, the study has identified the following strategy in seeking a sustainable solution.

- Land Use Development – keeping the different quarters in the city distinct so as to ensure that the cultural and residential features are not impacted negatively by the expansion of commercialization and increased traffic activity and to identify a future urban development model that would restrict less important trips to the city centre.
- Reorganising public transport – where the 200,000 bus passengers who arrive in Kandy CBD are processed efficiently and without adverse impact to the transport system especially with respect to reducing the nearly 200,000 transfers that take place daily within the city and to reduce the access distances to bus terminals that put heavy pressure on the road system causing pedestrian flow related congestion.
- Identifying the potential of developing the railways- to serve commuters including employees and school children.
- Identifying by-passes to the road network that can be developed to ensure that no other traffic other than which is intended to end in Kandy city uses the road network within the city.
- Re-design of the urban road infrastructure incorporating different road user needs including that of pedestrians, bus passengers, parking and private vehicle users that will allow different users high quality of use of the respective features.

6.1 Land Use Relocation

Protection of the heritage value of the living monument shall be given priority in any proposed solution. Accessibility to and usability of the heritage city and social inclusion shall play a vital role with this regard. Since KUDA has evolved with a multi-cultural society, it is important to note the particular diversity/ density composition to sustain the heritage values of universal recognition of Kandy. The sharing of urban space by many would attract vivid visitors as well as investments to the city, strengthening its character as a cultural diversity. It is clear that reorganizing the land use/ activity pattern in KUDA to make the city center user-friendly and accessible. It is also clear that some of the inappropriate uses such as hardware stores, furniture shops, and wholesale establishments shall be moved out of the city center and the scale of some other uses such as schools shall be managed to the existing level. The departmental stores can also be replaced by convenience store that could serve the visiting public. Kandy will then retain its heritage city character with a living population, and traffic congestion and the air pollution in the city center would be reduced.

Assessing the carrying capacity of KUDA in terms of the land use/ activity pattern would be first step towards resurrecting its livability. A morphological analysis of land use, city plan, and built forms indicates that KUDA has reached the limit of accommodating many uses, users, and activity patterns. Furthermore, a close scrutiny also indicates that the current land use as the major cause for deteriorating living standards. The demand for existing activities shall be assessed to curtail

inconceivable growth and to filter future proposals for new activities that may seek changes in land use, especially those that aim at converting entire urban quarters in to new uses. It shall be emphasized that KUDA needs stringent regulations to manage growth points, activity patterns, plot division patterns, and population to compose a land use that improves the livability of the city and strengthen the cultural capital of Sri Lanka. Such restrictions shall be guided to avert urban sprawl that may threaten the bounded nature of the city and out-migration of city dwellers. As a whole, the development plan shall reconsider a new zoning tool that is derived from the particular diversity/ density composition and how each zone may contribute to the making of that composition.

Any proposal to instigate Kandy's return to livable city shall start with the vision of conceiving the World Heritage City within the era of post-industrial city, ejecting heavy manufacturing industry and large scale commercial activities to the periphery. As a post-industrial city, it shall attract activities such as residential, cultural, leisure, and light industries. Since most of the large scale activities in KUDA are meant for visitors, shifting them to the peripheries would ease the traffic and improve living conditions, attracting the living community back to the city and as such returning the city to the public. It is possible to identify growth points on periphery, connected by a ring road and supplemented with infrastructure facilities, thus managing the visitor numbers and, at the same time, averting urban sprawl. These growth points could eventually become small scale cluster centers and even could be provided with parking. KUDA could introduce a circular bus or a park-and-ride solution from these growth points. It is also suggested to limit the Kandy Railway station exclusively for leisure while heavy goods transportation diverted at the periphery.

It is essential to curtail the growth of educational institutes such as schools, classes, etc. UDA or municipality shall take necessary steps to encourage them and especially the private and international schools that draw heavier traffic to shift outside the city limits. The major bus stations could be moved out of the inner city, and the space occupied by them could be converted into public plazas. The activities accommodated in the commercial precinct with the grid-iron street layout should be reconsidered. It is necessary limit this urban quarter only for those activities that do not draw heavy traffic. Following the parking formulae given in the UDA guidelines, the uses that have not provided sufficient parking shall be demanded to move out or contribute to the building of parking outside the KUDA limits.

Traffic congestion in Kandy is mostly caused by the inappropriate land use and activity pattern. However, the authorities shall take necessary steps to maintain the evolved character in reorganizing the land use and activity pattern. We believe that the appropriate balance of shifting some activities out of KUDA and inviting some others in shall be based on the unique perceptions most of us have on Kandy.

1. Set up Three Satellite Townships in each of the approaches namely at Peradeniya/Gatembe; Thennekumbura and Katugastota area. While more detailed studies will be necessary to identify an exact location for such an urban centre, the locations are chosen on the basis of the catchment point of the three major corridors. Each of these carries around 100,000 passengers in each direction. A satellite city which carries administrative offices, commercial centres, banks, tuition centres, medical centres including channel consultations, super markets can be attractive if set up under properly planned conditions. In order for these centres to be successful they should also be a transport node. Both Peradeniya and Katugastota have both bus and railway access and are thus ideally located. Both of these are well developed townships that have a tremendous potential to develop as major suburban centres. In the east, there is a possibility that a railway extension may be extendable to Digana. Along with the development of Pallekelle as an employment zone this

may be a logical location for setting up the satellite city. Making these urban centres the termination of the Cross Town bus routes will be most advantageous as there usually is a development impetus for locations where high frequency bus services commence. These satellite cities should be large enough to capture at least 50% of the trips passing through, so that the traffic entering the city centre could be reduced by 50%.

2. Move out or downsize all land use activities that cannot accommodate the parking requirements as set out in the UDA Building Regulations. This would mean that commercial activities such as hardware stores, banks, wholesale establishments etc that can relocate easily to suburban areas and more specifically to the aforementioned satellite cities would ensure that incompatible land use is reduced from the city centre thus creating more conducive urban environment compatible with that of a heritage city and tourism promotion.

3. Freeze school enrolment in city schools that cannot provide adequate parking within their premises. As most if not all schools would fall in to this category, encouragement may be necessary to commence either branch schools or new schools in satellite cities.

4. The UDA to reconsider its minimum plot size and zoning plan to make it compatible with the new development strategy.

6.2 Re-routing Bus Services

Several proposals are made for this all important intervention that can be achieved fairly quickly an done which will need to be in place for the formation of satellite town centres proposed above.

In order to reduce the heavy need for transfers of bus trips and also to reduce the heavy congestion of buses terminating at the city centre it is recommended that the major bus routes be re-routed. This should be considered as a separate study after taking in to account detailed operational data. However based on frequencies observed and origin-destination of bus passenger movements, the following re-routing given in Table 6-1 is suggested for consideration:

Table 6-1: Suggested Bus Re-routings for Consideration

Route No	Route	Buses	Re-routing suggested
652/4	Kandy-Akurana	24	Extend to Peradeniya, Kadugannawa and Gampola
593/5	Kandy- Alawathugoda	34	Extend to Peradeniya, Gampola and Kadugannawa
653/1	Kandy-Ampitiya	18	Extend to Pilimatalawa and Katugastota
602/5	Kandy-Aruppola	24	Extends to Peradeniya
633/2	Kandy-Deltota	22	Extend part to Katugastota and Digana
654/613	Kandy-Digana	68	Extend to part to Peradeniya and Katugastota
635/718	Kandy-Gampola	80	Extend part to Katugastota, Alawathugoda and Akurana, Digana
690	Kandy-Kadugannawa	45	Extend part to Ampitiya, Digana and Katugastota
698	Kandy-Haragama	15	Extend part upto Katugastota and Peradeniya
593/594/636	Kandy-Matale	41	Extend part to Peradeniya and Digana
652/7	Kandy-Panideniya	33	Extend to Sirimalwatta
620/621	Kandy Menikhinna	20	Extend upto Peradeniya
622	Kandy-Watthegama	31	Extend to Peradeniya

In addition some services using the by-pass roads could also be commenced as follows:

- Peradeniya – Matale via Guhagoda
- Peradeniya – Watthegama via Guhagoda
- Digana – Katugastota via Lewella
- Haragama – Katugastota via Aruppola
- Local services connecting railway stations

These services would be required to pass through town, by making stops are 3 or 4 designated stops within the CBD area. No long stops would be allowed within the CBD. CCTV technology could be adopted to note offenders.

6.3 New Commuter Railway Service

Discussions with the Sri Lanka Railways and inspections revealed that the existing single track between Peradeniya and Katugastota could be double tracked. This requires two bridges at Peradeniya and Katugastota. It also requires some filling and retaining structures in building the platform to accommodate the double track which is around 10 km in length. No acquisition is required, except in the case of relocating some illegal squatters. In operating a high frequency commuter service, it will be necessary to have closer stations. As such all the stations needs to be redeveloped with improved access, particularly provision of bus services and walkways to schools and other attractors. Special attention should be given to the transport of school children by connecting the stations with as many schools most of which are within 500 metres of a station. The main station at Kandy also need to be re-developed with the Matale Line which is most adjacent to the Good Shed being incorporated to the bus-rail terminal, so that there would be a high degree of transferability between the high frequency commuter service between Peradeniya and Katugastota to local bus services. The location of the stations and trace for commuter trains is shown in Map 6-1 of Volume II.

It is also proposed that attempts be made to extend the railway line eastwards to Digana or Pallekele. While the trace via Mawilmada will be through residential areas, the trace via Katugastota will be longer but still competitive for commuting from Digana. Moreover, Katugastota, Pallekele and Peradeniya could be developed for goods transport as well so that Kandy could be converted to a commuter station. These three stations at the Satellite towns could also be developed as Park and Ride locations.

6.4 Development of Integrated Bus-Rail Terminals

The location of the railway station and the Good Shed Terminal adjacent to it, allows the development of an integrated bus-rail terminal. Currently there is hardly any goods transport out of Kandy and further development of goods transport using Kandy terminal is not recommended. These could be moved to the railway stations at the proposed satellite town such as Katugastota and Peradeniya. However, there is potential for improving coordination between bus and rail to improve public transport. As such it is possible to develop a single design that would provide allow:

- Terminal for long distance trains
- Stop for commuter trains operating between Peradeniya and Katugastota
- Terminal for long distance buses

- Stop of high frequency Cross Town bus services
- Transfer facilities between all the above
- Drop off for three wheelers, taxis and private vehicles.

No overflow facilities for bus parking would be provided at this site. The existing Bogambara ground may be retained for now for long-distance buses. However this may be down sized to parking for around a maximum of 50 buses with scientifically determined time tables being introduced. Map 6-2 of Volume II shows the routing arrangement for this development.

6.5 Road Development

6.5.1 Improvements to Main Corridors

The study notes that the proposed widening by the Road Development Authority of the William Gopallawa Mawatha and the Katugastota Road (A9) from two lanes to 4 lanes will assist in increasing capacity on the southern and northern approaches. Improvements are also required for Sirimavo Bandaranayake Mawatha and William Gopallawa Mawatha to improve road safety. Improvements of intersections for both safety and capacity through better design is also recommended.

6.5.2 Development of By-Passes

Two sets of by-passes are proposed in this study. These are referred to as follows:

- **Outer Bypass** which will effectively divert traffic between the major national roads such as the A1, A5, A9, A10, A26 before entering the Study Area. This will be longer that running through the Kandy City and thus will not become a natural route, until congestion reaches high levels. It can however be used as designated truck by-pass routes and also long distance traffic that may wish to avoid the Kandy City Area especially during peak traffic periods. There are currently no roads that serve as outer bypasses, other than (a) Guhagoda Road and (b) Digana to Katugastota via Madawela, both of which are however just adjacent to the Study Area.

- **Inner Bypass** which will effectively be a bypass for traffic after they enter the Study Area or just before. This would be used by traffic that has at least one end of their trips in the Study Area and are more likely to be used than the outer bypass. Currently the roads such as Guhagoda Road, Anniwatta by-pass, Dharmasoka Mawatha, Dutugemunu Mawatha/Mawilmada Road and Pichchamal Mawatha functions in this role.

6.5.2.1 Development of Outer Bypass

Development of outer bypass roads to let the through traffic to avoid the Kandy City was studied. It was found most of the existing links that may be considered for an outer by pass are not very attractive due to terrain and geometry. Map 6-3 in Volume II shows the proposed Outer Bypass and technical details are summarized in Appendix 6-1. Table 6-2 shows the effectiveness when travelling between the respective nodes on the national roads.

Table 6-2: Travel Distance Comparison of Proposed Outer Links and the Main Roads.

No	Sections between Nodes on A Class Roads		Total Length (km) between Nodes		Change of Travel Length	% Change of Length
	Connections By Node Name	By Main Road	On Outer Link Roads	On Main Road		
1	Geli-Oya - Pilimatalawa	A5 to A1	12	10	Longer by 2kms	18%
2	Pilimatalawa - Hedeniya	A1 to A10	13	22	Shorter by 9kms	-42%
3	Hedeniya - Ambatenna	A10 to A9	14	10	Longer by 4kms	45%
4	Ambatenna - Thennekumbura	A9 to A26	21	12	Longer by 9kms	80%
5	Thennekumbura	A26 to A5	34	16	Longer by 14kms	112%

It is observed that the travel length of most of the links in the outer bypass is higher than when travelling through the study area. This has been reduced by 18% between the nodes on A1 and A10 Roads. Since the Guhagoda Road currently provides a connection between A1 and A10 and the need for another connection between A1 and A5 is not required as is the case with A9 and A10. However, the most important links are the links between A9 to A26 and A26 to A05, but as shown in Table 6-2 these are also the most unattractive links. Also it was found that the most difficult terrain among the selected outer links is the link between A26 and A05 which requires a bridge over the Mahaweli River at Kadugamuwa or Geli-Oya. Therefore, further studies for the options of Outer circular roads are not pursued in this study.

6.5.3 Development of Inner Bypass

The concept of an Inner Bypass is to bypass the most congested city centre after having entered to the Study Area or arrived at its precincts. There are only a few options available as bypass routes as the existing roads have little or no provision for widening and realignment to a level that large commercial vehicles can use them and also achieve reasonable speeds. The following roads have been identified for development.

1. **Guhagoda Road** is a two lane (6.6 meters) B class road connecting Gatembe and Katugastota that can be used as a bypass option from A1 to A9 and A10 roads. The distance of this road is only 7.2 km and it compared favourably with the distance of 9 km if going through the Kandy City. The surface of this road is in very good condition at present with newly laid asphalt surfacing. The road would be used as an access road to the Colombo-Kandy Alternate Highway to distribute traffic from Katugastota to Gatembe. However there are sections of this road with steep grades that prevent heavy goods vehicles using this bypass. Re-design to the standard widths and grades can improve this road for using as a proper bypass.

2. **Dharmasoka Mawatha** between Lewella and Katugastota Road passing Nittawela ground is also a bypass that is currently in good condition. The width of this two lane 2.8 km long road varies from 5.5 m to 6.6 m. It has an asphalt surfacing but the high gradient and adverse horizontal alignment reduces the capacity of the road. Proper improvements to the geometry and the cross sectional capacity will result in attracting more users to use this as a bypass. This road can also be connected to Katugastota Road further away from city area (at 1.4 km) by improving the existing 5.0 m wide Nittawela Road to at least 6.5 metres to use as a connector to Katugastota Road.

3. **Dutugemunu Mawatha**: This is a 2.9 km long road stretch starting from Lewella to Polgolla and it has a varying width between 4.3 to 6.2 m. It connects Polgolla and Siyambalagastenne on A9 just before the Katugastota Bridge via Mawilmada by a road stretch of 1.8km where

the road width is 6.5m. Re-surfacing and the geometric improvements are required for these roads to make them as attractive bypass options by widening at least to 6.5m throughout.

4. **Kuda Ratwatte Mawatha** between Gatembe and – Katugastota along the right bank of the Mahaweli River can be considered as a bypass. The road network through Mulgampola, Anniwatta, Bahirawakanda and Asgiriya are even at current alternative routes and have the potential for development. However, these roads have very poor horizontal and vertical alignments and need very high investments to make them as attractive by pass roads.

5. **Pichchamal Mawatha:** This is already use as a by pass road connecting Randenigala Road (B413) with Ampitiya Road (B195) at Ampitiya Town. The length of the bypass road stretch is only 3.1 kms. This is connected to Ampitiya at a point 4.8 km away from Kandy City on the Kandy – Ampitiya Road through Sangaraja Mawatha. Therefore the total length between the connecting point at Randenigala Road and Kandy City through this route is only 7.5 km whereas the distance through Thennekumbura and Boowelikada is 9.45 km.

   Pichchamal Mawatha has a single lane with wider shoulders at present and has adequate capacity (ROW) for widening it to two lane standards. Majority of the land use besides the road is shrubs and bare lands. Therefore, the damage to the adjacent properties is minimal for widening to two lane standard. The present geometry is moderate and need improvements to horizontal alignment and minor improvements to vertical alignment.

6.5.4 Opening New By-Pass

There are connector roads available between Katugastota-Madawela Road (B036) and Mahiyangana Road (A026) on left bank of the Mahaweli River. The length of one connector road between Polgolla Bridge and Lewella Bridge is around 3.5 km. But this length reduces to only around 3.1 km through the Dutugemunu Mawatha at the right bank of the Mahaweli River. The road from Lewella connects to A026 near Thennekumbura Bridge at Nattarampotha on the left bank of the Mahaweli River. The length of this is 3.2 km. This is against 4.0 km through the right bank main roads. Therefore, the total length between B036 and A026 while on the left bank and right bank are 6.7 km and 7.1 km. Therefore, the connectivity through left bank is around 0.5 km more compared to right bank at present. However, the condition and the possibility of widening the left bank connection exists and it has to be studied further.

6.5.5 Tunnel Option as a By Pass Option

The tunnel proposed by the RDA from Boowelikada to Bogambara has been revised by this study for an improved trace. It is proposed that this tunnel begins at Thennekumbura and emerges at Bogambara or preferably a location further south passing the hospital, but instead of connecting only to the William Gopallawa Mawatha which will create congestion at a location within the CBD it is proposed that it continues through an overpass for both William Gopallawa Mawatha and Sirimavo Bandaranayake Mawatha.

A preliminary inspection indicated the possibility of a second tunnel through the Bahirawakanda to bridge the western edge of the city which can be extended to join up with both Kuda Ratwatte Mawatha and Guhagoda Road located along the Mahaweli right and left banks. The road may then be extended to connect with the Hedeniya interchange on the CKAH. If this can be done, it will provide a western approach to the city, thereby developing a part of the city that has been the least accessible

and also providing a direct access to the city centre. Furthermore, traffic coming on the CKAH can pass through the city and emerge at Thennekumbura without entering the city road network.

The Map 6-4 of Volume II is a conceptual map showing the intended traces for the tunnel option to carry heavy traffic from Thennekumbura and beyond towards the A1, A5 and A10 without travelling through the city centre. As it proposes, the original trace can be moved to a lower elevation near the Thennekumbura Clock Tower Junction to ensure better access for heavy goods vehicles. This is important in order to avoid the steep climb to Boowelikada.

The length of the proposed tunnel between Bogambara and Thennekumbura Bridge is around 3.7 km whereas the length of the original proposal up to Boowelikada is 3.1 km. The tunnel passes Ampitiya Road (at 2.5 km) at a length of 2.4 km from Bogambara end. This point at Ampitiya road is about 10 m higher than the surface at Bogambara end. The Thennekumbura end is around 12 m lower than the elevation at Bogambara end. Therefore, there will be no major issue in maintaining a shalow gradient in the tunnel between Bogambara and Thennekumbura end. Therefore, there is a possibility to have an access for Ampitiya Road through properly designed ramps and it has to be considered at the detailed design stage. The length between William Gopallawa Mawatha and Guhagoda Road is 1.8 km. The elevation difference between the ends of this tunnel is around 13 meters.

This tunnel will serve as a major by pass for traffic will also enable the continuing closure of the Dalada Veediya adjacent to the Temple of the Sacred Relic of the Tooth and thus provide for the retaining of a suitable environment in that quarter of the city.

The original tunnel has been proposed as two lane standard with adequate facilities for walkways. However, since the length of the tunnel is longer, it is required to design for safety concerns such as fire escapes, accident management, vehicle breakdowns, etc. Therefore, there will be many issues with high volumes of traffic attractions as an bypass option for already congested Kandy City if the tunnel is designed as a two lane undivided highway. Also the problem will be much significant with high volume of heavy trucks as observed in the traffic data analysis. Therefore, study may also consider the feasibility of a four lane divided highway tunnel for at least between Bogambara and Thennekumbura connection. Also further studies should be conducted to test the traffic demand in connection with the Kandy Colombo Alternative Highway in terms of aligning it to connect from Guhagoda to the interchange at Hedeniya. Required detailed and extensive geological studies are required at initial stage to investigate the feasibility of the proposed tunnel options as well.

6.5.6 General Improvements including Safety

It was observed that the existing capacities of other city roads are significantly reduced by not having adequate walkway / shoulder and lane widths. More than 50% of road sections are operating at less than 80% of their capacities. Unauthorized on-street parking and poor intersection controls are particularly responsible for reduced highway capacities in Kandy City. The level of safety for road users especially for pedestrians should be drastically improved. In this respect, proper sidewalks and crossings and safe separation of road users is essential. Almost all the intersections within the CBD as well major intersections within the Study Area also require redesign with curbs, signs and markings with special attention provided for the safety of vulnerable road user groups.

6.5.7 Traffic Management

The traffic arrangement in the CBD should also be changed to ensure that least amount of conflicts are created while giving prominence to the routing of buses and provision of bus halts that allow passengers to board across the town without walking excessively. Some one-ways systems may be created where walking distances between such roads are less than 50 metres.

6.6 Pedestrian Walkways

The proposed re-routing of buses is expected to reduce the current volume of pedestrian traffic significantly. However, given the high intensity of trip ends in the CBD, most trips irrespective of the mode of transport used would travel the last few metres by foot. Moreover crossing of roads as a pedestrian would be necessary for almost all of the 350,000 people coming to the city. Thus sidewalks of adequate width should be constructed in areas where increased pedestrian activity is envisaged. Particular attention is required to areas that would be used by tourists and by school children. Guard rails and proper crossing are required. The CBD area should have a high priority level for pedestrians so that motor vehicles are consciously required to slow down approaching pedestrian crossing with ramped/elevated pedestrian crossings. Improvement in pedestrian facilities to approach bus halts as well as for waiting at halts would also be required. Details of minimum improvements to sidewalks are given in Appendix 6-2. Some of these roads could be turned to pedestrian walkways to revitalise the recreational and tourism value especially in the cultural quarter of the city.

The restoration of the alleys currently used for parking of vehicles and trading as well developed walkways with mobile trading where possible will also bring more tourist value to the city.

6.7 Parking

Certain recommendations can be made with respect to the management of parking within the city, based on the results of the parking surveys conducted as a part of this study and other observations. As discussed, roadside parking spaces available in most of the streets in the commercial grid-city area are over-utilised, and there is an under-utilisation of the Kandy city car park. It is also observed that there is around 15% of roadside parking in the CBD used by the long-duration parkers that park for more than 8 hours. These vehicles can well be shifted to the Kandy city centre car park, relieving the roads in CBD of excessive parking pressure.

6.7.1 Promoting Kandy City Centre Car Park for Long-Duration Parking through Adjustment of Fares

At present, the parking fares structure practised in the Kandy city centre car park does not encourage long duration parkers. However, it is observed that in the planning stage the facility has been planned to attract longer duration parkes as is stated in the feasibility report of the facility. It was proposed that for roadside parking higher fares are recommended for longer durations whereas at the city centre car park it was the other way around. This can be one of the reasons why it is possible to observe long-duration parkers still in the roadside and under-utilisation at the parking facility. It is therefore recommended that the parking fares structure at the Kandy city centre car park be revised to attract

long-duration parkers by offering concessionary rates for long-duration parking, while making the long-duration parking fares at the roadside higher.

In addition to the Adahana Maluwa off-street car park managed by KMC, there needs to be an additional parking supply of 50-70 vehicles towards the Northern stretches of the city. This will help reduce the parking pressure on D.S. Senanayake mawatha (upper stretch) and Katugastota road (up to Ra Kade junction). Similar off-street facilities are recommended for the Southern and Western areas of the CBD as well.

6.7.2 Control of Roadside Parking outside CBD

Most of the major approach roads to the Kandy CBD are presently congested partly due to the roadside parking. There is a chronic lack of off-street parking spaces in roads such as Sirimavo Bandaranayake mawatha, Katugastota road and Hewaheta road. During the past few years some privately-owned off-street carparks have been established in the CBD. However, outside CBD the supply of parking has not been in par with the growth of parking demand. It is also observed that some of the major traffic attractions, such as medical channelling centres, that do not provide enough parking facilities to the customers within the premises forcing them to park at roadside. Strict enforcement of the rules pertaining to the provision of customer parking at commercial developments is highly recommended.

Use of roadside spaces, sometimes blocking the pedestrian sidewalks, for idle bus parking along major access route to the city, such as William Gopallawa mawatha, is commonplace. This practice not only reduces the road capacities but introduces serious safety issues due to obstructions to visibility and blocking pedestrian spaces. Bus parking outside the designated overflow bus parks has to be avoided by adjusting the routes and scedules to minimise the requirement for overflow parking, especially in the case of short-distance bus services, and by managing the space available at bus parks.

As recommended in the section on regulating school transport, it is recommended to establish idle parking spaces for school vans at diffrenent school clusters. This will relieve the minor access roads and by-pass roads from excessive roadside parking pressure.

With the improvements in the public transport access to and within the city, it is expected that the growth of parking demand in the city centre will slow down.

6.8 Regulating School Transport

As the the peak traffic demand of most of the roads is contributed to great extent by the school traffic, the solutions proposed for the handling of school traffic are important in addressing transport related issues in Kandy. According to the issues identified in the previous chapter of this report, several suggestions may be recommended.

6.8.1 Improving School Van Service

School vans, probably, may be the easiest and most effective option in arresting the unfavourable growth of private vehicle usage in school transport. However, some interventions are needed in addressing certain negative impacts of school van service. At present, this service is highly unregulated. Except for the requirement for registration at RPTA, which came into effect as a security

related measure in the past, there is no control whatsoever exists with respect to the operation of school vans. They are naturally organised at the home end through a communication between the parents and the service providers. As discussed in previous chapter, an intervention at the destination end, through schools or RPTA, may be used to control the school clusters that any van is serving. Ideally, any given van should serve the schools in a single cluster. This will help reduce reasonable amount of unnecessary cross-city trips of school vans and create opportunities for the use of by-pass roads and alternative routes. An intervention of this nature can better be in the form of certain incentives such as providing a space for idle parking. Coordination of school vans service, preferably by RPTA or the schools they serve may be an option that can be considered. Parents may have the option of contacting this coordinating body to select a suitable service provider operating from their area to the school their children are attending, in addition to the present practice of selecting a service provider through personal contacts or advertisements. Such a coordinated service may also be useful later in enforcing certain other regulating policies with respect to the riding conditions and uniform fares etc.

Provision of suitable idle parking for the school vans near the clusters they serve would promote the operators to serve only a selected cluster. That will also help relieve the residents of the areas where the school vans are presently parked roadside along the minor access roads round the city. If the school vans are considered as a favourable transport option in school transport, local authorities, RPTA and schools need to make an intiative to arrange suitable off-street parking for the idling school vans at a reasonable cost. In this respect, the decision by the KMC to provide idle parking for school vans at the Kandy city car park at a concessionary rate must be commended.

6.8.2 Cluster-Based School Buses

Instead of the present school bus services that operate as common school buses or school-based services, it is recommended to explore the possibility of introducing cluster-based school buses from different residential areas. Such services will help reduce the travel times of the students and promote the use of by-pass roads by school buses. It is also recommended to identify residential areas that are not presently covered well by the school bus services.

6.8.3 Revision of Public Bus Routes during School Times

In addition to the provision of school buses, routes of public bus operations during school peak may be revised, extended or diverted to cover the locations of schools. This will enable the students to reach the destination in fewer changes of buses, reducing the total travel time and inconvenience, attracting more students to public buses.

6.8.4 Promoting Ride-Sharing Among Private Vehicles

Through public awareness programmes and other school-based or work-place-based awareness programmes, it is possible to promote public-participatory demand management techniques such as ride sharing among parents who drive their children to school in private vehicles. Under this technique group of parents volunteer to drive their children to school in one vehicle, sharing the ride in rotation, instead of each one riding his/her child to school everyday in several vehicles. This practice increases the occupancy rates of private vehicles carrying school children and thereby reduces the number of vehicles.

6.8.5 Staggered Opening and Closing Times of Schools

Staggered school opening/ closing times may be used as a peak spreading technique in handling the school peaks, especially the morning peak. This can be based on the school type (primary, junior and senior) or the school clusters. The quantum of time to be staggered for effective results can be even 10-15 mins. This can be used even to address local traffic circulation problems at a problematic locations. However, a proper investigation is recommended before enforcing such measures.

6.8.6 Railway as a School Transport Mode

As stated in the previous chapter, there is a great potential in promoting rail as a popular school transport mode by fully utilizing the location of the rail track to advantage. However, this is only possible with the improved service frequency. If the present rail track from Peradeniya to Katugastota is improved to double track, as proposed elsewhere in this chapter, it is possible to promote the rail as a school transport mode. Stations and halts are to be located taking into consideration the locations of schools, and the walkways from halts to schools are to be improved for higher safety and convenience. It is also recommended to explore the possibilities of introducing integrated services with bus, or even school vans, at Peradeniya, Sarasavi Uyana and Katugastota stations, towards the home end.

6.8.7 Establishment of Branches of Popular Schools in Satellite Cities

As a measure of spreading schools concentrated at the municipal areas, it is recommended to explore the possibilities of establishment of branches of popular schools, especially the primary classes, outside the congested municipal areas, preferably in the proposed satellite cities; Peradeniya, Katugastota and Digana.

6.9 Traffic Restraints

The overall strategy that has been adopted in this study is to divert activities that are incompatible with Kandy City as a World Heritage City to satellite cities and to make such the nodes of future growth. The by-passes will also protect the city centre (CBD) from excessive through traffic making it more amenable for cultural and leisure activities along-side the urban activities required by the population resident within the city.

In order to ensure that the social cost of travel through the city is felt in making a decision to drive through the city it is proposed that an Electronic Road User Toll be imposed after the above recommendations have been implemented. A pre-requisite for this would be the successful implementation of the by-passes including the tunnel as well as the improvement of bus and rail as discussed above. Electronic Road User Toll could be made variable by hour of day to discourage intense road use during peak hours. It could be relaxed to encourage off peak travel as well as recreational travel during weekends and evenings. A separate study would be required at a suitable future date in order to determine the cordons for implementing this together with the technology that is required as well as to determine the toll rate. It would however be necessary that the necessity of imposing such vehicle restraints be discussed in the public domain at present in making public aware of the realities of interventions that would be necessary at some point in time.

6.10 Safety

As is evident from traffic accident information as well as other data collected, it is very important to improve the conditions of junctions. Proper turning lanes, improving visibility, gradient at junctions are some important areas to consider. Some of these junctions are blocked by vehicle parking and large size commercial holdings.

Heerassagala Junction on Sirimavo Bandaranayake Mawatha as well as William Gopallawa Mawatha, High School junction on Sirimavo Bandaranayake Mawatha, Goods Shed bus stand, Queens Hotel Junction, Entrance of Kandy Hospital, Railway Station Junction, Clock Tower bus stand are few locations identified as highly accident prone. These locations require urgent attention to separate different road users and provide facilities especially for vulnerable road users such as pedestrians. The re-design of Kandy-Katugastota Road as well as William Gopallawa Mawatha as four lane highways should ensure adequate pedestrian facilities consistent with the high density of roadside development. Sirimavo Bandaranayake Mawatha is one other road that requires re-design especially for safety improvements by incorporating better pedestrian facilities, bus stop design, intersection design and speed control

7 Conceptual Proposals for Selected Recommendations

This chapter provides conceptual proposals including a brief cost and benefit statement of 20 selected projects recommended in this study. These projects selected by the Study Team are as follows:

1. Creation of Basic Infrastructure for Satellite City at Peradeniya
2. Creation of Basic Infrastructure for Satellite City at Katugastota
3. Creation of Basic Infrastructure for Satellite City at Digana
4. Double Tracked Suburban Rail Operation between Peradeniya and Katugastota
5. Railway Extension to Digana
6. Park and Ride Service
7. Tunnel from Thennekumbura to William Gopallawa Mw
8. Extension of Tunnel from William Gopallawa to Hedeniya (CKAH Interchange)
9. Improvement of Guhagoda Road by-pass
10. Improvement of Dharmasoka Mawatha by-pass
11. Improvement of Dutugemunu Mawatha By-pass
12. Improvement of Kuda Ratwatte By-pass
13. Improvement of Pichchamal Mawatha by-pass
14. New by-pass from Thennekumbura to Katugastota
15. Integrated Transport Terminal at Good shed
16. Re routing local bus routes through the city
17. Improvements to Junctions and Traffic Circulation System
18. Development Pedestrian Path network
19. School Van Clustering Scheme
20. Electronic Road Pricing System

7.1 Creation of Basic Infrastructure for Satellite City at Peradeniya

Institutional Framework	Urban Development Authority
Description of Work	This includes providing land and developing it for the required quality infrastructure that is required to make Peradeniya as a Satellite city that would attract around 10,000 jobs currently taking place in the Kandy CBD. This should also include space for schooling for at least 10,000 students and a integrated bus and rail terminal capable of handling the above traffic as well as the current traffic at Peradeniya. Given the scarcity of land multi story complexes are encouraged for commercial and official spaces. The land and infrastructure may be developed by the UDA and private sector invited for constructing buildings. The integrated public transport terminal may be considered as a PPP project. The land already earmarked called Eriyagama could also be developed as part of this project.
Costs	
Cost Estimate	Cost of land filling, service roads and other services may be estimated as Rs 575 million. The building spaces required for all the different activities identified above may be estimated at Rs 2,163 million.
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Under PPP where private sector will put up the capital it is expected that the maintenance and operating costs will be borne by the private company and the cost received through user fees.
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	Will reduce the demand for travel to Kandy town by 1/6th, It is assumed that approximately 30,000 of the current trips ends in the Kandy CBD can be terminated at the new satellite city. This would reduce around 10,000 vehicle trips travelling between Peradeniya and Kandy. There would be an estimated 2 minute travel time saving for those travelling to Kandy from Peradeniya due to this. 50% of total vehicle operating cost and travel time savings will be considered as net savings. Other land use development benefits will not be included.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 14.8 billion in 2011 prices returning an EIRR of 33%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 7 • Economic Viability 10 • Regional Development Impacts 10 • Environmental Impacts 6 • Social Impacts 6 • Equitable (Distribution of Costs & Benefits) 5

7.2 Creation of Basic Infrastructure for Satellite City at Katugastota

Institutional Framework	Urban Development Authority
Description of Work	This includes providing land and developing it for the required quality infrastructure that is required to make Katugastota as a Satellite city that would attract around 10,000 jobs currently taking place in the Kandy CBD. This should also include space for schooling for at least 10,000 students and a integrated bus and rail terminal capable of handling the above traffic as well as the current traffic at Katugastota. Given the scarcity of land multi story complexes are encouraged for commercial and official spaces. The land and infrastructure may be developed by the UDA and private sector invited for constructing buildings. The integrated public transport terminal may be considered as a PPP project. The land adjacent to the Katugastota railway station could be developed as part of this project.
Costs	
Cost Estimate	Cost of land filling, service roads and other services may be estimated as Rs 582 million. The building spaces required for all the different activities identified above may be estimated at Rs 1,974 billion
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Under PPP where private sector will put up the capital it is expected that the maintenance and operating costs will be borne by the private company and the cost received through user fees.
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	Will reduce the demand for travel to Kandy town by 1/6th, It is assumed that approximately 25,000 of the current trips ends in the Kandy CBD can be terminated at the new satellite city. This would reduce around 8,000 vehicle trips travelling between Katugastota and Kandy. There would be an estimated 2 minute travel time saving for those travelling to Kandy from Katugastota due to this. 50% of total vehicle operating cost and travel time savings will be considered as net savings. Other land use development benefits will not be included.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 8 billion returning an EIRR of 20%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 7 • Economic Viability 8 • Regional Development Impacts 10 • Environmental Impacts 7 • Social Impacts 6 • Equitable (Distribution of Costs & Benefits) 5

7.3 Creation of Basic Infrastructure for Satellite City at Digana

Institutional Framework	Urban Development Authority
Description of Work	This includes providing land and developing it for the required quality infrastructure that is required to make Digana as a Satellite city that would attract around 10,000 jobs currently taking place in the Kandy CBD. This should also include space for schooling for at least 10,000 students and a integrated bus and rail terminal capable of handling the above traffic as well as the current traffic at Digana. Given the scarcity of land multi story complexes are encouraged for commercial and official spaces. The land and infrastructure may be developed by the UDA and private sector invited for constructing buildings. The integrated public transport terminal may be considered as a PPP project.
Costs	
Cost Estimate	Cost of land filling, service roads and other services may be estimated as Rs 565 million. The building spaces required for all the different activities identified above may be estimated at Rs 1,813 million .
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Under PPP where private sector will put up the capital it is expected that the maintenance and operating costs will be borne by the private company and the cost received through user fees.
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	Will reduce the demand for travel to Kandy town by 1/6th, It is assumed that approximately 25,000 of the current trips ends in the Kandy CBD can be terminated at the new satellite city. This would reduce around 8,000 vehicle trips travelling between Digana and Kandy. There would be an estimated 3 minute travel time saving for those travelling to Kandy from Digana due to this. 50% of total vehicle operating cost and travel time savings will be considered as net savings. Other land use development benefits will not be included.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 8 billion returning an EIRR of 22%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 7 • Economic Viability 9 • Regional Development Impacts 9 • Environmental Impacts 7 • Social Impacts 6 • Equitable (Distribution of Costs & Benefits) 5

7.4 Commuter Railway Service between Peradeniya and Katugastota

Institutional Framework	Sri Lanka Railways
Description of Work	This includes the provision of the second railway track and realignment of the existing track between Peradeniya and Katugastota. In this process, a new bridge is required across the Mahaweli at Peradeniya and 8 new stations are to be built. In addition all the 6 stations including Kandy main station and halts between these two stations have to be modernized and developed for better access by walking, public transport and other vehicles. Special attention is required to connect the stations in the CBD to the schools and offices in the area. Cost of Rolling Stock is also to be included.
Costs	
Cost Estimate	Cost of providing the second track requires the complete modernization of 10.9 km of track including a bridge and 14 stations which is estimated at 4.1 billion. Cost of the rolling stock, 8 power sets, will be 7.9 billion. Thus the total costs associated with the service will be 12 billion.
Duration of Project	Five Years (2012-2016)
Maintenance/Operating Cost per year	With the SLR operating it is assumed that there would be a 16 hour operation with peak period frequency of one train per 10 mts and off peak frequency of 15 mt and given that there would be 4 peak hours the total number of trains in one direction would be 72 making a cost of Rs 17 billion for a 10 year operation.
Life of Project (yrs)	50 years
Benefits	
Description of Benefits	The above service will provide around 20,000 seats per day, which is expected to have a much higher load factor during peak period and lower one during off peak. Overall around 40,000 passengers in both directions are estimated from this service. This is expected to reduce around 8,000 vehicle movements on the road between Katugastota and Kandy as well as Peradeniya and Kandy. This will also have some decongestion benefits especially in the peak period.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 30 billion returning an EIRR of 16%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact-5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 4 • Economic Viability 7 • Regional Development Impacts 9 • Environmental Impacts 9 • Social Impacts 9 • Equitable (Distribution of Costs & Benefits) 8

7.5 Railway Extension to Digana

Institutional Framework	Sri Lanka Railways
Description of Work	This requires the extension of the double line railway from the Matale Line to Digana from Mawilmada with a bridge closer to Thennekumbura area. It will also require 12 new stations and halts over an estimated length of 15.5 km
Costs	
Cost Estimate	The cost of 15.5 km of new track and 12 new stations is estimated at Rs 7.85 bn. Cost of the rolling stock, 4 power sets, will be 3.95 billion. Thus the total costs associated with the service shall be 11.8 billion.
Duration of Project	Two Years (2015-2016)
Maintenance/Operating Cost per year	With the SLR operating it is assumed that there would be a 16 hour operation with peak period frequency of one train per 20 mt and off peak frequency of 30 mt and given that there would be 4 peak hours the total number of trains in one direction would be 36 incurring a cost of Rs 17 billion for a 10 year operation.
Life of Project (yrs)	50 years
Benefits	
Description of Benefits	The above service will provide around 10,000 seats per day, which is expected to have a much higher load factor during peak period and lower one during off peak. Overall around 20,000 passengers in both directions are estimated from this service. This is expected to reduce around 4,000 vehicle movements on the road between Digana and Kandy. This will also have some decongestion benefits especially in the peak period.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 24.5 billion with a EIRR of 12%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 5 • Regional Development Impacts 9 • Environmental Impacts 9 • Social Impacts 9 • Equitable (Distribution of Costs & Benefits) 8

7.6 Park and Ride

Institutional Framework	Central Province Road Passenger Transport Authority
Description of Work	This requires three park and ride locations to be set up at Katugastota, Peradeniya and Digana. Each location is to be designed for 100 vehicles with adequate security and access to the main roads as well as to the railway station and bus services.
Costs	
Cost Estimate	The cost of each location with buildings and access roads is estimated at Rs 17 mn. .
Duration of Project	Two Years (2015-2016)
Maintenance/Operating Cost per year	This would be a private sector investment that could be operated on financial viability basis with subsidy for up to 3 years to allow for recovery of investment costs.
Life of Project (yrs)	50 years
Benefits	
Description of Benefits	The above will prevent at least 200 vehicles from travelling to the CBD in each of the directions. There would also be decongestion due to this on the main road corridors as well as reduction of parking space required in the CBD.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 228 billion per locations returning a EIRR of 70%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 9 • Economic Viability 10 • Regional Development Impacts 6 • Environmental Impacts 6 • Social Impacts 6 • Equitable (Distribution of Costs & Benefits) 6

7.7 Tunnel and Road connecting Thennekumbura and William Gopallawa Mw

Institutional Framework	Road Development Authority
Description of Work	This requires a 2 x 2 lane tunnel of around 3.7 km in two sections connected by approach and connection roads to be constructed to connect Thennekumbura and William Gopallawa Mawatha just south of the General Hospital. The trace will have an exit to Ampitiya road as well as to the William Gopallawa Mw.
Costs	
Cost Estimate	Cost of tunnel and road for this is estimated at Rs 8.2 billion. .
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	This could also be constructed as a PPP since tolls could also be charged. The operating cost could be recovered from the toll. Tolls need not be placed at higher value so that economic benefits are prevented.
Life of Project (yrs)	20 years
Benefits	
Description of Benefits	This will reduce the travel time by an average 20 mts for all vehicles approaching Kandy from the east. It is estimated from a preliminary run of TransPlan that an average of 10,000 such vehicles will use the road.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 23.8 billion returning a EIRR of 18 percent.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 7 • Economic Viability 7 • Regional Development Impacts 10 • Environmental Impacts 3 • Social Impacts 5 • Equitable (Distribution of Costs & Benefits) 5

7.8 Extension of Tunnel from William Gopallawa to Hedeniya (CKAH Interchange)

Institutional Framework	Road Development Authority
Description of Work	This requires a (2x2) 4 lane tunnel of around 1.8 km connected by approach and connection roads to be constructed to connect William Gopallawa Mawatha just south of the General Hospital to the CKAH interchange at Hedeniya. The trace will have an exit to Kuda Ratwatte Road as well as Guhagoda Road.
Costs	
Cost Estimate	Cost of tunnel and road for this is estimated at Rs 3.8 billion. .
Duration of Project	Three Years (2015-2017)
Maintenance/Operating Cost per year	This could also be constructed as a PPP since tolls could also be charged. The operating cost could be recovered from the toll. Tolls need not be placed at higher value so that economic benefits are prevented.
Life of Project (yrs)	20 years
Benefits	
Description of Benefits	This will reduce the travel time by an average 10 mt for all vehicles approaching Kandy from the west on CKAH. It is estimated that an average of 10,000 such vehicles will use the road. Moreover, it will provide a by-pass for east-west vehicle movements across the country without burdening the commuter sections of the road network in Kandy city.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs11.9 billion returning an EIRR of 20 percent.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 7 • Economic Viability 10 • Regional Development Impacts 10 • Environmental Impacts 3 • Social Impacts 5 • Equitable (Distribution of Costs & Benefits) 5
Other Remarks	

7.9 Improvement of Guhagoda Road by-pass

Institutional Framework	Road Development Authority
Description of Work	This 7.2 km by pass on the left bank of the Mahaweli River is required to be developed to standard two lane capacity with improved vertical and horizontal alignment along with improved intersection including at Gatembe and Katugastota
Costs	
Cost Estimate	Cost of improvement is estimated at Rs288 million. .
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Assumed as 1% of construction cost
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	This will reduce the travel time by an average 8 mts for an estimated 8,000 vehicles using that road.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 1,445 million returning an EIRR of 32%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 10 • Regional Development Impacts 6 • Environmental Impacts 6 • Social Impacts 7 • Equitable (Distribution of Costs & Benefits) 7
Other Remarks	

7.10 Improvement of Dharmasoka Mawatha by-pass

Institutional Framework	Road Development Authority
Description of Work	This by pass is required to be developed to standard 4.2 km of two lane capacity with improved vertical and horizontal alignment along with improved intersection including at Boowelikada and Katugastota Road.
Costs	
Cost Estimate	Cost of 4.2km of road is estimated at Rs 210 million. .
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Assumed as 1% of construction cost
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	This will reduce the travel time by an average 01 mts for an estimated 8,000 vehicles using that road.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 1,653 billion returning an EIRR of 46%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 10 • Regional Development Impacts 6 • Environmental Impacts 6 • Social Impacts 7 • Equitable (Distribution of Costs & Benefits) 7
Other Remarks	

7.11 Improvement of Dutugemunu Mawatha by-pass

Institutional Framework	Road Development Authority
Description of Work	This by pass is of 4.7 km length required to be developed to standard two lane capacity with improved vertical and horizontal alignment along with improved intersection including at Boowelikada and Katugastota Road.
Costs	
Cost Estimate	Cost of 4.7 km of road is estimated at Rs 246 million. .
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Assumed as 1% of construction cost
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	This will reduce the travel time by an average 5 mts for an estimated 8,000 vehicles using that road.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 1,229 million at an EIRR of 31 percent.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 10 • Regional Development Impacts 9 • Environmental Impacts 6 • Social Impacts 7 • Equitable (Distribution of Costs & Benefits) 7

7.12 Improvement of Kuda Ratwatte Mawatha by-pass

Institutional Framework	Road Development Authority
Description of Work	This by pass is required to be developed to standard two lane capacity with improved vertical and horizontal alignment along with improved intersection including at Sirimavo Bandaranayake Mawatha and Katugastota Road.
Costs	
Cost Estimate	Cost of 7.8 km of road is estimated at Rs 468 million. .
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Assumed as 1% of construction cost
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	This will reduce the travel time by an average 20 mts for an estimated 5,000 vehicles using that road.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated 2,781 million at 37 percent EIRR.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 10 • Regional Development Impacts 7 • Environmental Impacts 6 • Social Impacts 7 • Equitable (Distribution of Costs & Benefits) 7
Other Remarks	

7.13 Improvement of Pichchamal Mawatha by-pass

Institutional Framework	Road Development Authority
Description of Work	This by pass is required to be developed to standard two lane capacity with improved vertical and horizontal alignment along with improved intersection including at Thennekumbura and Ampitiya.
Costs	
Cost Estimate	Cost of 3.1 km of road is estimated at Rs 140 million. .
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Assumed as 1% of construction cost
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	This will reduce the travel time by an average 5 mts for an estimated 2,000 vehicles using that road.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 309 million at an EIRR of 12%.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 10 • Regional Development Impacts 6 • Environmental Impacts 6 • Social Impacts 7 • Equitable (Distribution of Costs & Benefits) 7

7.14 New by-pass from Thennekumbura to Katugastota

Institutional Framework	Road Development Authority
Description of Work	This is a new by pass required to be developed to standard two lane capacity on the left bank of the Mahaweli River that will connect Digana to Katugastota.
Costs	
Cost Estimate	Cost of 6.7 km of road is estimated at Rs 335 million. .
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Assumed as 1% of construction cost
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	This will reduce the travel time by an average10 mts for an estimated 5,000 vehicles using that road.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 1,337 million at EIRR of 26 percent.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 10 • Regional Development Impacts 8 • Environmental Impacts 4 • Social Impacts 7 • Equitable (Distribution of Costs & Benefits) 7
Other Remarks	

7.15 Integrated Public Transport Terminal

Institutional Framework	National Transport Commission
Description of Work	This will be an integrated public transport terminal that will connect the Kandy railway station and the Goods Shed bus station in to a single entity. It will also provide access from William Gopallawa Mawatha and Sirimavo Bandaranayake Mawatha for local buses. The Goods Shed bus stand will be used as a terminal for long distance buses and this integrated terminal will also be the primary station for the new commuter railway and long distance railway passengers as well.
Costs	
Cost Estimate	Cost of this integrated terminal with modern facilities is estimated at Rs 300 million.
Duration of Project	Two Years (2012-2013)
Maintenance/Operating Cost per year	Assumed as 2% of construction cost for building and staff of around 50 persons who are even at present employed in the Goods Shed bus stand.
Life of Project (yrs)	20 years
Benefits	
Description of Benefits	This will reduce the waiting time cost of around 100,000 passenger journeys that are estimated to be made through this terminal, including around 10,000 from the new commuter rail.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits are difficult to estimate. However it is envisaged that properly designed facilities could pay for at least 50% of the cost through selected value adding commercial developments and balance could be through terminal handling charges levied on buses.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 8 • Economic Viability 8 • Regional Development Impacts 6 • Environmental Impacts 8 • Social Impacts 6 • Equitable (Distribution of Costs & Benefits) 8
Other Remarks	

7.16 Re routing local bus routes through the city

Institutional Framework	Central Provincial Road Passenger Transport Authority/SLTB
Description of Work	This requires the design of the proposed routing system, developing of schedules, setting up of bus stops, and bus parking facilities at locations such as Peradeniya, Katugastota and Digana.
Costs	
Cost Estimate	Cost of three bus parks and terminals at Peradeniya , Katugastota and Digana are assumed at Rs 300 mn and other costs another Rs 100 mn .
Duration of Project	Two Years (2012-2013)
Maintenance/Operating Cost per year	These could be constructed under PPP where private sector will put up the capital it is expected that the maintenance and operating costs will be borne by the private company and the cost received through user fees.
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	Will reduce the pedestrian movements and also the bus circulation within the CBD.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 19 billion.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 7 • Economic Viability 10 • Regional Development Impacts 10 • Environmental Impacts 9 • Social Impacts 9 • Equitable (Distribution of Costs & Benefits) 6

7.17 Improvements to Junctions and Traffic Circulation System

Institutional Framework	Road Development Authority
Description of Work	The current traffic circulation system and traffic management system has to be improved with signalized intersections, channelization's, one way systems, safety measures etc as recommended in this report. There are a total extent of 8,000 sq mt in the CBD and 19 intersections to be treated.
Costs	
Cost Estimate	Cost of general improvements inclusive of safety measures, lightings, road signs, signalization, are estimated at Rs 9,700 per sq mt and Rs 12.2 mn per intersection. Total cost is taken as Rs 690 million.
Duration of Project	Three Years (2012-2015)
Maintenance/Operating Cost per year	Overall operating cost may be assumed as 5% per annum.
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	Expected to improve traffic circulation speed by 5% . Also reduce accidents by 10%.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 3,211 million at an EIRR of 30 percent.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 2 • Economic Viability 10 • Regional Development Impacts 0 • Environmental Impacts 8 • Social Impacts 8 • Equitable (Distribution of Costs & Benefits) 8

7.18 Development Pedestrian Path network

Institutional Framework	Kandy Municipal council
Description of Work	This includes the development of 2 km of sidewalks and the development of 800 metresas pedestrian walkways utilizing especially the old alleys within the CBD area.
Costs	
Cost Estimate	The cost of above is estimated at Rs 20 million while the pedestrian malls are expected to cost around Rs 4 million per 100 m.
Duration of Project	Two Years (2012-2013)
Maintenance/Operating Cost per year	It may be reasonable to assume a maintenance cost of 2% of the capital cost.
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	Reduced walking times, less accidents 2%.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 1.4 billion in nominal tersm.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 10 • Regional Development Impacts 10 • Environmental Impacts 4 • Social Impacts 6 • Equitable (Distribution of Costs & Benefits) 8

7.19 School Van Clustering Scheme

Institutional Framework	Kandy Municipal council/Central Province Road Passenger Transport Authority
Description of Work	This requires stakeholder discussion and persuasion of school van operators to concentrate in one of five clusters without serving all schools.
Costs	
Cost Estimate	A nominal cost of Rs 5 million is assigned for this program as capital cost. .
Duration of Project	One Year (2012)
Maintenance/Operating Cost per year	Licensing and monitoring cost will be taken as Rs 1 mn per year.
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	The reduced km operated by school vans and the decongestion due to excessive van trips across the CBD.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated Rs 3.9 billion.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 3 • Economic Viability 10 • Regional Development Impacts 8 • Environmental Impacts 6 • Social Impacts 4 • Equitable (Distribution of Costs & Benefits) 5

7.20 Electronic Road Pricing System

Institutional Framework	Road Development Authority /Kandy Municipal Council
Description of Work	This requires a cordon of toll gates for the electronic road pricing to be implemented after the alternative transport means as discussed in the other projects are developed. This could be done as a PPP where private sector investment could be obtained for financing as well as management of facilities.
Costs	
Cost Estimate	Cost of staff, electricity and telecommunication are the major operational cost elements in connection to the system. Occasional and periodical maintenance also necessary to keep operation unbroken. Estimated operational and maintenance cost is about Rs. 1.3 billion. .
Duration of Project	Two Years (2016-2017)
Maintenance/Operating Cost per year	Cost of staff, electricity and telecommunication are the major operational cost elements in connection to the system. Occasional and periodical maintenance also necessary to keep operation unbroken. Estimated operational and maintenance cost
Life of Project (yrs)	10 years
Benefits	
Description of Benefits	This will enable the continuous intervention in ensuring traffic levels are maintained within sustainable levels. As such traffic congestion cost may be managed.
Estimated Quantifiable Value of Benefits for Life Time	The total benefits for a 10 year period amounts to an estimated reduction of Rs 54 billion.
Non Quantifiable Benefits ***Rating as follows:*** *Excellent 10; Very Good 9; Good 8; Moderately Positive 7; Marginally Positive 6; No Impact- 5; Marginally Negative 4; Moderately Negative 3; Poor 2, Very Poor 1; Extremely Bad 0*	• Financial Viability for PPP 9 • Economic Viability 9 • Regional Development Impacts 6 • Environmental Impacts 7 • Social Impacts 5 • Equitable (Distribution of Costs & Benefits) 4
Other Remarks	

Appendix 2-1: Detailed Bus Route List Serving Kandy

Appendix 3-1: Field Data Collection Forms

Appendix 3-2: Detailed Schedules of Field Surveys

Appendix 4-1: Vehicle and Passenger Flows at SA & CBD Cordons

Appendix 4-2: School Van Flow in Study Area

Appendix 4-3: CBD Road Inventory Data

Appendix 4-4: Travel Time Analysis

Appendix 6-1: Technical Details of Outer Bypass

Appendix 6-2: Improvements Details for Pedestrian Walkways