RAIL BUS INTEGRATION FOR COMMUTER TRAFFIC FOR COLOMBO METROPOLITAN REGION

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DECLERATION OF THE CANDIDATE

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any University or other institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text

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ABSTRACT

Despite of Commuters often use more than one mode of transport even in a single journey an Intermodal coordination and organizational facilities of public transport service in Sri Lanka is yet to be developed. Transport Integration means coordination of two or more modes with a combine time table. Developing of integration between transport modes is difficult in Sri Lanka as several authorities separately involve in a decentralized sector fragmented transport service. In this context implementing of intermodal connectivity in the public transport system is a paramount requirement to improve the quality of the service.

Most of the passengers use to visit Colombo city when they travel other main cities of the country, since the Central, Gunasinghepura and Bastian Mawata bus stands and Fort rail way station of Colombo city function as primary hubs for bus and rail transport respectively though no proper integration in between above two modes. Aftermath is unnecessary traffic congestion in the city which leads environmental pollution as well as disadvantages of passengers such as long trip length and travel time etc. Proper railway system can prevent the congestion of roads in substantial extent. Passengers who use rail are not facilitated with an intermodal connection up to their destinations and hence they often use to walk more than 100m distance for the bus. This may discourage passengers' use of rail. The rail transport carries only a 10% of its total demand in Sri Lanka.

In this study the necessity of rail & bus integration in Colombo metropolitan region to reduce the difficulties of public transport passengers is explained comprehensively. Dematagoda rail station and surrounding bus stop towards Borella was taken to explain the current situation and the need of the connectivity in between Dematagoda station and bus stop towards Borella. An Origin/Destination and boarding counting survey was conducted to find the current situation. The study identified travel characteristics, demand for intermodal connectivity of the rail & bus passengers and their travel requirements to minimize the difficulties of their journeys.

63% and 66% of bus and rail passengers respectively use rail and bus as access mode. Majority of bus and rail passengers have home based work trips. It is 50% and 53% while the percentage of home based other trips are 42% and 41% respectively. There is no significant difference in trip purposes between rail and bus passengers. The railway can therefore, be expected to attract all types of trips.

Therefore it is necessary to improve the quality of the public transport service for commuter satisfaction. In this context participation of support of responsible authorities to implement an efficient intermodal connectivity of public transport system, giving special emphasis to Rail/Bus integration in Colombo metropolitan region.

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INTRODUCTION

1.1 INTEGRATED TRANSPORT IN GENERAL

Transport is a key element in the infrastructure of any country. It provides services essential for promoting development. It plays a significant role in influencing the pattern of distribution of economic activity and improving productivity. It acts as a life-line linking markets, educational institutions and health institutions etc. With above all, it connects the cities, towns and villages of the country.

In general, transport system comprises a number of modes. The capacity of each has to be developed to meet its specific demand within the requirements of the transport system as a whole. The system has to be viewed at each step as an integrated structure, keeping in mind the relationship between different transport services.

An integrated public transport system is a system that has ideally two or more forms of public transport (buses, light rail/tram, commuter rail, transit rail or suburban rail) working together to adequately provide for the transport requirements of the town's/city's/region's/populace. In order to provide a better service to the public, it should have adequate facilities along with enough frequency of the service under compatible routes and timetables.

The objective of integrated transport is to foster the development of the various transport modes in a manner that will lead to the realization of an efficient, sustainable, safe and a regionally balanced transportation system. The broadly the following objectives of an integrated transport could be summarized as follows.

- Meeting the transport demand generated by a higher rate of growth of Gross Domestic Production.
- Effecting a transport development to ensures a successful participation of all regions of the country in economic development.

- Capacity augmentation, quality and productivity improvement through technology up-gradation and modernization.
- Maintenance to be given overriding priority with increased emphasis on higher maintenance standards so as to reduce need for frequent reconstruction of capacity.
- Increased generation of internal resources and also realization of optimal inter-modal mix through appropriate pricing and user charges.
- Increase in overall economic efficiency through injection of competitive impulses in provision and maintenance of transport infrastructure and services wherever possible.
- To promote sustainable transport system with increased emphasis on safety, energy efficiency, environment conservation and social impact.

The planning and implementation of an integrated public transport system is intrinsically tied in with urban/town planning. Since the planning of infrastructure is predominantly under the control of government bodies, the extent to which public transport is incorporated and integrated into planning submissions is entirely reliant on government bodies. With the support of government bodies, then the transport integrated can become significant factor. Public support and patronage can also influence for public transport services.

1.2 REQUIREMENTS OF INTEGRATED TRANSPORT SYSTEM

1.2.1 Improving Connections

The places where different transport systems are used need to be designed with passenger ease and comfort since integrated transport is the coordination of services between two or more transportation modes. Coordination must be including schedules, fares, stations and information. Transportation integration could be difficult especially in some cities where varieties of private and public operators control the transit system. An integrated public transport system needs to have different kinds of transport modes. This ensures both adequate coverage and frequency of service. Integrated public transport systems address

the problems of whether the city/area has an adequate and regular coverage of transport service. Integrated public transport system must provide access for the user and for their traveling needs as well.

There are several factors that can affect an integrated public transport system. These can be included its connectedness, cost of service used, access, travelling time, and level of both government and public support. Integrated public transport system provides passengers reasonable amount of time of their journey without much difficulty.

Passengers should allow speedy changes between buses, suitable feeder and shuttle services. La Defence in Paris has a new transport interchange integrating buses, metro, suburban trains, cars, taxis, tourist coaches and eventually, the high speed train.

1. 2.2 Co-ordaining Timetables

When people need to change one form of transport to another, two operators should ensure to minimize the waiting time of the passengers. Passengers don't need to waste the time for waiting for public transport mode. Different operators can agree to harmonize arrival and departure times. In Graz, Austria, a signal announces to a bus that an approaching tram is within a few minutes of the stop. The bus can then waits for the tram and pick up connecting passengers.

1. 2.3 Better Information

Up to date timetables and 'real time' electronic information at stops and stations tell passengers when their bus or tram is due. National travel information's service, as in Holland, could include a cheap telephone helpline and local services information. Since 1992, Dutch people have been able to ring a single national telephone number for a full door-to door timetable, fares and other information for all forms of transport. Victoria rail station in London is one of the best examples where commuters are facilitated with better information for a smooth integrated multimodal transport services.

1. 2.4 Through Tickets

Ticket systems can be simplified so that passengers can buy a single ticket at the beginning of their journey which is valid to their destinations. In Holland a single travel card can be used on public transport services anywhere in the country. The London Travel card can be used on buses, tubes and trains. After it was introduced in 1982, use of public transport increased by 16%.

1. 3 PURPOSE OF THE STUDY

At present substantial portion (66%) of the public transport around Colombo municipal Council area is shouldered by bus and Rail. But so far there is no proper integration between above two transport modes. On contrary there are lots of problems remain unsolved in the public transport system in Sri Lanka. In the bus sector, overloading, misuse behavior of bus crews, non ticket issuing, and unnecessary delays in journeys and no time schedules for buses are the main issues. In rail sector, train delays, very low conditions of user facilities, high walking distance between rail station and bus stop, no intermodal transport facilities, less accessibility at the stations, no reliability etc are the main weaknesses. These issues all together may cause short term and long term adverse impact on environmental, social, and economical state of the country.

If road network and rail network are improved then public transport system will strong enough to serve the traffic demand. In this situation, a comprehensive integrated strategy to solve above problems is a must for Colombo and its suburbs. Priority should be given to plan strategies in the integrated public transport and traffic management sectors.

Considering the above this study aims to see the feasibility to introduce a rail bus integration strategy for the passengers who travel to Colombo and suburbs by bus or rail as a remedial measure mainly for the increasing traffic congestion and passenger related issues. For this purpose, Dematagoda rail station & surrounding bus stop towards Borella was selected as the sampling point where would be a one of the platforms of the Rail/

Bus Integration in Colombo City. In this case the purpose of study was, to find the frequency of Home Based Trips (HBW), Home Based Other Trips (HBO) and Non Home Based Trips (HNB) of the bus and Rail, to select the highly demand bus route from platform station, to identify rail bus passenger's access and egress mode.

1.4 REASON FOR SELECTION OF PARTICULAR SITE

Dematagoda Station was taken as an example to identify which routes are more appropriate the linkage. With regard to daily rail passengers traveling to Colombo from different areas of the country over all 4 rail Lines (i.e. Coastal Line, Main line, Negambo Line and Kelani Vali). Dematagoda Rail Station plays a significant role as one of the busiest transfer point of the Colombo Metropolitan region. Within a short radius from the station there are number of commercial and service oriented cities, main roads and junctions where many crowded cities interconnected by several bus routes. With ongoing new office and commercial development around Sri Jayawardenapura, usage of the station as a transit point may rapidly increase within next few years. Therefore commuters often transfer to buses to their destinations directly from Dematagoda or Borella. Demataqgoda station is the first station of main line from Colombo and its monthly earning could be put in the third place amongst the station in Sri Lanka.

Table 1.1 Boarding data at survey stations

Station	Survey Date	No. of boarding	Demand Routes from the rail passengers
Dehiwala	30.06.2009	3988	119,163,176,183
Wellawatta	30.06.2009		141
Bambalapitiya	02.07.2009	5296	154,177,104,112,
Kollupitiya	02.07.2009	5278	140,177,175,
Slave Island	25.06.2009	5931	138,168,
Fort	08.07.2009	36564	
Maradana	24.06.20096	24995	
Dematagoda	30.06.2009	8362	178,152,135,104,140,193,154,143,
Nugegoda	25.06.2009	986	176,183, ,119,163,159
Narahenpita	25.06.2009	972	141,103,135,178,
Kotta Road	25.06.2009	270	171,144,170,190,

Figure 1.1: Demand Routes from the rail passengers

Maradana and Fort situated at the Colombo city center. Rail and bus passengers visit the city center to find another transport mode from the stations or main bus terminal causing a severe traffic congestion as well as increasing travel time, travel fare, travel length of themselves. In this survey it was found that there is a high demand among the passengers to Dematagoda station as a transfer point if a proper bus service is available. According to the statistics Dematagoda station acquires the highest boarding next to Fort and Maradana stations. This may due to the high frequency of busses passing over the station from various bus routes.

CHAPTER 2

BACKGROUND & PROBLEM IDENTIFICATION

2.1 LAND USE & TRAFFIC PATTERN IN THE AREA

Sri Lanka is a developing country with around 20,010,000 inhabitants living in an area of 62,705 km^2 and the population density is 319 per km^2 in year 2007. Colombo is the largest city and major economic center in Sri Lanka with a metropolitan area of 5.6 million inhabitants which is expected to grow 8.4 million by the year 2030.

The main urban transport issues in Sri Lanka are traffic congestion, environmental pollution, increase of traffic accidents, poor public transport system, and weakness of road networks. An estimated around 830,000 people arrive to the Colombo city from outside every day. Of this 90% arrive by road and railway carrying approximately 80, 000 or 10% of this demand. The road passengers enter the city through 12 roads with 56% of all passengers arriving by bus and the others arriving by private vehicles such cars (11%) and motor cycles (5%) and hired vehicles such as three wheelers and vans (18%). Presently around 15% of the road space is utilized for bus transport even though it transports 62% of the road passengers. On the other hand, 65% of the road space is used by private and hired vehicles which in sum total carry only 38% of the passengers. In addition to the vehicles entering the city, there are a further 250,000 vehicles registered within the Colombo Municipal Area. Colombo city plays a great role in the economy of the country. Number of people gathering places such as government and private offices, shop, factories, hospitals, hotels, schools and the main harbor located within the city. Therefore most of passengers travelling from western part of Colombo city and other parts of the country enter Colombo since the important buildings or places above are situated within Colombo city. It shows in table 2.1

Table 2-1: Important Buildings in Colombo City

Features	Nos.
Police stations	19
Primary and Secondary Schools	132
Government and Private Banks	97
Government offices	161
Government and private Hospitals	40
Embassies	31
Hotels	13
Theatres & Cinemas	27
Places of Worships	53
Bus Stopping and Terminals(Fort and Pettah only)	10
Railway stations	6

Source: Weerawardana J. 2009

Private transports modes such as motorcycles, three-wheelers, create congestion on the roads in Colombo city. These congestion issues can be considered as the outputs produces by attracting people and vehicles for the activities in the city. These outputs interact within the prevailing socio-economic environmental aspects and produces negative outcomes. For an example, output such as traffic congestion consumes higher amount of fuel and also emits higher amount gaseous emissions to the environment polluting air in surrounding. Therefore it can be concluded that the traffic congestion leads to two negative impacts of fuel wastage and air pollution in economic and environmental sectors respectively.

Surveys carried out from 1965 show that until 1995, the annual increase in the number of persons arriving to the city on a daily basis has been increasing by around 5% annually. From 1995 it has been observed to decrease signifying that business are moving out of Colombo city to more accessible suburbs such as Moratuwa, Nugegoda, Kiribathgoda etc. which are now becoming unplanned commercial areas. These in turn are causing congestion along the major roads. (Weerawardana J, 2009)

Particularly Parliament Road, Colombo-Kandy Road, Colombo-Galle Road, Colombo-Negambo Road and Nawala-Narahenpita Road are more congested due to private vehicles. People use their private vehicles to go to office/business since unavailability of

optimum public transport services in these routes. Especially in the peak hour's traffic congestion is more complicated.

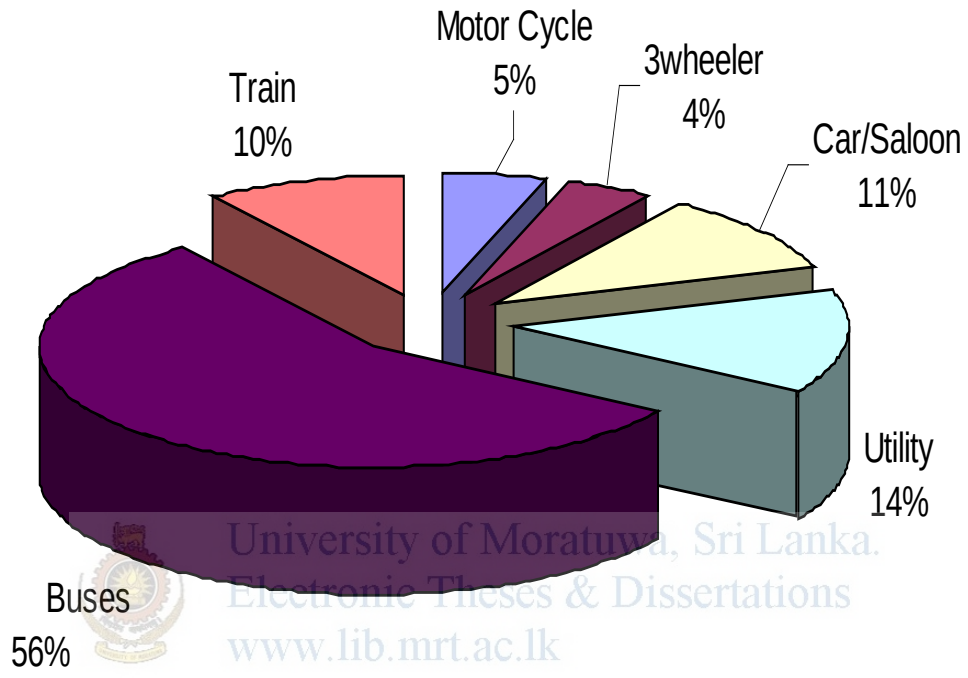

Figure 2.1 Modal shares at CMC boundary

A study identified potential areas for demand on trips attraction and generation within Colombo municipal council (CMC) and found that on average 30,000 trips in Fort, 25,000 trips in Slave Island, 25,000 trips in Maradan, 20,000 trips in Petah, 20,000 trips in Colpetty, 20,000 trips in Cinnamon Gardens, 13,000 trips in Borella, 11,000 trips in Town Hall, and 10,000 trips in Bambalapitiya are made. Many city roads with increasing traffic demand for road space is clearly seen to have reached critical proportions. One of the most pervasive and flustering problems of modern transportation is urban traffic

congestion; the city of Colombo is no exception. About 200,000 vehicles daily enter the city by six major roads and bring over 750,000 passengers. Of them 75% travel to the city for working or business purposes from Colombo's suburban areas.

2.2 ROAD CAPACITY DEVELOPMENT

The road infrastructure in Colombo city and its suburbs are difficult to further widen. New roads can be built keeping with the rate of demand created by people who are shifting from public transport to private transport. The inability to obtain the required land for road space, parking spaces etc. are fast becoming constraints that are severely restricting the flow of vehicles which far exceed the capacity of the road system to efficiently discharge the demand. As a result, around 70% of the length of the national roads within the 10 km radius from the city centre is congested throughout the day. The average speed on these roads falls below 15 km per hour (Weerawardana J, 2009). At such speeds, fuel consumption doubles, increasing air pollution as well. On the other hand, widening or building new roads cannot be accepted as a solution of managing travel demand since Colombo and its suburb already contains lengthily road network providing several accessing options for single specific location. It indicates that Sri Lanka is having CMC and its suburb exceeds overall value of Sri Lanka equaling to a value of 3.48 km/km^2. Besides that, the higher population density of 17.40 pop/km^2 is also clearly indicates the difficulty of land acquisitions for further road development activities. (See Table 2.2) Projects such as the extension of the Dulpication Road, widening and extension of Baseline Road and Marine Drive have clearly illustrated the difficulties in land acquisition in a city which is both historic and densely built up.

Table 2.2 Road density comparison

Country	Road Density (km/km^2)	population (km/1000)	Population Density (1000 /km^2)
Nepal	0.13	0.71	0.18
Pakistan	0.33	1.73	0.19
Bangladesh	0.95	1.01	0.94
Bhutan	0.20	5.71	0.04
India	1.01	2.78	0.36
Sri Lanka	**1.61**	**5.53**	**0.29**
Colombo Metropolitan Region	**3.64**	**2.80**	**1.30**
Colombo District	**5.40**	**1.80**	**3.00**
CMC	**3.48**	**0.20**	**17.40**

Source: Weerawardana J.2009)

Experiencing practical limitations in developing of highways is a common issue particularly in urban areas. As an alternative solution for this, it is given priority to increase affectivity and efficiency of the public Transport services. In this context integration of transport is vital for linking of different modes of transport in order to cater the passenger demand for the outside city centers. Integrate public transport mean high transits modal share with a seamless service using two or more modes. Therefore it is necessary to have a proper management of present travel demand for the Colombo city.

2.3 PRESENT STATUS OF PUBLIC TRANSPORT IN SRI LANKA

The present system of bus transport operations and railway services of law reliability have to be improved to a status wherein they form a realistic choice to those who own a private vehicle. In this context management restructuring of the bus sector as well as introduction of premium level valued added rail and bus services will be a priority. It will also include the provision of priority for public transport which is a wide spread policy adopted by many cities in their attempt to reduce traffic congestion and environment pollution. It also requires reducing the number of excessive vehicles, Re-routing and terminating some bus routes away from city centers.

Attracting higher amount of vehicles and passengers leads to the traffic congestion on the roads as well as the inter-modal congestion in public transport modes. These congestion issues can be considered as the outputs produced by attracting people and vehicles for the activities in the city.

2.4 PRESENT ROUTE NETWORK & RE-ROUTING

Colombo city is served by provincial and inter-provincial bus services operated by private and state sector buses. Both types of state sector buses are operated by Sri Lanka Transport Board while inter and intra provincial private sector buses are operated by individual private operators under the supervision of National Transport Commission and Western Province Passenger Transport Authority respectively. At present 166 of inter provincial bus routes and 98 of intra provincial bus routes enters to Fort and Petah area (Weerawardana J, 2009).

Even though the Colombo serving buses and their capacities were increased in last few decades, it is clearly observed that both private and public sector operators still have not been able to handle the increasing travel demand especially in the peak periods of the day. In addition to the demand increase, being private sector operators are highly profit oriented, all the buses serving Colombo in peak periods are highly congested giving unpleasant experiences for the travelers. Furthermore road revenue conflict among operators adds higher degree of contribution for the traffic congestion as well. These issues confirmed that increasing passenger carrying capacities is not a solution for the inherited problems of the bus services at present. Map 2.2 shows the Colombo metropolitan region rail and bus road network.

Figure 2.2: Colombo Metropolitan Region Rail and Bus Road network

2.5 BEHAVIOR OF BUS & RAIL PASSENGERS

Following issues on Bus/Rail passenger travel have been interviewed by university of Moratuwa in 2007

Identified issues reflect the behavior of passengers coming to CMC.

- 53% of bus passengers and 37% of rail passengers are coming to Fort/Petah to have a transfer to a bus going out of CMC. Greater of these travelers are coming

to city during the day time. It reveals that there is a demand to decentralize long distance bus services.

- Majority of trips between CMC and outside CMC can be considered as Home Based Work & schooling trips and travelers of 43.2% by bus and 46.9% by rail are having transfers at Petah/Fort from intra & inter provincial services.

2.6 IMPORTANCE OF THE INTEGRATION SYSTEM FOR COLOMBO METROPOLITAN AREA.

According to the above mentioned circumstances travel demand management is acceptable. Under that situation upgrading of public transport is very important. The present system of optimal bus transport operations and low level reliability of railway services have to be improved. Integration system of bus and rail would also include the provision of priority for public transport which is a wide spread policy adopted by many cities in their attempt to reduce traffic congestion and environmental pollution. A better transport integration system would lead to reduce the private vehicles entering in to the Colombo city. Then the demand for parking spaces as well as traffic congestion in main cities will be reduce. It also encourages reducing the number of excessive vehicles, re-routing and terminating some bus routes away from city centers.

Integrated public transport needs following basic factors in order to better implementation.

- Closely interlinked modes.
- Compatible routes and time tables
- Frequent service.
- Well planed implementation of Bus and Rail Integrated system.
- Efficient infrastructure facilities for quick transit.

Passengers who use rail don't have direct bus service from railway stations and hence they have to walk for buses to go to their destinations. The main travel modes with in Colombo City are bus and rail. Among those buses are divided in to private and public.

Three wheelers are used as a para transit mode in Sri Lanka. Commonly they need to transit one to another in the process of the journey and the average distance from such railway station to bus halt are more than 100 m in sub urban areas in Sri Lanka.

From Moratuwa to Fort, there are 12 stations. Among those stations Lunawa, Mt Lavenia and Angulana have very little boarding and alighting because no travel facilities from these points to destination and homes as well. Aftermath is spending more money, time and distance. Almost every transit points no direct relationship between other transport modes. One of the important rail bus transit points in Colombo City is Bambalapitiya.

Table 2.2: Distance from Stations to Bus as example

Railway Station	Distance From Stations to Bus Stop in Meters	Demand Routes from the rail passengers
Dehiwala	250	119,163,176,183
Wellawatta	300	141
Bambalapiiya	150	154,177,104,112,
Kollupitiya	100	140,177,175,
Dematagoda	50	178,152,135,104,140,193,154,143
Narahenpita	500	141,103,135,178,
Homagama	600	128,149
Nugegoda	100	176,183, ,119,163,159

With regards the distance between the Rail station and near Bus stop, Dematagoda seems a significantly short distance between the Rail station and near Bus stop. According to the table 2.2 rail passengers have to walk more than 100 miters to distance to take a bus for various bus routes from the stations.bus stops to catch the bus However from reason past bus services have been launched from Bambalapitiya, Kollupitiya and Dehiwala stations for passengers convenience. But it is not a proper rail bus integration system. Bambalapitiya station is one of the major transit points of the coastal railway line. Study has been already conducted at every station from Dehiwala to Fort. If there is a good rail bus integration service, people could use rail as well. It would be some kind of solution for Galle road traffic congestion. Since the distance between station and surrounding bus stop seems to be less than others Dematagoda station is the ideal place to initiate steps

improving rail and bus integration service. This will reduce number of passenger travels by private transport modes. The study also focused to see the importance of bus and rail integration for passengers who travel by rail and bus. Generally there are routes originates from the center of the city in sub urban and urban cities in Colombo. Most of the time there are no direct coordination with rail and bus. In generally integrated system would help to improve the accessibility of the area and in any country it can be developed a public transport system providing of better integrated transport.

Following state control authorities and private operators involved in public transportation service in Sri Lanka. But those agencies have almost no coordination with each other and do operations isolate manner. Time tabling and operation schedules of each authority can be given as common examples.

- Railway Department
- Passenger Transport Authority & National Transport Commission
- Sri Lanka Transport Board

This kind of disciplines may often problematic to commuter and hence faced number of inconveniences. Commuters face lot of problems at the stations. No time table display, no transit facilities, No toilet etc. The fact that Rail and buses do not origin or terminate at a same platform emphasizes the necessity of integration of these two modes.

There are 12 stations from Moratuwa to Fort. Except at Fort there are no user facilities at other stations. There are 19 stations from the main line from Maradana to Veyangoda. Out of that Maradana and Dematagoda stations located within Colombo Municipal Council area.

This phenomenon is not particular to Colombo as most cities experience similar problems when public transport fails to match the improved quality of transport and complexity of mobility needs that arise with increasing incomes of the population. This can be observed when one compares the relative deterioration in the comfort of bus or rail transport when compared with the ever increasing features in private vehicles. Even though buses have increased in number, the quality of service, reliability, conditions of bus stops and

terminals have continued to deteriorate. There are two types ticketing system for bus and rail passengers. Long walking distances to railway station to bus stop. Therefore commuters have to spend more time for the buss.

CHAPTER 3

LITERATURE REVIEW

Transport integration is a widely discussed subject. There are four basic principles include the public transport integration system. An integrated public transport system needs to have different kinds of transport available. This ensures both adequate coverage and frequency of service. Integrated public transport system has its transport services working together, by having compatible routes and timetables. An integrated public transport system must provide access for the user, as well as provide options for their travelling needs. There are several factors that can affect an integrated public system. These can include its connectedness, cost, availability/frequency of services, types of services used, access, travelling times, and level of both government and public support. (Mogridge M. 1980),

Integrated public transport has received particular attention in recent years as a means to improve public transport services and reduce on car travel in developed countries in Asia pacific Region. Cities such as Singapore and Hong Kong already have high modal shares in public transport (63% and 90% of all motorized trips, respectively). The high population densities in these cities naturally help promoting travel by public transport, but the high quality of transport services is also another key factor. In public transport services, Singapore also relies on high car ownership and usage costs and Hong Kong on road congestion and car parking control to maintain a low-car ownership and modal shares and good service levels still require extra effort to integrate the services across all modes. In car-based Australian cities, improving public transport systems alone may not be effective in reducing car travel. The investment required to effect significant modal shift will be high. The introduction of complementary measures such as more bus and transit lanes and even congestion pricing may be necessary to reduce car use in Australian cities. (L. James, 2003)

"The integration of public transport is one of the major issues that in South Africa and particular Gauteng city in the process of grappling with at the moment. The concept of integration has a multiplicity of meanings depending on the individual's involvement and expertise in the process of integration. Further, there has in some cases a tendency for those attempting to achieve integration of public transport, to be swept up in the glitz and glamour of the technological solutions.

Gauteng a highly populated province has a population of approximately 9.4 million and is comprised of strong metropolitan authorities. Even though transport takes place at the local level, commuter movement patterns do not follow the local authority boundaries. Further, in South Africa and in particular in Gauteng there are a multiplicity of road and rail–based public transport operators that have up to today operating on an individual basis with, if not any relationship with one another. Further, there is no relationship between road based or rail based operations.

What Gauteng needs is an entity that synthesizes all transport – related initiatives whether existing, under construction and the pipeline, into a seamless, integration whole. This is for all modes of transport and all dimension of transport. Through an extensive participation and consultation process, Gauteng has been defined as a global city region. It is therefore the intention of the GPG, through the Gauteng transport management authority, to ensure alignment of all its major policy and investment initiatives with the 11 pathways of the global city region including,

- Intelligent, integrated and intermodal transportation system, including integrated timetables and ticketing, central clearing house etc.
- Ensure that the integrated transport agenda forms the basis for all public transport initiatives.
- Contribute to the economic footprint of Gauteng from an access and mobility perspective.
- Ensure that all subsidized public transport operators on a kilometer basis so as to ensure efficiency and sustainability.

In order to ensure that the ultimate approach used and implementation plan is both effective and sustainable, there is a need to ensure that problem are identified that are both quantity and quality oriented.

- Inefficiencies and disjointed public transport systems in Gauteng.at present there are no enforced linkages between operators and even less between modes. There is a tendency for operators to not only operate on isolation but also to negatively complete with each other, to the detriment of the commuter in many cases.
- Severe congestion on the roads and ever increasing peak times morning and evening, this is due to there be an increase in low occupancy vehicles on one hand and a declining public transport service in terms of reliability, service quality and efficiency.
- The lack of safety has become a major issue. There are major issues in relation to safety and security in relation to public transport. These problems are exacerbated due to the fact that public transport is not integrated and there are major delays between two operators. In Gauteng, it is believed that over 70% of all commuters in Gauteng utilize more than one operator for each trip that is taken. Integration is therefore critical. To ensure a more streamlined approach and an integrated timetable for a public transport services.

One of the major problems is that the public transport system in Gauteng is the lack of choice for existing and potential commuters. There are also very few iterations of utilizing scheduled public transport in the province due to the limited times of operations, the lack of services on weekends and the operating times being limited.

Increased costs in both time and money for the commuter .Due to non-integration and the separation between operators, plus due to unreliability issues, overcrowding and double counting, the cost if borne by the commuter. Integrated transport needs to streamline the service and cut out time and financial costs to the commuter.

Disjointed, inefficient and uncoordinated public transport operators. Currently there are no uniform norms and standards for public transport operators in Gauteng. This relates to

all issues from the calculation and implementation of penalties, to lack of compliance with timetables to different approaches to fares etc.

There is also currently an over-emphasis on road-based public transport in South Africa and specifically in Gauteng. in order to achieve integrated transport, there is a need to address the integration of all modes and typologies of public transport. All actions will utilize the Gauteng intermodal strategic public Transport Network (GISPTN) as the backbone for intervention.

Once the system has been set, there is a need to ensure the implementation of efficiencies within the overall operations of public transport, for the benefit of the existing and potential commuter. The operations relate to, amongst other things, the following;

- Timetables and schedule management to ensure at least a 95-97% compliance
- Standardization of the fleet and the related livery
- Unification of the penalties system for public transport and linkage back to an efficient and effective public transport system.
- Ensure that the public transport service adequately covers the Gauteng intermodal Strategic Public Transport Network
- Ensure that service are extended to 18 hour operation in weekdays and 16 hour operation on weekends
- Extend the public transport services to ensure that there are buses at 10 minute intervals during the peak periods and between 20-40 minutes intervals during off peak times
- The public transport service needs to be response driven should there be special events or should there be emergency/traffic management issues.
- The management of operating licenses in relation to scheduled public transport in Gauteng. (Whitehead. M, 2008)

CHAPTER 4

METHODOLGY & DATA COLLECTION

Primary data were collected from origin/destination survey and boarding counting survey. A bus-rail O-D data matrix was compiled from 2009 survey. Three day station boarding counts were obtained from 10 stations within the study area. Passenger interview data was obtained from 4003 bus passenger's responses and 8362 rail passengers' responses, from interviews conducted at 28 bus stops/stands and10 rail stations with in urban and sub urban areas of Colombo. Number of responses was collected from each location. Railway stations and bus terminal (or stand) were being covered simultaneously.

Urban Transport unit of the National Transport Commission conducted an origin and destination survey and boarding counting survey in urban and sub urban areas of Colombo. 10 stations and 28 locations where vastly affect for bus passenger demand, and as bus stops and major transaction points were selected. Whole survey was conducted during the period from 24.06.2009 to 09.08.2009. Two hundred enumerators were employed. Amongst them there were undergraduates of the University of Moratuwa, University of Colombo, Employees of Sri Lanka Transport Board, Sri Lanka Railway and Western Province Passenger Transport Authority. In order to ensure the reliability of data surveys were done by employing well trained enumerators.

Data collected only at Dematagoda station and surrounding bus stop as it is one of the most suitable platform for rail bus integration. The whole survey was carried out by National Transport Commission in collaboration with Sri Lanka Railway, Sri Lanka Transport Board and Western Province Passenger Transport Authority. The urban transport unit of National Transport Commission made significant effort on accuracy of the results. Before the survey sketches of each location were mapped. And then it was planned how many enumerators employ in each location for passenger interview and boarding counting. Each of them were given sketch map of the location and was pointed out how when and where each commuter are interviewed and boarding counted. Just

before the survey all enumerators were undertaken field rehearsal. Survey time duration was 12 hours started from 6.00 am to 6.00 pm on Tuesdays and Thursdays. Two enumerators were assigned to a bus to collect these data during peak and off-peak periods of the day.

Boarding count of bus passengers was 4003. Out of them 150 were interviewed. Out of 8362 the rail passengers subjected for boarding counting 449 were interviewed during the said duration at Dematagoda Station and surrounding bus stop towards Borella. The survey was carried out under a assumption that all rail passengers who get down from Dematagoda station use surrounding bus stop as their transit point for bus. The survey location is shown in the map 4.1.

Figure: 4.1 : Sketch of the Dematagoda Location

CHAPTER 5

DATA ANALYSIS

The O-D matrix for bus/rail travel was prepared using the data collected from the bus/rail passenger interview survey together with the bus/rail boarding count survey. To analyze the data on Origins and Destinations, district and sub area codes were used. After coding the origin and the destination, passengers who travel between the certain origin and destination were counted. After that number of passengers interviewed, were multiplied by the expansion factor. The Rail O-D Expansion factor was received by dividing the number of rail boarding count by the number of rail passengers interviewed. The bus O-D expansion factor was received by dividing the number of bus boarding count by the number of bus passengers interviewed.

The urban form and the transportation system are closely related to the relationship of the employees and the housing density. The employee population provides a better transportation system. Therefore, setting these bus and rail connectivity shown the better results. The figure 5.4 shows the rail passengers demand for buses at the surrounding bus stop of Dematagoda rail station.

Figure 5.1: Image of Dematagoda Rail Station

5.1 ANALYSIS OF ACCESS AND EGRESS MODE AT DEMATAGODA RAIL STATION AND SORROUNDING BUS STOP TOWARDS BORALLA

Access and Egress are the means by which the principle transport modes are approached. Table 5.1 gives the distribution of access modes for the different principle modes.

Table 5.1: Percentage of Access mode for Bus and Rail

Access Mode Used	Access Mode%	
	For Bus	For Train
Bus	10%	66%
Train	63%	2%
Walking	27%	29
Other	0	3%

According to this analysis 10% of the bus passengers' chose buses as their transfer mode to complete the journey. 63% of the bus passengers choose train as their transfer mode to complete the journey. The balance 27% of bus passengers select walking to go their destinations as access mode.

On the other hand 66% of the rail passengers choose buses as next transfer to complete the journey. 2% of the rail passengers transfer to a train again to go to the destination at the transfer point. 29% of passengers get off the transfer point walk to end their journey. Only a 3% use another mode such as motor cycles, three wheelers or vans to complete their journey as access mode.

Table -5.2: Percentage of Egress mode for Bus and Rail passengers

Egress Mode Used	Egress Mode%	
	For Bus	For Train
Bus	99%	66%
Train	0	0
Walking	1%	27%
Other	0	7%

When analyze the egress mode from bus passengers 99% use buses to end their journey due to unavailability of the rail. 1% of them walk to complete the journey.

According to the analysis of rail passengers, 66% use bus as egress mode and no train users. 27% use walking and 7% use motorcycle, vans or any other passenger's personal mode as egress mode.

Bus is the most predominant access/egress mode for both bus and rail. Bus passengers are to be persuaded to use the railway; an important element is to increase frequencies to be compatible with their demand frequencies.

Table -5.3: Analysis of Trip Purposes (Bus & Rail Passenger)

Trip Purpose	Present Bus Passengers	Present Rail Passengers
Home Based Work Trip	50%	53%
Home Based other Trips	42%	41%
Non Home Based Trips	8%	6%

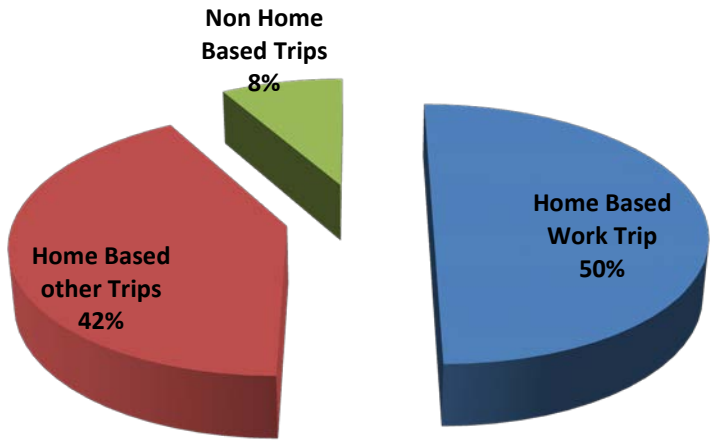

Figure 5.2 Travel Purposes Bus Passengers

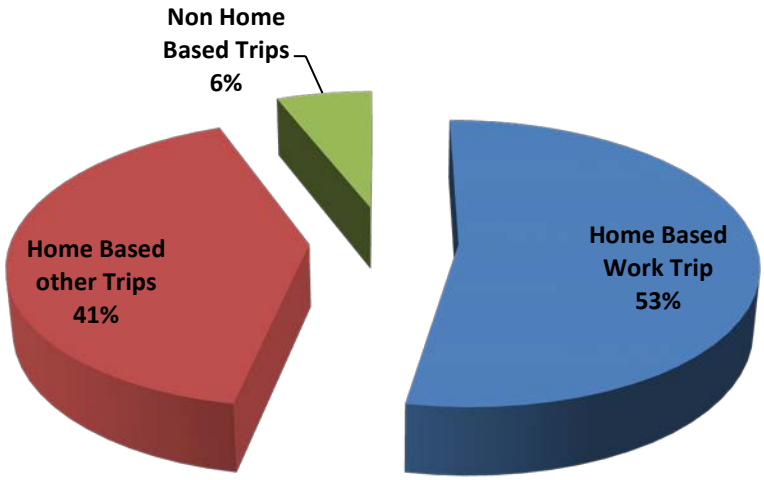

Figure 5.3 Travel Purposes Rail Passengers

Passengers who are boarding at Dematagoda surrounding bus stop can be identified as Home Based Trips; Home Based Other Trips and Non Home Based Trips. Majority is Home Based work trips. It is 50%. Home Based other Trips are 42%. Non Home Based trips mainly include official and business trips. Results of trip purpose of rail passengers' are also very similar to those of bus passenger. It is 53% for Home Based work trips and 41% for Non Home Based trips respectively. See figure 5.2.

One end of the most of trips coming to the Damatagoda Station is a home based. 53% of Home based and 41% is Home based other trips. Home based other trips are produced for schooling purposes. Non home based trips such as business and official trips are 6%. There is no significant difference in trip purposes between rail and bus passengers.

The 50% of passengers board from Dematagoda station get buses from their dropping station to complete the journey while others don't use an another mode, but walk on to complete their journey.

81% of Bus passengers, who take buses from Dematagoda, walk to their destinations (office, work or business) from the 2nd transit point. The balance (19%) use another bus for their destinations. See figure 5.5. The second travel transfer passenger demand routs from Dematagoda are 138 (Homagama-Petah), 177 (Kaduwela-Kollupitiya), 144 (Wellampitiya-Kollupitiya), 175 (Kohilawatta-Kollupitiya), 176 (Karagampitiya-Hettiyawatta), 163 (Battaramulla-Dehiwala), 173 (Narahenpita-Kotahena), 168 (Nugegoda-Kotahena) 156 (Borella-Nawarohala) and 143 (Hanwella-Petah).

The passenger's demand routs towards high level road and Piliyandala/Horana road is significantly high. But there are no direct buses to above areas directly from Dematagoda. Out of additional transferring, 15% of passengers take 138 and 175 routs. 11% of passengers take 176, 177 and 143 routs. And 4% of passengers get 156 and 173 routs.

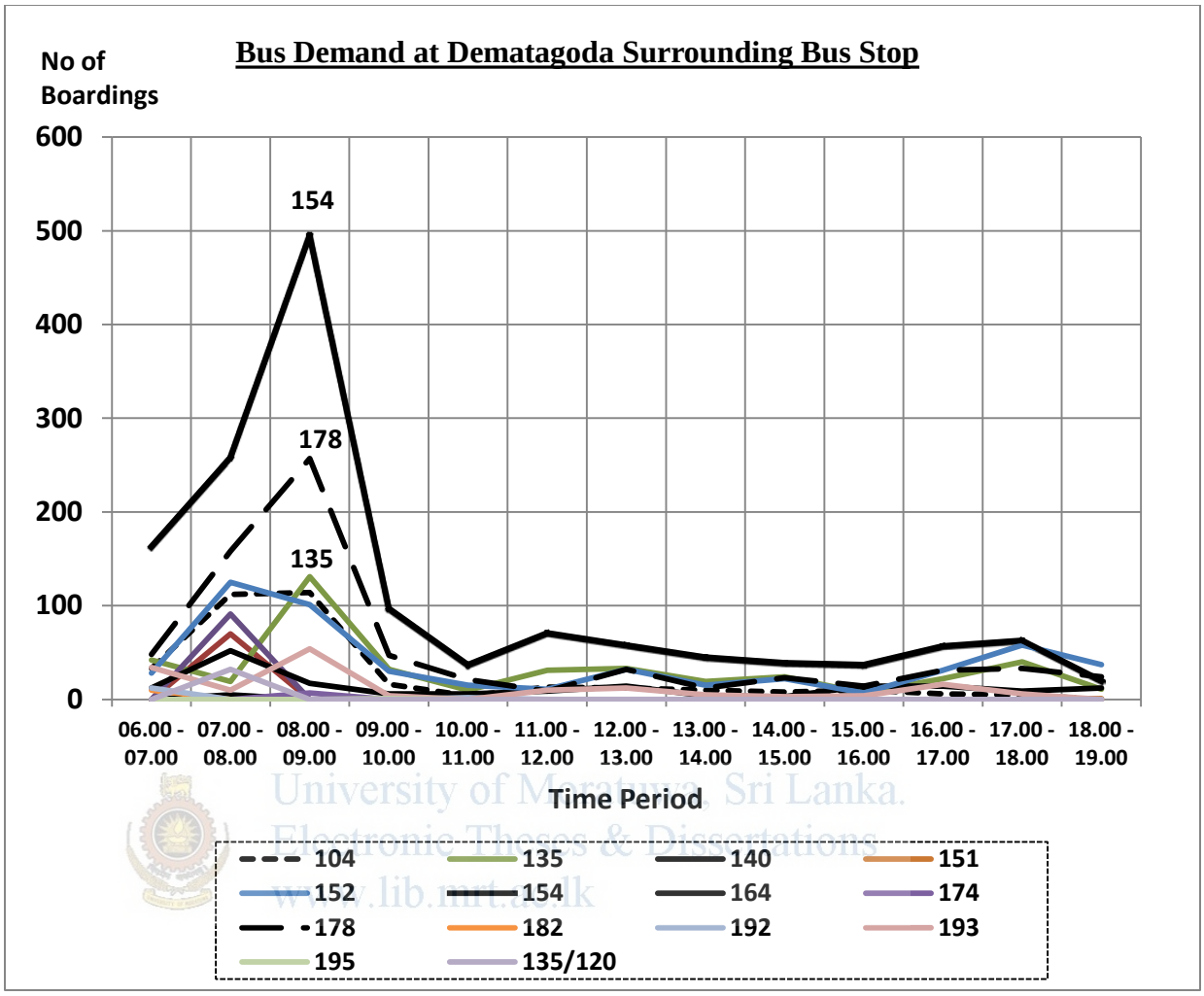

Figure 5.4 Bus demand at Dematagoda surrounding bus stop

According to the boarding count boarding demand for following routes from the bus stop at Dematagoda is as follows.

154 -Mount Lavinia – Kiribathgoda

178 -Mattakkuliya-Narhenpita

152 -Bambalapitiya-Pettah

135 -Kelaniya-Kotahena

104 -Wattala-Bambalapitiya

140 -Wellampitiya-Dematagoda

193 -Kadawatha-Townhall

Specially during morning peak time 6.30 am – 9.00 am passengers' demand seem a high. The following diagram shows the share of passennger demand for the feeder services.

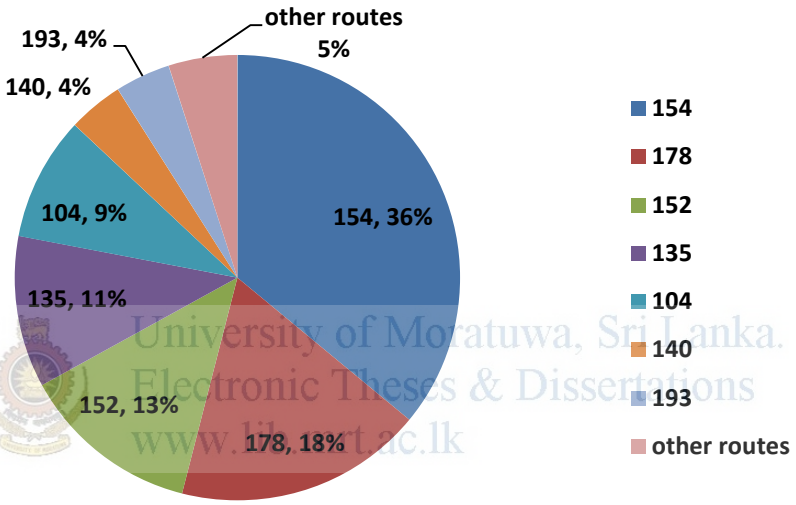

Figure 5. 5: Demand for Bus Routes

According to figure 5.5. there is 5% demand for other routes. These routes are 138 (Maharaga.Homahama and Kottawa), 120 (Piliyandala, Kohuwala). But there is no direct bus services for those routes from Dematagoda. Therefore passengers have to transfer at different locations.

CHAPTER 6

CONCLUSION

Bus and Rail are major public transport modes available in Colombo Metropolitan Region. Lack of integration between these two modes has made passengers away from the public transport service. Instead passengers increasingly turn to use alternative travel modes. Aftermath is large amount of private vehicles entering in to Colombo city. The capacity of road network in Colombo city is not enough to properly absorb ever increasing vehicles. Construction and widening of roads are practically difficult and not cost effective for a developing country. Traffic congestion in peak hours in Colombo city is common practice and this leads environmental pollution, fuel and time wastage which could adversely affect on national production. While overcoming above issues commuters entering to Colombo city need to be facilitated with a qualitative public transport service. Rail/Bus integration is a commonly use public transport strategy in the world.

Based on passenger transport demand at Dematagoda, 63% of bus passengers required train service and 66% of rail passengers required bus service vice versa. It clearly spells that both passengers have a choice at Dematagoda to exchange each modes to complete their journey. Bus demand from Rail passengers peak during 8.00 am to 9.00 am. Giving special attention to above peak duration, a proper Bus/Rail integration system could be commenced for the convenience of passengers who make home base work trips and other trips. Therefore transport network system must be integrated in planning, implementation and operation. It is needed to provide a rail/road based public transport network for feeder routes. The urban and suburban public transport system should be planned to be constructed consisting of rail-based main corridors.

No significant difference could be observed in trip purposes between rail and bus passengers. Home based worked trips are dominant. The railway can therefore, be expected to attract all types of home based trips. As some of passengers need extra

transfer to go their destinations re planning of routs need to be formulated based on passenger demand. Rail/Bus integration would streamline the service and then reduce both time and cost of travel of the commuters. Local transport routes plan to be supplied to access the activity centers.

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