A STUDY ON FINDING AN EFFICIENT MODE BETWEEN BUS AND RAIL SERVICES FOR COMMUTERS LIVING OUTSKIRTS OF DHAKA

SUBMITTED BY

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A Study on Finding an Efficient Mode between Bus and Rail Services for Commuters Living Outskirts of Dhaka

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Abstract

Dhaka city has been developing rapidly as a modern city and is throbbing with activities in all spheres of life. It is the centre of economic, commercial and industrial activities for Bangladesh. Many people from the outskirts travel to and from Dhaka on a daily basis to earn their livelihoods. These commuters depend heavily on the public transport system for their trips. Some prefer the rail while others prefer the bus to make their day-to-day journeys. In many cities of the world, including Dhaka, there is ongoing debate over the relative advantages of rail and bus transit investments. Rail transit can only serve a limited number of stations, but those stations can stimulate intense development, with increased density (residents, employees and business activity per acre), higher per capita transit ridership, increased walking trips and lower per capita vehicle trips. However, bus transit has higher accessibility. It can serve more destinations, including dispersed, suburban activity centers, but attracts fewer riders per capita, and by itself has little or no effect on land use patterns. Rail has lower costs per passenger-mile due to higher load factors whereas buses tend to have lower costs per vehicle-mile. The aim of this study is to assess the overall transit system performance of rails and buses. These observations are then used to make a comparative analysis between the two modes. The study quantitatively verifies which transport mode has the higher efficiency and is worth improving. It can be used as a guideline by government agencies in their decision to invest in public transport systems.

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Chapter 01
Introduction

Transportation is the system of relocating people, goods and animals from one place to another. For the purpose of movement of people a number of modes are introduced to travelers with the passage of time. But in most of the cases travelers choose those transport modes or systems that seem most efficient to them. It means that an efficient transport system has benefits over other modes as it saves travelers' time, money, and energy and so on. That's why now a day efficient transport system is the mostly preferred option for traveling especially to commuters who travel a longer distance from periphery of a city to the city centre to earn their livelihood or get other services daily. Commuters are those people who belong to that class of the society who cannot afford a decent life in the crowded and expensive city centers, so often choose to commute a long distance for the sake of their living .Very often they are found to trade off between travel cost and time while choosing a transport mode. So it is definite to find out an efficient transport system for long distant travelers by checking out the efficiency factors carefully is of great significance.

1.1 BACKGROUND OF THE STUDY:

Dhaka, the 20th mega city of the world has become overcrowded with a population of around 15million.Besides, being the capital of Bangladesh; Dhaka is the hub of all the administrative, educational, social, political and all other economic activities. As the core of the country, Dhaka city attracts people from its outskirts as those places couldn't be grown because of the imbalanced development of Dhaka, for giving better opportunities of work and earning livelihood. So, everyday a large number of people come to the city centre from outskirts, like Uttara, Tongi, Narayanganj, Gazipur etc. These people have to go back to their residence after the completion of their daily activities. So, commuting is regular travel between one's place of residence and place of work or full-time study. Thus the circulation patterns of the commuters revolve within cycle from outskirt to city and then city to outskirt.

These commuters play an important role in the production system, economic activity and sustainability of various important sectors of the Dhaka city. In order to ensure participation of commuters in the economy of Dhaka city, it is a prerequisite to provide an efficient transportation system for the commuter for their travelling within city and peripheral area.If the transport system remains at an inefficient level commuters will find travelling unsafe, more time consuming and expensive. Then at one point of time these commuters will be compelled to live within Dhaka city which is already suffering from inability to provide its residents with required services because of imbalance growth of population and available facility. If the commuters start to live permanently in Dhaka, this augmented population will

add fuel to worsen the existing worse situation. So, development of an efficient transport system is necessary to avert this ensuing problem.

It is a natural instinct of human being to spend less time and money for transportation. That's why when more than one mode is available to the travelers; they often choose the one that is more efficient than the others. But this efficiency measurement varies from person to person as many factors (like-speed, safety, adequacy, frequency, regularity, integration, comfort, cheapness etc.) (Kadiyali,L.R. 2007) work behind it. Everyday hundreds and thousands of people are commuting from Joydevpur, Tongi and Uttara to central and other parts of Dhaka. At the same time people from other parts of Dhaka are also commuting to Ashulia, Tongi, Uttara and Joydevpur.

Transportation sector is a massive playground for its user. And Bus is the biggest player in the road based public transportation system. In the case of Dhaka city commuters often choose bus services for long distance journey because of its high accessibility, and frequent movement between city centers and suburb places. At present, bus service is considered to be the most popular transport system which has the potentiality of being a cheap, high capacity transport mode (Quium, A, S, M, n.d). Bus service of the city is in unsatisfactory condition due to lack of proper maintenance, planning and management, and uncontrolled development (Olsson and Thynell, 2004). Although rail service is not so widely used in Bangladesh and less than 5 percent travelling or commuting is done by train. But it has a great potentiality for a highly crowded city like Dhaka as it has more passenger carrying capacity and higher speed and less travel time than bus (Kibria, A. 2012, Quium, A. S. M. n.d). Traffic pressures on road can be easily reduced by providing some commuter train service from Kamlapur to Joydevpur. As rail connectivity between other parts of the country and Dhaka fully depends on Dhaka-Joydevpur rail route, some attention, however, has been paid to this route.

It is high time to think about searching the most efficient transport system for commuters who spend a long time for travelling every day. That's why, the main goal of the study is to find out the efficient mode for the commuters which will obviously lessen their travel time and at the same time increase their productive output with decreasing the probability of Dhaka city to be over-burdened. Not only improving bus services but also rail transportation is needed to be improved because besides bus, rail is also a very popular mode among the commuters. From these two important modes, now the time has come to point out the most efficient one. And if it is possible then a number of population related problems of the capital city can be solved and further development in suburb areas will be easier.

Chapter 01
Introduction

1.2 OBJECTIVES OF THE STUDY:

1. To prepare an inventory of existing bus and rail services for commuters living outskirts of Dhaka.
2. To find out an efficient mode of travel between existing bus and rail services for those commuters.

1.3 RATIONALE OF THE STUDY:

An efficient transport mode is considered as an integral part of an efficient transport system. As the people commuting to Dhaka city from outskirt areas use mostly bus and rail, it is necessary to improve efficiency of these transport modes. In a developing country like Bangladesh, it may be difficult for government to invest on both modes for their improvement. So, it is necessary to identify the most efficient mode between this two. The prime purpose of this study is to identify the most efficient mode between these two so that government can make appropriate investment decision and making maximum utilization of government fund which is a policy objective of "National Land Transport Policy" of Bangladesh.

If the most efficient transport system can be identified then it can be appropriately incorporated into the existing transport system for developing an "Integrated Transport System".

1.4 SCOPE OF THE STUDY:

The main target of the study is to find out the efficient mode for commuters between bus and train. To reach the ultimate goal of the study at first the study area and the routes are selected (both for bus and train) and different surveys are conducted related to study. Volume survey has been conducted in the selected bus routes to find out the efficient route between same origin & destinations, to determine the capacity of the intersections of the routes and overall analysis of the selected bus routes. Then user opinion survey has been carried out to gather the opinions from the commuters regarding the efficient mode choice who come from outskirts (Joydevpur and Narayanganj) to Dhaka using Bus and Train services along the selected routes. In the analysis using these data regarding different factors which influence modal choice of the commuters, trip pattern of commuters, level of service, problems associated with the commuting modes etc. have been used. Key informant interview supports the analysis of user opinion survey and the existing inventory analysis of bus and rail services for the commuters. Thus the information related to problems and existing inventory of the

two commuter modes can provide a guideline for any improvement of these modes. And finally, the study reveals the efficient commuting mode for the commuters with respect to several factors which influence the mode pattern behavior of the commuters.

1.5 LIMITATION OF THE STUDY:

Time constraint is the major obstacle considered, during the study. Because of very limited time many field surveys related to the study has not been possible to conduct. Speed survey and Delay survey are very much an integral part of the analysis of volume survey but because of time constraint these surveys could not be conducted. Thus because of the information lacking of these surveys, stronger base of the study could not be constructed to some extent. The study is carried out only for two bus routes from Narayanganj to Dhaka and two Bus routes from Joydevpur to Dhaka. But if the study could have covered all the route analysis, it would have represented the result more perfectly.

Chapter 02
Literature Review

Introducing the most efficient transport system needs to study a number of relevant factors and techniques. It is initially important to have clear knowledge of the terms that are intermingled with the topic thus with efficient transport system. Commuters' transport system is a very well-known topic of the present world. So, modal choice of commuters is a multifaceted occurrence in transportation. In this chapter commuter's efficient mode choice related relevant studies will be reviewed of some countries that show some resemblance to Dhaka's economic or social condition. This study will help to know about the up to date ideas, explanations and theories in formulating the most efficient solution regarding efficiency in commuters' transport system.

2.1 OPERATIONAL DEFINITIONS:

At this section some operational definitions and relevant theories or ideas are discussed below:

2.1.1 Commuters: Commuters are those people who travel a long distance from outside of a city between their place of residence and place of work or full time study. Sometimes regular or often repeated travel between locations is made that are not working related trips. Commuters usually travel a longer distance from their own village, town, and city especially in industrial societies. In case of developed countries many large cities are surrounded by commuter belts, commuter towns, dormitory towns or bedroom communities. Typical commuters live in one of these areas and travel to the city centre daily for work or education purpose (Wikipedia, n .d.).

2.1.2 Efficient transport system: An efficient transport system is such that which can provide the best possible service within its input limit for the particular group of travelers it serves; usually it reduces vehicle miles traveled. But there is no definite transport system that can be considered as standard one since numbers of factors affect the efficiency of transport system. Major factors considered to affect efficiency are speed, safety, adequacy, frequency, accessibility, regularity, integration, comfort, economic fare etc. and from the perspective of these different factors efficient transport system can be defined in a different way.

Firstly, from the accessibility perspective an efficient transport system is the one which increases road network connectivity and support more accessible and multi-modal community. Again from the perspective of multi-modal transport system, a transport system

will be considered efficient if it can support and encourage use of resource-efficient modes, so that the users may choose the most efficient options for each trip. Besides from different factors' perspective, efficient system can be defined from planning efficiency point of view in such a way where an efficient the system would be considered the one which is planned, well-designed, well enough for convenient travel and perfectly managed to support strategic objectives.

2.1.3 Public Transport: Public transport is a shared passenger transport service which provides service to general people all the day long. It is district from taxicab, car pooling etc in the sense that it allows sharing of the mode by strangers.

Bus, train, tram, rapid transit (like metro, subway, underground), ferries are the common public transport mode available in almost all countries. Public transport usually maintains a scheduled timetable with the most frequent services running to headway. It is usually funded by government subsidies and fares charged to the passengers of public transport (Wikipedia, n .d.).

2.1.4 Suburb: Suburb means a residential area which exists either as a part of a city or as a separate residential community within a commuting distance of a city. They usually have lower population density than that of inner city neighborhoods. They are usually formed by a number of suburban areas (Wikipedia, n. d.).

2.2 TYPES OF COMMUTER SERVICES:

Commuter services throughout the world vary according to population, modal choice, road factors and some other determinants. The mostly used services are:

2.2.1 Commuter Bus Service:

A commuter bus service means a fixed-route bus and is characterized by its service mainly in one direction during peak periods, limited stops, use of multi-ride tickets, coordinated relationship with other mode of transportation and lengthy routes usually between the central business district and outlying suburbs (Wikipedia, n.d.).They can be operated under private or public ownership. In many developed countries rail service is more preferable to commuters than bus service, but still in some developing countries like in Bangladesh buses plays the major role of commuter travel. In Bangladesh BRTC plays a significant role for daily

commuter travel which is indicated by around 90% bus travel by commuters to Dhaka from suburbs.

2.2.2 Commuter Rail Service:

Commuter rail or suburban rail is a passenger rail transport which primarily operates between a city centre and outer suburbs areas to drag large number of commuters every day. They are usually economic; provide service to larger number of people and safer and more environment friendly than bus. In most metropolitan areas of the European countries commuters use this mode widely. In the case of America, usually Asian people use commuter rail for their travel to work place.

In Bangladesh, commuter rail serves people from Narayanganj, Joydevpur, Uttara, Togni to Dhaka for working purpose. But the convenient and desired services are not yet available to people here. So to improve this sector very recently government has taken some initiatives to improve commuter travel. Two new commuter rail on Dhaka to Narayanganj route has been introduced and 25 initiatives are about to be taken to improve service.

2.2.3 Metro Rail:

Metro rails usually cover a smaller inner-urban area ranging outwards with a higher frequency and can run on grade separated underground or elevated tracks (Wikipedia, n. d.). They are usually speedy, more comfortable but expensive. They provide world class facilities to its users.

2.2.4 Auto mobile:

In developed countries people use their own private car for commuting. In such case two possible events may take place. Either they commute to their work place driving alone or they may drive to any public transit station, then using park and ride facility traveling the rest distance by public transit. From a survey conducted in 2009, it is observed that 76.1% American commute to their work place using automobile.

2.2.5 Carpooling:

Carpooling or ride-sharing is the sharing of car journeys by more than one people. This is an efficient way of commuting as it reduces per person travel cost, carbon emission and traffic

congestion (Wikipedia, n. d.). A survey in United States reveals that about 10% commuter travels to their work place through carpooling in 2009.

2.3 COMMUTER SERVICE FOR DHAKA CITY:

Everyday many people commute from peripheral areas like Joydevpur, Tongi, Munshiganj, Savar, Gazipur, Uttara to central and other parts of Dhaka.A rough estimation shows that almost 90 percent of the commuters depend on buses and mini-buses (Kibria, A. 2012). Bangladesh Road and Transport Corporation (BRTC) provides bus service facilities in different outskirt areas of Dhaka city like Dhaka to Narayanganj, Dhaka to Maoa, Dhaka to Narsindi, Mothijeel to Narsindi and Dhaka to Kuliarchar (BRTC, 2013).

Although rail service is not so widely used in Bangladesh and less than 5 percent travelling or commuting is done by train. But it has a great potentiality for a highly crowded city like Dhaka as it has more passenger carrying capacity and higher speed and less travel time than bus (Kibria, A. 2012, Quium, A. S. M. n.d).

2.3.1 Dhaka to Gazipur (Joydevpur):

Travel demand of commuters can easily be met by train service. The trains that are running on this route have the potentiality of carrying passengers in large numbers. Dhaka and Joydebpur is also well connected by train. Express train runs on this route.

Bus service is also available for meeting the travel demand of the passengers. BRTC runs its bus service on Dhaka-Gazipur route which carries the commuters to Dhaka city. V.I.P bus service is available on Dhaka-Azimpur- Gazipur routes.

Gazipur Town is connected to Dhaka through all the City Bus. These buses mainly ply on the following routes.

TranseCilva—Jatrabari-Gazipur

Gazipurparibahanltd.--Dhaka-Gazipur

Dhaka Paribahan ltd.--Motijhiil-Gazipur (Wikipedia, 2013)

2.3.2 Dhaka to Narayanganj:

One of the most used routes for commuter travel is Dhaka-Narayanganj as Narayanganj is only 19 km far from Dhaka city. For that reason, there have been many initiatives taken by

BRTC for meeting the travel demand of commuters. Bus runs on this route under the possession of BRTC and private companies. Among these bus services Utsav, Ekota, Bandhan etc. are some bus under private sector running on this route (BRTC, 2013). Both AC and Non-AC buses are plying in this route. The service providers provide tickets depending on distance of travel on current trips. The accommodation capacity of each bus is fifty persons per trip. At present, 13 trains are operating in this route making 26 trips to and from Dhaka city every day. (Financial Express Report, 2012). Most of these trains are local train.(Travel1bd.com,2013).

Recently, government has inaugurated 10 articulated bus service having 50 seats in this route (BanglaNews24.com). Express trains like Turag and Lalmoni express trains run on Dhaka-Tongi-Joydebpur route. (Travel1bd.com, 2013, UNB Connect 2012).

Gazipur Town is connected to Dhaka through all the City Bus. These buses mainly ply in the following root.

2.3.3 Dhaka to Maoa:

In this route there is no BRTC bus service available. The private bus service named Dhaka to Maoa (Elish) serves the route from Gulistan to Maoa Ghat. The accommodation capacity is 40 person per trip.

2.4 COMMUTER SERVICES ABOARD:

2.4.1 Commuter services in Kuala Lumpur, Malaysia:

Public transport in Kuala Lumpur and its surrounding outskirts covers a variety of transport modes such as bus, rail and taxi. The main operator is the government-owned Rapid KL, which stands for Rangkaian Pengangkutan Integrasi Deras Kuala Lumpur Sdn Bhd. Rapid KL took over the operations of the two main bus operators, Intrakota and Cityliner. Most new RapidKL buses are disabled-friendly. Kuala Lumpur's rail-based transit system consists of two Light Rail Transit lines (rapid transit), three commuter rail lines (including the Rawang-Tanjung Malim shuttle service), one monorail line and an airport rail link to Kuala Lumpur International Airport, which consists of an express and a transit service. The main rail services are: Ampang Rail Line, Kelana Jaya Rail Line, KTM Komuter (abckualalumpur.com:Visitors Guide to KualaLumpur,2013).

Table 2.1: Kuala Lumpur Integrated Transit Network Average Daily Commuters

Kuala Lumpur Integrated Transit Network Average Daily Commuters	2001	2002	2003	2004	2005
Rapid KL *Kelana Jaya Line*	143,778	149,105	154,869	160,361	165,695
Rapid KL *Ampang/Sri Petaling Line*	88,201	91,702	107,082	120,426	125,208
KTM Komuter	57,339	60,504	67,522	74,960	85,733
KL Monorail	-	-	23,872	33,837	44,442
Express Rail Link *KLIA Ekspres / KLIA Transit*	-	4,983	7,323	9,990	12,075

Source: Visitors Guide to KualaLumpur, 2013

2.4.2 Commuter services in New Delhi, India:

As the capital of India and an economically vibrant city New Delhi a huge amount of pull factor from its suburban areas. Commuters travel to and from downtown New Delhi to its outskirts on a daily basis using public transportation. Delhi Suburban Railway is a suburban rail service operated by Northern Railway for the National Capital Region where Delhi Ring Railway is part of this service. The Ring Railway is a circular rail network in Delhi, which runs parallel to the Ring Road. At present, it has a daily ridership of approximately 5000 passengers.

It is actually considered as an example of failed mass transit system because of lack of workable connections to other methods of transportation as well as a low-density population in the areas of reach. The network is now utilized as a freight corridor, though limited passenger EMU train services are available during peak hours. However bus service in suburban Delhi is very poor as compared to its railway services (Wikipedia,n.d.).

2.4.3 Commuter services in Sydney, Australia:

Public transport in Sydney and its outskirts is provided by an extensive network of public transportation operating in road, rail and water transport modes. Sydney's early urban sprawl can be traced in part to the development of its passenger rail network. This rail infrastructure allowed working-class suburbs to develop at a large distance from the city centre. Bus services in the regions surrounding Sydney are considered part of the metropolitan network. Passenger rail services in Greater Sydney are provided by City Rail. Sydney's suburban commuter rail service consists of eleven railway lines. City Rail's performance declined

significantly. Sydney was ranked as the fourth-worst public train system. Sydney does not have a separate metro system, but most suburban lines run through the city centre.

2.4.4 Commuter Service in Chicago:

Throughout the 21st century, Chicago Commuter Rail Service known as Metro has been the second busiest commuter rail system in the United States by average weekday passenger trips. Chicago has the one of the most efficient commuter rail service connecting 241 stations and 11 rail lines. Initially rail service for Chicago was used for freight transport, but with increasing rate commuting Metro evolved as stronger rail service authority. Several ticketing options like one-way ticket, one-way ticket, ten-ride, weekend pass and monthly pass exist for passengers. The transport system was developed such that stations are easily accessible by commuters (Wikipedia, n. d.).

Chicago Transit Authority (CTA) has 2,000 buses operate over 150 routes for commuting passengers. It serves nearly 40 surrounding suburbs of Chicago city. The whole bus service is designed to take commuters from 12000 bus stops (Chicago Land Chamber of Commerce).

2.4.5 Commuter Service in Singapore:

Realizing the adverse affect of automobile increase and to the serve the densely populated Singapore the bus services has always been on focus for commuter service. The bus service of Singapore has always considered convenience and comfort of the commuter keeping the service within an affordable level. To speed up the buses and enhance their reliability, bus priority measures such as full-day bus lanes was introduced so that buses can travel unimpeded by other traffic for commuter travel (Menon, G. and Kaung, L.G. 2006).

There are at present two train networks in Singapore – the mass rapid transit (MRT) lines and the light rapid transit (LRT) system (Wikipedia, n. d.).

2.5 INVENTORY AND EFFICIENCY DETERMINANT FACTOR:

Efficiency of a transport mode depends on upon its performance, service quality standards and many other factors.

I.M. Garcia Sanchen in a study to determine the transport system efficiency of Spain used three types of indicators for determining efficiency of mode. At first, the three supply-side indicators: hours, vehicles-km, and seat; in the second, the demand-side measure passengers;

in the third, the three quality outputs: frequency, comfort, and accessibility (Sanchen, I.M.G. 2009).

Demalesh Abate Abraha in his study on measuring the efficiency of public transport mentioned five distinct category of efficiency measuring tool such as network, vehicle, labour, finance and system operation on the basis of main operational components. These are described below.

System efficiency refers to the road and vehicle infrastructure such as speed of traffic, quality and comfort of the mode, reliability, ticketing system, accident rate (Abraha, D.A. 2007, Byatt, A. *et al,* n. d.). The distance between routes and stops or terminal makes a tradeoff between cost and journey time. Journey time should cover waiting time, walking, boarding time, in vehicle time, walking to destination time. System efficiency also depends on number of people served and vehicle availability in peak and off-peak hour. All this factors were considered for determining the quality of the transport service (Abraha, D.A. 2007).

Zhao, F. *et al* recommended including indicators like comfort, cleanliness, pedestrian accessibility to transit station, frequency of service, reliability, amenities, safety and security, parking space, service coverage, travel cost to study efficiency of public transport mode. Service coverage includes presence and existing condition of sidewalk giving accessibility to transit stops, street light etc. Amenities include bench, trash receptacle, information signage, vending facility, air conditioning in station (Zhao, F. et al**.**, 2002). Safety means protection against mugging, fire extinguishing facility for sudden fire hazard in vehicle, no propensity to overtake, efficiency of driver (Kadiyali, L.R.2006). For assuring safety user should feel safe in the station and in vehicle (Jin, X. et al, 2005).

Mobility measures the quality of movement and quantity being moved. For determining the mobility parameters like volume-capacity ratio, capacity related LOS, speed, delay, trip reliability and user cost. Better mobility is ensured by speedy vehicle as it ensures reduce travel time. Accessibility is measured by proximity and connectivity by distance within the origin of the travel and from the transport terminal and connectivity by pedestrian pathway (Abraha,D.A. 2007, Fang et al., 2002). A transport mode providing door to door service ensures intregity and makes the transport system efficient (Kadiyali, L.R.2006). An efficient transport mode should be affordable and equitable for common people in terms of travel cost. (Abraha,D.A. 2007).

Table 2.2: Category of Efficiency

Efficiency category	Description	Indicators	
System efficiency	System efficiency is the ratio of output to the input consumed in the transportation process. It depends on labor, financial, network and utilization efficiency.	accessibility	
		mobility	
		equity	
		productivity	Passenger volume
			Vehicle-km
		Infrastructure availability	
		safety	
		Quality, comfort, conveniences	
Network operating efficiency	Network efficiency measures the ability of the network to support direct services between areas, short distance flexibility and coverage.	Continuity and balancing of lines	
		Operating flexibility	
		Integration with other modes	
		Cost of the system	
Labor efficiency	Labor efficiency refers to the amount of labor required to produce unit system out put.	Operating employee per vehicle-km	
		Passenger carried per day per total number of employee	
		Number of workers employed in maintenance shop per vehicle serviced in it	
		Administrative staff employed per operating bus	
Utilization efficiency	This compares the rate of resource (vehicle, labor, line) utilization to the available capacity.	Vehicle utilization	
		Vehicle break down in service	
		Fuel consumption per km	
		Vehicle capacity utilization	
		Line capacity utilization	
		Labor utilization	
Finance efficiency	Finance efficiency refers to the amount of investment required and/or gained to/from produce unit system out put.	Operating cost per vehicle-km Operating cost per passenger trip Revenue per vehicle-km Revenue per vehicle-hr Total revenue per total operating cost	

Source: (Zhao, F. et al., 2002)

For determining the efficiency of bus service Abraha suggested to consider the speed, length and number of lane, service offered at bus station etc (Abraha,D.A. 2007). Jin, X. *et al* identified key factors that determine transit use were on-street service, station safety, customer service, safety in route, reduced fares, cleanliness, seat availability in order of importance (Jin, X. et al.,2005). Productivity of a transport system is an indicator of efficiency and depends on vehicle-km, passenger-km and passenger-vehicle (Abraha, D.A. 2007).

Chapter 02
Literature Review

Hang Yang and Haupa LU in a study for regarding the urban transportation study used resource factors like energy, human resource, land, labor and environmental impact for determining efficiency of a mode along with other factors. Minimum resource occupying and minimum operating cost and minimum emission and environment hampering vehicle were considered to be efficient (Hang, Y. and LU, H. n. d.). The vehicle which requires less fuel is considered to the more economical and efficient than any other mode (Kadiyali, L.R.2006).

L.R. Kadiyali identified some other relevant factors to judge efficiency of a transport mode like comfort, adequacy, responsibility, regularity, employment generation capacity. Comfort is ensured by available facilities for travelers such as seat per head, air cooling, inner vehicle circulation space, suitable size of seat, food or water availability etc. Adequacy can be judged by proportion number of seats to passenger carried, number passengers riding standing or on roof etc. Regularity implies the extent to which the transport mode is maintaining its schedule and not making any delay in arriving in time or starting from station. Responsibility refers to maintaining rules and regulation and traffic signal, providing compensation, not taking overloading passengers (Kadiyali, L.R.2006).

In a case study of Dar-es-Salaam, Tanzania it has been seen that, for commuters proposed Bus Rapid Transit (BRT) efficiency has been evaluated by stated preference survey of potential users consisting of 684 commuters. The BRT attributes considered for study are: travel time, travel fare, and comfort. A higher preference is indicated for in-bus comfort by commuters from zones close to the CBD, while commuters from the city peripheral zones seemed to have a higher preference for travel fare and appeared less willing to pay for comfort than those from the inner zones of the city (Nkurunziza et al., 2012).

An efficient and convenient transport mode can help the commuters to a great extent. Commuters always want to get on any mode at any point of time to meet their travel demand and the selection of mode depends on various factors associated with the commuting. Without proper knowledge regarding the factors of efficiency of transportation related to commuting, proper implication of these in placing a fruitful mode for commuters is nearly impossible. Besides, the used commuter services throughout the world have given the ideas about different types of modes and their applicability. Some studies have shown the methods by which efficiency can be measured and the mode can be chosen. The overall study has revealed an initiative which is very helpful for fulfilling the main task of the project that is finding out efficient mode for commuters.

2.6 0-1 UNWEIGHTED FACTOR METHOD

This is a method of comparing different things with each other on the basis of some factors.

Table 2.3: 0-1 unweighted factor method

Name of the Factor	X object	Y Object
Factor 1	0(Satisfies)	1(Does not satisfy)
Factor 2	1	0

But in this method no weightage is given to the factors. In this method, if a factor satisfies any particular condition then a value of "1" is assigned. If the factor does not satisfy the condition then the value assigned is "0".

All the values are then added up for each object and then the object with the highest sum is chosen as the better one between the two objects.

2.7 VOLUME/CAPACITY RATIO:

Volume/Capacity ratio is the ratio between the volume of traffic at intersection leg and the standard volume capacity of the intersection. From the ratio of volume it is understand that higher the ratio values lower the level of service of the intersection and vice versa. And thus for each range of V/C ratio a category for level of service is given to the intersections.

Table 2.4: Volume/Capacity Ratio (V/C Ratio)

V/C Ratio	Level of Service
>0.60	A
0.6-0.7	B
0.7-0.8	C
0.8-0.9	D
0.9-1.00	E
>1.00	F

Source: Kadeyali, L.R, 2007

Literature review is the foundation of that knowledge based on which the whole study has been carried out. As the factors affecting people's decision of choosing efficient mode varies from that of general mode choice factors, so they should be taken into consideration. All these knowledge has been applied when the project has been carried out to achieve the goal of the study.

Chapter 3
Methodology of the Study

Any project or work needs a particular procedure through which the project can be completed successfully and the output becomes perfect. To obtain the exact objectives of any project it is must to follow a gradual process. So, for achieving the two particular objectives of this project, some definite steps, procedures and survey methods are followed. In this chapter the whole methodology of this study will be discussed in detail.

The methodology of the study is described below (Figure 3.1):

3.1 PROJECT IDENTIFICATION AND FORMULATION OF OBJECTIVES:

Before starting a project identification is very important. At the beginning a project has been identified based on which the whole project is started. After identification of project, two objectives are formulated and the other procedures of the project has been started to achieve these two objectives.

3.2 LITERATURE REVIEW:

To understand the objectives, appropriate studies related to this project are carried out. Different definitions associated with this study and also other relevant studies are carried out to have a very clear idea. Various webs, transportation related reports and books; journals are used as the important sources of study for this project. This literature review is also reflected upon real life scenario related to this project.

3.3 PREPARATION OF CO-ORDINATION SCHEMA:

Based on literature review, a co-ordination schema has been prepared comprising of variables against the objectives, parameters against variables and the source of data.

3.4 SELECTION OF STUDY AREA:

According to the study, two modes bus and train are compared between same origin and destination to find efficient mode. As the study is concerned of the commuter transport service for those who come to Dhaka from its outskirt areas, so among many outskirt areas of Dhaka city two areas are selected. They are Narayanganj and Joydevpur. The reason behind choosing these areas as study area is first of all both bus and train services are available within these two areas and a huge number of people from this area come to the city centre every day.

Now from the first study area which is Narayanganj to Dhaka it is found that two bus routes and one train route is selected. One of the bus routes starts from Narayanganj and reaches Gulistan in Dhaka via Doyaganj.The total length of this route is 16.94km (Appendix B, Map 3.1).

The second route starts from Narayanganj which also reaches Gulishtan via Signboard. The total length of the route is 17.4 km (Appendix B, Map 3.2).

And the only rail service considered in the study area starts its journey from Narayanganj which stops at Kamlapur rail station in Dhaka.

The second study area is Joydevpur to Dhaka, where again two bus routes and one train route is selected. But the length of bus routes in this study area is higher than that of Narayanganj, which means Joydevpur is located at more distant place to Dhaka than Narayanganj.

Now from the selected two bus routes in Joydevpur first one selected starts from Joydevpur which reaches Zero Point at Gulistan via Mohakhali. The total length of this route is 32.7 km (Appendix B, Map 3.3).

While another selected bus route starts from Joydevpur but it reaches Dhaka at Sayedabad via Badda. The length of this route is 33.32 km (Appendix B, Map 3.4).

And finally the train route selected from Joydevpur starts from here and thus ends at Kamlapur rail station is Dhaka.

3.5 DATA COLLECTION:

For this study mainly two types of data are collected to get the result. The data are:

3.5.1 Primary Data Collection:

In this data collection procedure there have been conducted some surveys for collecting data from the real field. The surveys carried out here are:

3.5.1.1 Reconnaissance Survey: Reconnaissance Survey is mainly done for identifying location of study and gaining an overall idea about the place. In this project, reconnaissance survey is conducted on the selected routes. The main target of this survey is to gather experience on commuter bus and train travelling with commuters. Some important information like the stoppages or terminals of commuter bus and rail; number of bus and rail services and their time schedule for commuters; time needed for

journey; overall condition and environment of these modes; service facilities; special characteristics of the routes and also the important places from where commuters mainly commute etc. are collected to have a gross conception about the locations and modes.

3.5.1.2 Field Survey (Volume Survey): Volume survey has been conducted at some selected intersections of Dhaka city to observe the volume of a particular intersection and to determine the impacts of traffic on different roads within the Dhaka and the outskirts. This survey is completed through some sequential steps.

- **Preparation of Volume Survey Format:** Before starting the field survey and selection of intersections a standard survey format is prepared in which different modes including time and direction of traffic flow.
- **Selection of Intersections and Survey time:** The survey is conducted at 22 selected intersections. The time of survey is divided in three categories-Morning Peak (8 AM to 10 AM), Morning off Peak (11 AM to 1 PM) and Evening Peak (4:30 PM to 6:30 PM).
- **Field Survey:** After preparation of survey format and selection of intersections, field survey is conducted. The whole project is completed through group work (six groups) and the intersections have been also divided among these groups for completing the survey. Two days are needed for completing the survey.
- **Data Collected from Volume survey:** The data which have been collected from the survey are: Peak off-peak variation, directional variation and Passenger Car Unit (PCU) from modal composition.

3.5.1.3 User Opinion Survey: The aim of user opinion survey is to find out the information in relation to efficient mode from the point of view of the commuters. This survey is conducted through Questionnaire. This survey has two orderly stages:

- **Preparation of Questionnaire:** Based on the parameters and variables of prepared co-ordination schema a questionnaire is designed. It involves commuters' opinion about the frequency, comfort, cost, time, problems and priority related to the modes and routes.

- **Questionnaire survey:** After preparation of questionnaire format and fixation of routes, at first a pilot questionnaire survey has been conducted to the commuters on those routes. After that final questionnaire survey has been carried out for which the sample size was 210 in total (35 for each of six groups).

3.5.1.4 Key Informant Interview: At first a checklist of key informants and about the questions to be asked is prepared. Then the interview of these people based on the checklist is carried out to gather information in detail about the quality, level of service provided to commuters.

3. 5.2 Secondary Data Collection:

3.5.2.1 Collection of road network map: A road network map is collected from secondary source to find out the existing commuter service routes from outer suburb areas of Dhaka city toward city centre.

3.5.2.2 Preparation of road network map: In this map the currently active bus and train routes from Gazipur and Narayanganj to inside Dhaka city are identified along with the existing bus stoppage and rail stations throughout these routes. Based on this map the routes have been selected for different surveys.

3.6 DATA PROCESSING AND ANALYSIS:

The data collected from the primary data collection process (Different Surveys) have been analyzed using different analytical tools. Comparison between two modes has been carried out through the analysis.

Detail data analysis is given in Data Processing and Analysis Chapter (Chapter 6).

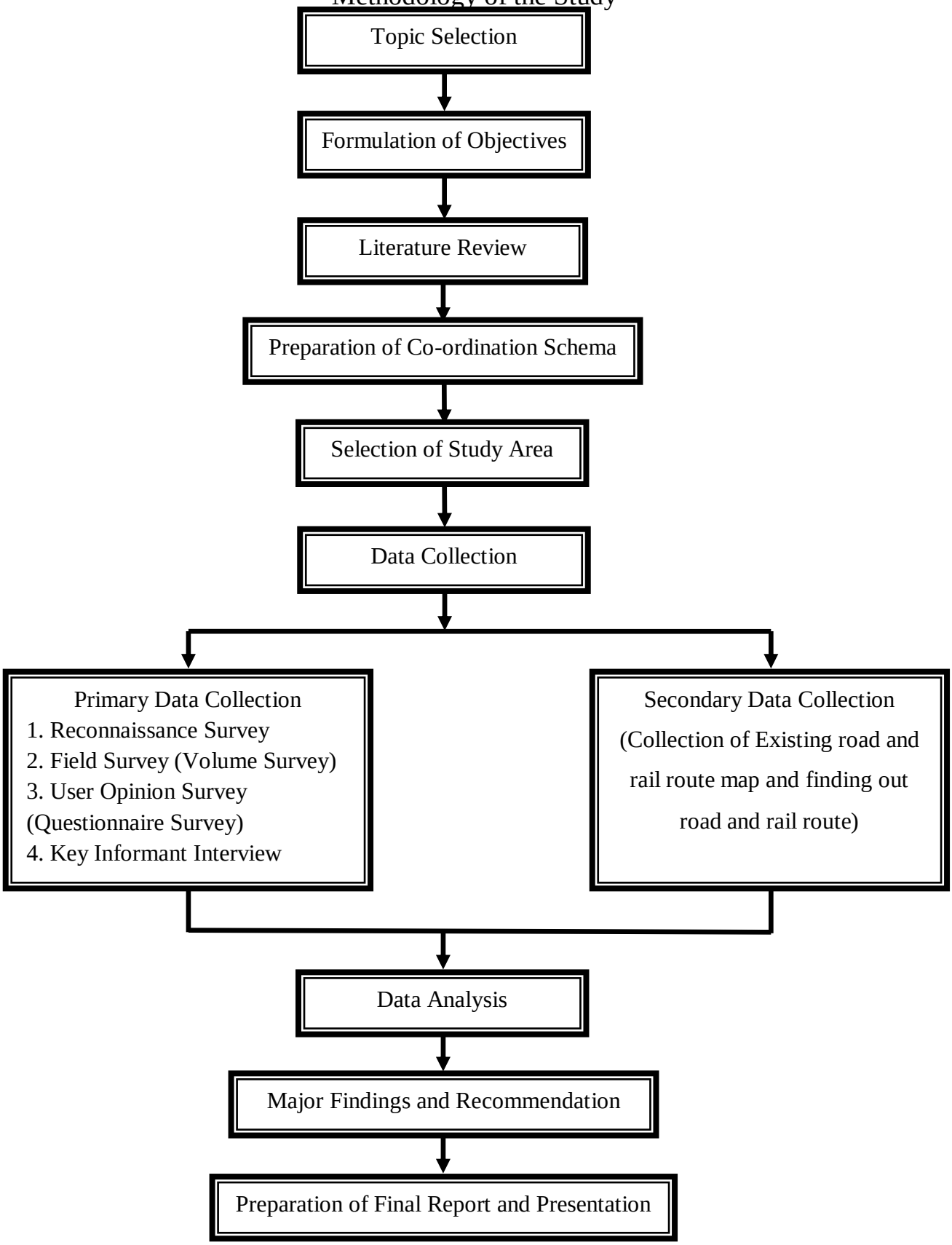
3.7 MAJOR FINDINGS AND RECOMMENDATION:

After completing the analysis of various survey data, some key points to indicate the efficient mode for commuters are found. So, based on this information the efficient mode for commuters can be identified and for further improvement, change in design of efficient mode and its route recommendations can be made.

3.8 PREPARATION OF FINAL REPORT:

After the completion of necessary analysis and other works like recommendation based on major findings, a final report is prepared on the overall study and the result.

Chapter 3
Methodology of the Study



Source: Field Survey, 2013

Figure 3.1: Flow diagram of Methodology

Chapter 04
Data Collection Process

In order to complete the analysis of required data at first data for specific type of analysis is collected. From the collected data further processing and analysis is done. Thus before heading toward the analysis the data collection process for the three different type of survey is provided here.

4.1 VOLUME SURVEY

Volume survey is the first step of whole data collection procedure. This survey is conducted to have an idea of the existing volume characteristics and the intensity of traffic at different time and location. For the completion of volume survey a few steps are followed. They are:

4.1.1 Preparation of Survey Format: First of all a survey format is prepared to conduct the volume survey in manual observer method.

4.1.2 Selection of Study Route and Intersections: Then two commuter bus routes originating from Joydevpur and two routes from Narayanganj are selected. Now from these four routes 22 major intersections are identified where volume survey is conducted by six groups.

The selected routes are given in the following table:

Table 4.1: Selected routes and intersections along the routes of the study

Selected Routes	Intersections
Joydevpur to Dhaka (via Mohakhali)	Gazipur chourasta
	Gazipur station
	Kuril
	Mohakhali
	Bijoy sarani
	Kawran bazaar
	Paltan
	Shapla Chattar
Joydevpur to Dhaka (via Kuril)	Gazipur chourasta
	Gazipur station

	Kuril
	Badda
	Malibagh
	Sayedabad
Narayanganj to Dhaka (via Doyaganj)	Narayanganj Railgate
	Chashara
	Fotulla
	Doyaganj
	Rajdhani
	Joykali Temple
	Fulbaria
	Zero Point
Narayanganj to Dhaka (via Signboard)	Narayanganj Railgate
	Chashara
	Signboard
	Jatrabari
	Rajdhani
	Joykali Mondir
	Alico Tower
	Zero Point

Source: Field Survey, 2013

4.1.3 Selection of Survey Time: Among the six groups who are assigned to conduct survey, each group is assigned to survey four intersections. Thus each intersection is surveyed by two members of a group and the survey is conducted on two working days for three different time periods. Those are morning peak period starting from 8:00am to 10:00am, morning off peak period starting from 11:00am to 1:00pm and evening peak period starting from 4:30pm-6:30pm.The reason behind choosing such time period is to observe the traffic volume composition at different time of a normal working day.

Chapter 04
Data Collection Process

4.1.4 Data Collection: From the volume survey many observations are found related to traffic, they are: modal variation at different time period, peak-off peak traffic volume, directional traffic volume, relation between traffic volume and land use etc.

After the data collection is completed data are analyzed for further use.

4.2 USER OPINION SURVEY

User opinion survey is conducted to focus on the factors which the commuters from outskirt area consider to be more significant while choosing a travel mode. The survey is done in a systematic way by following all the steps given below:

4.2.1 Study Area Selection: At the very beginning of user opinion survey study area is selected. The study areas are Dhaka to Narayanganj and Dhaka to Joydevpur.

4.2.2 Study Route Selection: After that to conduct survey on train and bus commuters, two bus routes and one train route from each of the study areas is selected. The bus routes originating at Joydevpur are Dhaka to Joydevpur via Kuril, Dhaka to Joydevpur via Mohakhali and the train route is Dhaka to Joydevpur. Again the bus routes originating at Narayanganj are Dhaka to Narayanganj via Dayaganj, Dhaka to Narayanganj via Sign Board and the only train route is Dhaka to Narayanganj.

4.2.3 Preparation of Questionnaire: At this point a questionnaire is prepared to accomplish a pilot survey on the commuters of the above six routes. These are the routes originating from Joydevpur and Narayanganj and the commuters are those people who come to the city centre from these outskirt areas.

4.2.4 Final Survey: After the completion of the pilot survey a final survey is conducted on the preset routes where 6 groups were assigned to conduct survey with a total sample size of 210. Here each group is assigned to survey 35 commuters on any of the above routes. For the survey morning peak period is selected and the survey time for bus and train is chosen between 7:30am to 10:30am and 6:20 am to 9:30am respectively. During this survey only the working class people are asked questions who come to Dhaka to reach their destinations at government and private offices, business place or other places of livelihood.

4.2.5 Data Collection: During the survey commuters are asked about the travel time, travel cost, level of services, satisfaction level of commuting mode and causes of refusing the substitute mode from which data is further analyzed to find out the efficient mode between bus and train.

4.3 KEY INFORMANT INTERVIEW

After the completion of user opinion survey, key informant survey is conducted to gather more information about these two commuter modes for a better analysis. This survey is conducted following the easy two steps. They are:

4.3.1 Preparation of Checklist: To conduct the key informant interview at first a checklist of key informants is prepared. Here the key informants are selected on the basis of required data type to support in data analysis. Key informants are selected for four bus routes and two train routes of the study area. People who are selected for bus's key informant are the people related to bus service anyhow. They are: bus driver, supervisor, bus Owner's Association and BRTC officials. While for train's key informant survey the people selected are Station master and station officials.

4.3.2 Information Collection: After the preparation of checklist based on it key informant interview has been carried out. The information got from the bus key informants related to cost and revenue are: fare for private and BRTC bus service, labour cost, fuel cost, maintenance cost, daily revenue; information related to service provided: total trip per day by each bus, total stoppage point, time of arrival, number to total and standing travellers per trip, total number of bus; related to level of service: ticketing system, luggage facility, problems faced by travellers and bus operators.

From the key informant related to rail service the following information is gathered: daily total trip made by trains, time of arrival and departure, ticketing system and ticket cost, frequency, total revenue and cost incurred by concerned authority, problems faced by passengers etc. After the collection of information integrating that with user opinion survey data analysis is done finally to get the efficient mode between bus and train.

The whole data collection process is the most important part of the study. Perfection of the surveys conducted, is very necessary for gathering pure data and further analysis of the data to achieve the objectives of the study.

Chapter 05
Existing Inventory of Bus and Rail Services

The first objective of the study is the preparation of the inventory of Bus and Rail services for the selected study Routes. To fulfill this objective this chapter focuses on the information gathered for the inventory of particular bus and rail services. The overall idea about the commuting services along the selected routes and also travel cost, length of the routes, travel time etc information have been collected for further analysis and to reach the final goal of the study.

5.1 BUS SERVICES ALONG DHAKA TO JOYDEBPUR ROUTE:

Bus service is available for meeting the travel demand of the passengers. Government owned BRTC bus service serves from Azimpur to Khamarbari to Gazipur(Joydevpur). Recently, government has inaugurated 10 articulated bus service having 50 seats in this route (BanglaNews24.com). Express trains like Turag and Lalmoni are running on Dhaka-Tongi-Joydebpur route. (Travel1bd.com, 2013, UNB Connect 2012).

In Dhaka-Joydevpur there are many private and BRTC bus. The private buses V.I.P. Seating Service use the route Azimpur to Framgate to Gazipur(Joydevpur). Another Private bus serves the corridor of Motijheel to Framgate to Gazipur. Fare is collected manually in the bus throughout the trip. The accommodation capacity is 40 persons per trip. The Government owned BRTC bus service serves from Azimpur to Khmarbari to Gazipur(Joydevpur).Fare is collected through computerized tickets in counters.

Bus service from both public and private ownership runs in these routes. There are four bus companies which starts from Joydebpur(Shibbari Bus Station) from which three are private owned namely Dhaka Paribahan, Gazipur Paribahan and Balaka as well as one is Government owned (B.R.T.C). Several number of bus companies are operated to carry commuters which starts from Gazipur chourasta and share majority flow towards Dhaka (Field Survey, 2013).

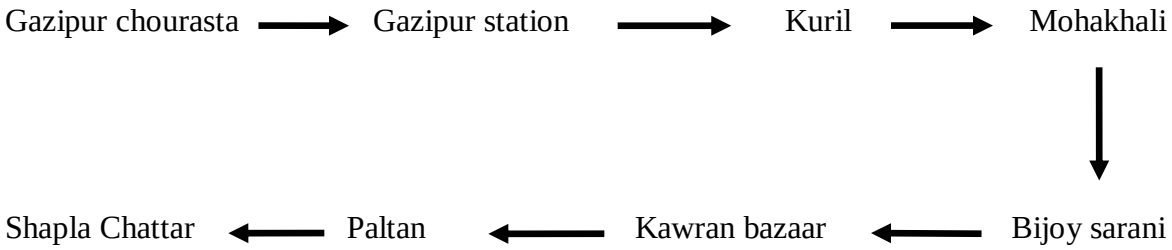
There are twenty five bus operated under Dhaka Paribahan. Every bus is operated to serve four trips. Approximately a bus counter in a day in one direction has fifty arrival and departure. Total forty buses were operated just two month ago and from next month again forty buses will be operated (Field survey, 2013).

Maintenance cost differs from day to day. However 20000 to 25000 taka per month per bus incurred generally. Labor cost for driver 700 taka per day and for helper 300 taka per day. The ticket checker gets forty percent of total penalty he collects. A trip needs 2800 taka for fuel cost. Lubricant and engine oil cost is 1000-2000 taka per bus per month which varies from vehicles to

vehicles in terms of operational hours (Field survey, 2013). Monthly total cost per bus is more or less 30000 to 35000 taka which varies month to month (Field survey, 2013).

5.1.1 Bus Services in Dhaka to Joydebpur via Mohakhali:

Total length of this route is 32.7 kilometer (Google Map, 2013). It follows the following route.



Source: Field Survey, 2013

Figure 5.1: Intersections of Dhaka-Joydebpur via Mohakhali Route

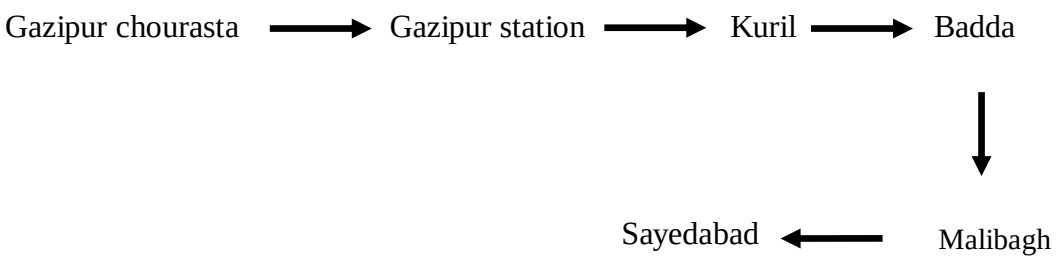
Raibar, Panjeri, Ababil, Turag etc are some of the buses plying on this route.

About 65-70 buses from Turag Company are running on the route from Gazipur to Zero point via Kuril Bishwa road. Every day they make 3-4 trips. Though the bus has 9 stoppages they provide fare flexibility for special commuters who travel only by this bus. Their actual fare is 50 taka from Gazipur to Zzero point via Kuril bishwa road but for commuters they sometimes take 40-45 taka and for students half price (25 taka). 80% of their total passengers are commuters (Field Survey, 2013).

Service interval normally ranges from 10-15 minutes (Parjatan.bd.com, 2013).

5.1.2 Bus Services along Dhaka to Joydebpur via Kuril:

Total length of this route is 32.32 kilometer (Google Map, 2013). It follows the following route.



Source: Field Survey, 2013

Figure 5.2: Intersections of Dhaka to Joydebpur via Kuril Route

Anik Bus, Ababil, Borak Transport, Turag, Panjeeri, Gazipur Paribahan Ltd etc are some of the buses plying on this route. Anik Bus has a fare of 35 Taka. Panjeeri reaches to Tongi station by this bus route (Parjatan.bd.com,2013). BRTC buses are also running on this route.

Service interval normally ranges from 10-15 minutes. Computer based ticketing system is available for the travelers (Field Survey, 2013).

5.2 TRAIN SERVICE ALONG DHAKA (KAMALAPUR) TO JOYDEBPUR:

The length of this train route is 38 km. Number of trains running on this train route is 16. Train capacity is (no. of seats): 5*60+0.5*60=330+standing (around 70% of seat capacity=330*0.7=230) =560. Ticket fare is 10 Taka/person taken from counters and monthly pass is 2200 Taka. Most ticket are bought from Tongi, Joydevpur. No problems in maintaining schedule.

Express train runs in this route. Turag/1, Turag/3, Turag/4, Turag/5, Turag/6, Turag/7, Turag/8, are the trains running through this route.

There are total 23 trains that pass through the Joydevpur stations in each day. 3 commuter trains operate through these stations which are mainly from Jamalpur and Maimansingh. AlsoTurag express which starts from Joydevpur to Dhaka operated from this station (Field survey, 2013).

There are three types of ticketing system in Bangladesh Railways Online ticketing system, monthly pass system and ticketing from ticket counters. There are two types of ticketing system mainly monthly pass and ticketing from ticket counter is found. Also Bangladesh Railway works on contract basis in the ticketing system with other private organization. The fare structure for monthly pass ticket is 450 taka per month for a passenger. The fare for Turag express from Joydevpur to Dhaka is 15 taka and for commuter trains it is 20 taka. For other trains the fare is 35 taka (field survey, 2013).

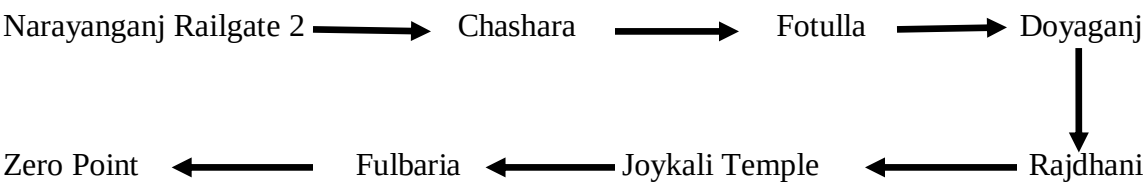
The destination for most of the commuters is Kamalapur Rail station as every commuter has bought ticket for Kamalapur whether any destination in Dhaka he wants to go. Also for other destinations like Khulna and Rajshahi ticketing is most from this station (Field survey, 2013).

5.3 BUS SERVICES ALONG DHAKA TO NARYANGANJ ROUTE:

BRTC has taken many initiatives to improve bus services in this route. At present various bus service in private ownership is plying in this route. Among these bus services Utsav, Ekota, Bandhan etc. are some buses under private sector running on this route (BRTC, 2013). There are 16 trains plying on this route. Among them 3 are newly introduced DEMO.

5.3.1 Bus Services along Dhaka-Narayanganj via Doyaganj:

Total length of this route is 17.94 kilometer (Google Map, 2013). It follows the following route.



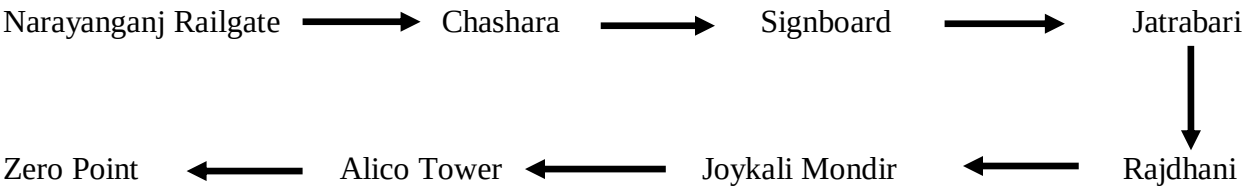
Source: Field Survey, 2013

Figure 5.3: Intersections of Dhaka-Narayanganj via Doyaganj Route

Bus starts its first trip at 5.30 am and last trip starts at 9.30 pm from Narayanganj bus stand. Total number of buses is 52.Total no. of stoppage is 8. Average no. of trips per bus per day is 5. Average no. of passenger standing in each Bus is 7. Daily Revenue per bus is 2000 tk. 60% of the total passengers are commuters. Ticketing system is fare collection directly. number of seats per bus on average is 41.There are 4 seats in a row and 6 seats are reserved for disabled, women persons. Randomly loading and unloading of passengers is observed. No extra facility for carrying bags, luggage etc. 15 min interval period for starting a new bus (Field survey, 2013). Ullash, Borak Paribahan Bus Service runs its service on this route.

5.3.2 Bus Services along Dhaka to Narayanganj via Signboard:

Total length of this route is 17.4 kilometer (Google Map, 2013). It follows the following route.



Source: Field Survey, 2013

Figure 5.4: Intersections of Dhaka to Narayanganj via Signboard Route

Bandhan Bus Service runs its service on this route. Its route starts directly from Mothijeel and directly ends in Naryanganj. Their fare is 16 Taka/person on average. Ekota runs from starts from Gulistan to Nayanganj. Its fare is 16 Taka per person.

Total number of buses is 32.Total no. of stoppage is 6. Average no. of trips per bus per day is 4. Average no. of Passenger standing in each Bus is 8. Daily Revenue per Bus is 3000 tk. 62% of the total passengers are commuters. Ticketing system is fare collection directly. Total number of seats per bus on average is 55.There are 5 seats in a row and 9 seats are reserved for disabled, women persons. No extra facility for carrying bags, luggage etc. 10 min interval period for starting a new bus (Field survey, 2013).

5.4 TRAIN SERVICE ALONG DHAKA TO NARAYNGANJ ROUTE:

A total 16 pairs of trains daily operate on Dhaka-Narayanganj route making 32 trips up and down. Among these 16 pairs of train, 3 are newly introduced DEMU (Diesel-Electric Multiple Unit). However, in the weekly holidays, 6 instead of 16 pairs operate in this route.

A private company was given the charge of taking care of commercial side of Dhaka-Narayanganj rail service. For the conventional trains the fare has been determined as 10 taka while in case of DEMU it is 15 taka. However, there is no online ticketing system and no provision for monthly pass (Field survey, 2013).

Although there are 560 seats in each train, we consider 1000 people both standing and seating as standard capacity for the conventional trains. In fact, during the peak hours each train has to accommodate nearly 2000 passenger per trip which is double of the standard capacity (Field survey, 2013).

The two sets of DEMU are joined together each containing 3 units. For each set; there are 151 seats on its three compartments with additional capacity of carrying 149 standing passengers. Thus, DEMU trains operating with two set can totally contain 600 passengers per trip (Field survey, 2013).

The rush of commuters becomes the highest in the morning peak period. Especially the four early trains in the morning starting from Narayanganj Station at 6:35 am, 7:35am, 8:20 am and 9:35 am have accommodates more than 2000 passengers per trip(Field survey, 2013).

Chapter 05
Existing Inventory of Bus and Rail Services

From the existing inventory of bus and rail services, the existing situation of these commuter services in the study route has been exhibited and using the inventory further progress of the study has been conducted. This inventory helps to easy finding of any types of information related to the services.

Chapter 06
Data Processing and Analysis

Data collected through three types of surveys namely- volume survey, user opinion survey and key informant interview has been used in data processing and analysis for achieving the ultimate objective of the study. The Volume survey has been carried out in total twenty two intersections of four routes which come from the outskirt – Joydevpur, Gazipur (Route: Joydevpur to Dhaka via Mohakhali; Route : Joydevpur to Dhaka via Kuril) and Narayanganj (Route : Narayanganj to Dhaka via Doyaganj; Route : Narayanganj to Dhaka via Signboard) at three peak period: Morning Peak (8:00-10:00 am); Morning off Peak (11:00 am-1:00 pm) and Evening Peak (4:30 – 6:30 pm). Then user opinion survey is conducted on the commuters coming from outskirts of Dhaka city to the city centre for work purpose. Among them only the commuters using bus and train using the selected routes (For Bus: Joydevpur to Dhaka via Mohakhali; Joydevpur to Dhaka via Kuril; Narayanganj to Dhaka via Doyaganj and Narayanganj to Dhaka via Signboard; For Train: Joydevpur to Dhaka and Narayanganj to Dhaka) are surveyed in order to get an overall idea of the service provided by the particular mode, whether bus or train. During the survey the commuters are asked about their satisfaction of the level of service of commuting mode, problems faced while using this mode, travel time, cost and reasons for refusing the substitute mode and about some other facilities. In the survey, the substitute mode for bus is considered train and vice versa. After conducting user opinion survey, key informant interview has been carried out to experts of Bus and Rail services to gather more information of commuter bus and rail services from outskirts of Dhaka and to relate this information when analyzing the data collected from user opinion survey. All the data collected from the surveys has been properly utilized to take the final decision regarding the efficient commuting mode.

6.1 ANALYSIS OF TRAFFIC PATTERN:

Analysis of traffic pattern mainly focuses on the investigation of data regarding traffic volume (for three peaks) of intersections along the selected bus routes; modal composition of those intersections (for three peaks) and directional variation (for three peaks) which have been gathered through volume survey.

6.1.1 Analysis of Traffic Volume:

6.1.1.1 Analysis of Traffic Volume for Route-Joydevpur to Dhaka (via Mohakhali):

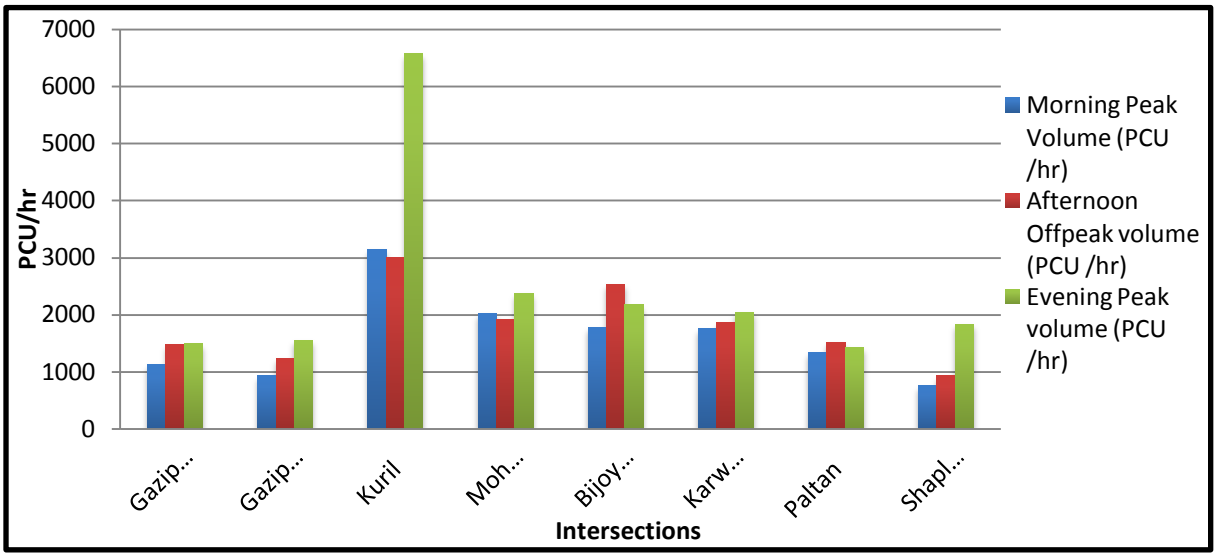
This route starts from Gazipur and ends in Mothijeel. It covers eight intersections which include Gazipur chourasta, Gazipur Sation, Kuril, Mohakhali, Bijoy Sarani, Kawran Bazar, Paltan, Shapla Chattar intersection (Appendix B, Map 3.1).

- **Traffic Volume Analysis of Intersections:**

It seems at most of the intersections highest flow occurs among three considered time in evening peak (Figure 6.1). It may be explained by huge number of home bounding journey trip occurring in evening altogether but this journey might have their origin is different times of the day in scattered manner.

- **Comparison for Morning Peak and Morning off Peak:**

Morning peak flow is highest for Kuril and second highest for Mohakhali. It may be because at morning peak when transport modes enters into the city through this two intersections from peripheral areas and adds with urban traffic which increases its traffic volume in the peak. Due to passing of trains after every 15 minutes at the Kuril intersection reduces each volume than Mohakhali. Then traffic gets dispersed to different parts of the city and ultimately gets lowest at Shapla Chattar. Shapla Chattar has the lowest morning flow may be dispersing in different parts of Dhaka city from route 1 it has only small part left to reach central city.



Source: Field Survey, 2013

Figure 6.1: Traffic Volume of all the intersections of Route-Joydevpur to Dhaka (via Mohakhali)

On the other hand Kuril intersection has also the highest traffic volume in morning off peak because it is point of commingling of peripheral traffic and urban traffic. Due to merging of types of traffic the overall volume increases. Then traffic volume decrease from one intersection to next due to dispersion of traffic to different parts of city and Shapla Chattar it has the lowest. But there is a sudden rise in volume at Bijoy Sarani because in morning off peak there are many schools which break up and increases traffic volume (Figure 6.1).

- **Comparison for Morning Peak and Evening Peak:**

In the evening first and second lowest volume exists for Paltan and Shapla Chattar intersection. Paltan generates more traffic than Shapla Chattar intersection may be because it is a residential area to produce less home destined trip than Mothijeel commercial area. Shapla Chattar generates more traffic then morning peak and off peak because many offices, bank closes in the mean time and produces journey towards the home. Whereas Kuril intersection has the highest flow may be as all commuter trips merge in his place to flow outskirt along with intercity home directed flow at evening. Commuter journey may start at different times in the morning, but all commuters return to home in Gazipur in evening together which may make more volume of traffic for Gazipur Chourasta in the evening peak. Compared with morning peak all the intersections here has the higher traffic volume in evening than morning peak (Figure 6.1).

6.1.1.2 Analysis of Traffic Volume for Route-Joydevpur to Dhaka (via Kuril):

This route with a number of significant intersections not only provides service to internal traffic but also creates path for external commuter traffic. This route starts from Joydevpur and ends at Kamalapur crossing Sayedabad within the city. Throughout this route mainly six intersections are surveyed. They are- Gazipur Chourasta, Gazipur Station Road,Kuril, Badda, Malibag and Sayedabad intersection (Appendix B, Map 3.2).

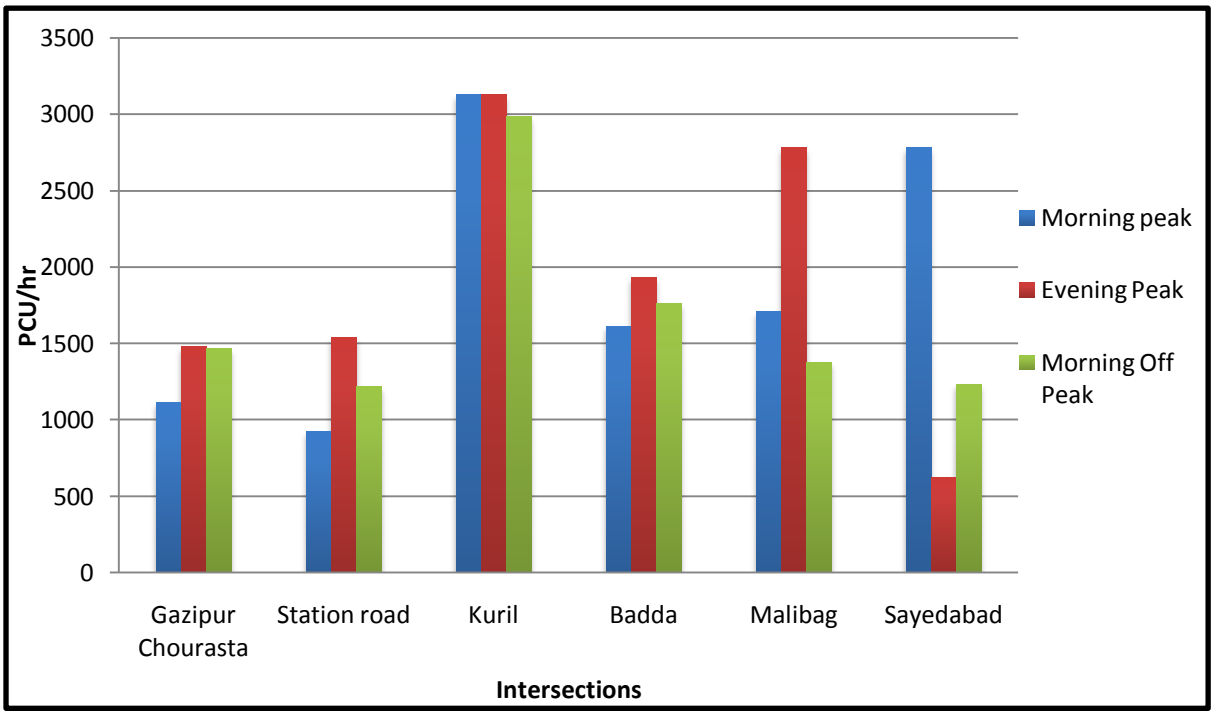
- **Traffic Volume Analysis of Intersections:**

From figure 6.2 it is seen that amongst the 3 different time periods in most of the cases evening traffic volume is the highest as people return home at this time, which travel throughout the peak and off peak period in the morning or a portion of this total travelers. Among all the intersections Kuril intersection's evening volume was the highest and it was 6567.4 PCU/hr. But at Gazipur Chowrasta intersection evening volume seems to be moderate. The reason is the outflow from Dhaka to Gazipur and internal traffic returning

home,where the main modes were cars for internal and bus for commuter traffic. Again for Kuril intersection morning off peak traffic volume was highest 2986.3 PCU/hr and the morning peak highest PCU was at Kuril and it was 3127.75 PCU/hr. The reason behind such scenario for Kuril may be that Kuril mainly serves intra city bus for commuters from outskirt of the city and the huge rush of intercity buses like,Dhaka-Chittagong,Dhaka-Comilla,Dhaka-Sylhet etc. and car type traffic from the surrounding residential areas Basundhara,Gulshan etc. Buses carrying commuters mainly returns back in the evening as majority come for work purpose. Besides a certain part of the local car traffic goes out for work, shopping or schooling or other purposes toward Mohakhali or Badda or nearby places return in the evening. That's why Kuril has the highest all time volume.

- **Comparison for Morning Peak and Morning off Peak:**

Usually it is considered that during the morning peak period all the modes are gone to their destination. But some people get out late according to their needs. As a result morning off peak flow never falls down.



Source: Field Survey, 2013

Figure 6.2: Traffic Volume of all the intersections of Route- Joydevpur to Dhaka (via Kuril)

From Figure 6.2 it is seen that at first two intersections- Sayedabad and Badda intersections the off peak flow is higher than that of peak period. The reason is the travelling of people to

day shift school, business, shopping centers and local offices, which keep the Gazipur Chowrashta intersection busy during this period. Besides at Gazipur Station Road intersection different land uses nearby like office,market,schools keep this intersection busy at this time and the same for Badda intersection. So the off peak traffic mainly serves people to reach their destination.

- **Comparison for Morning Peak and Evening Peak:**

Morning peak and off peak period is the time when people from every strata of life of every occupation come out of their houses to reach their destinations. So the overall time is considered as the time to get to the work place. In the evening, people from work places and in some cases students return back from their institutions to home. That's why during the evening peak period the traffic flow remains high basically on those roads that lead towards residential areas and outskirts of Dhaka city for commuters. From Figure 6.2 it is seen again that except for Badda intersection at all intersection evening traffic was high. In case of Gazipur Chourasta inter district buses use the route. Again at Gazipur Station Road intersection commuter bus, car type vehicles from local offices, trucks go to kaliganj using Tongi-Kaliganj diversion road to reach their origin. But for Kuril the scenario was very extreme which can be interpreted as the overall high flow of inter and intra city buses during day time.

6.1.1.3 Analysis of Traffic Volume for Route- Narayanganj to Dhaka (via Doyaganj):

This route has been defined as one of the routes that commuters use to travel between Narayanganj and Dhaka City. More specifically, this route comes from Narayanganj via the intersections of Narayanganj Railgate, Chashara, Fotulla, Doyaganj, Rajdhani, Joykali Mandir, Fulbaria and lastly Zero Point (Appendix B, Map 3.3).

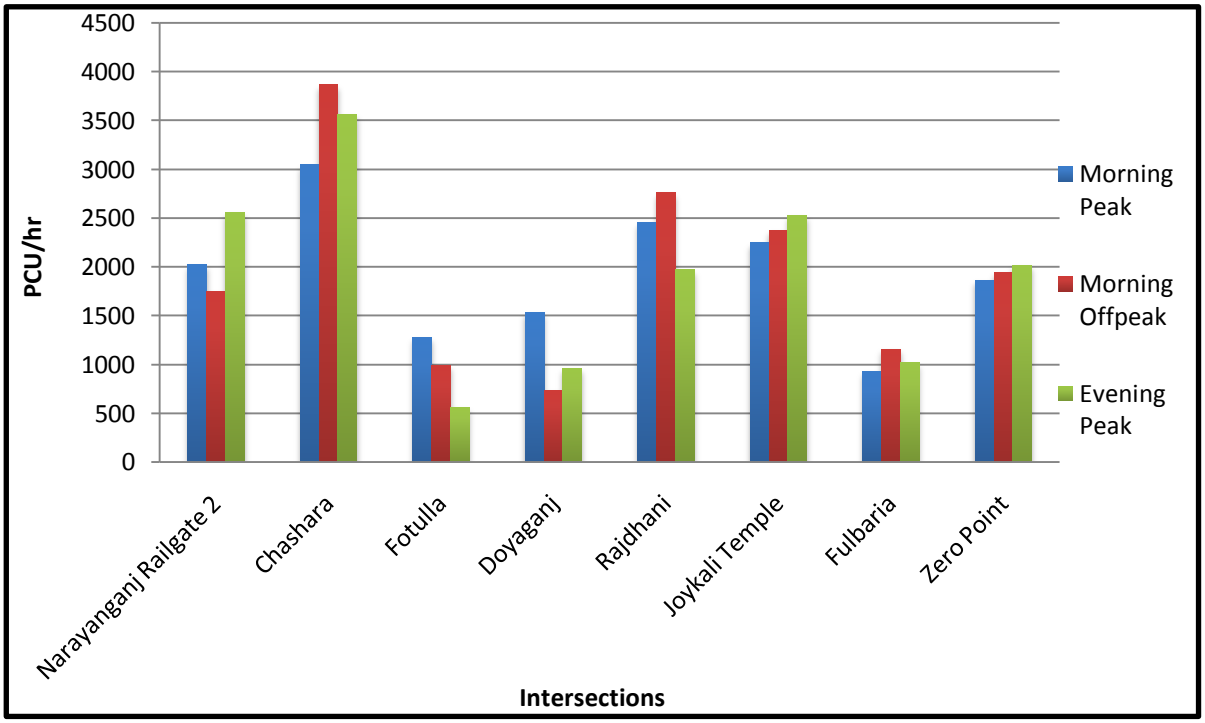
- **Traffic Volume Analysis of Intersections:**

The Passenger Car Unit (PCU) per hour values for each of the eight intersections of route 3 during the morning peak, afternoon off-peak, and evening peak is shown in Figure 6.3. PCU values convert the number of vehicles to equivalent number of cars that pass through a road space. Therefore, the PCU/hr values in Figure 6.3 reflect the volume as number of cars that passes through each of the intersections in one hour of the selected period.

It can be seen from Figure 6.3 that the highest volume of traffic occurs in Chashara intersection during the afternoon off-peak period. It is followed by the volume that occurs in the Rajdhani Super Market intersection during the afternoon off-peak. In fact, Chashara has the highest volume (PCU/hr) during all three periods among the eight intersections and Rajdhani intersection has the second highest values of each period. Narayanganj Railgate has the third highest values, followed by Joykali Temple and Zero Point.

- **Comparison for Morning Peak and Morning off Peak:**

Figure 6.3 shows that in the intersections of Chashara, Rajdhani and Fulbaria the afternoon off-peak traffic is greater than the morning peaks. This indicates that the commercial land uses in these areas, such as the Rajdhani Super Market and Fulbaria Super Market, may attract more customers in the off-peak hours of the day.



Source: Field Survey, 2013

Figure 6.3: Traffic Volume of all the intersections of Route - Narayanganj to Dhaka (via Doyaganj)

A very interesting observation from the Figure 6.3 is that in the morning and afternoon periods, there is a huge flow of traffic in Chashara intersection but the immediate next intersections of Fotulla and Doyaganj have very low traffic. It can be stated that majority of the volume leaving from Chashara intersection does not reach the intersection in Fotulla. It

may be dispersed in other routes or in the various commercial and institutional land uses along the way, such as the Tolaram University College and Narayanganj Adarsha College.
Conversely, there is very little traffic in Doyaganj intersection but a huge volume in the next intersection of Rajdhani Super Market in the morning and afternoon periods. This suggests that most of the traffic volume merging with this road is generated between Doyaganj and Rajdhani intersections. The various types of land uses in the area, including residential areas of Wari and Motijheel may contribute greatly to this high volume. The traffic may also join the Rajdhani intersection from other connecting roads in the way.

- **Comparison for Morning Peak and Evening Peak:**

The flow of evening peak is in the opposite direction to the morning peak. It can be seen from Figure 6.3 that in all the intersections except Fotulla, the volume of traffic is higher in the evening peak than in the morning peak. It may be because during the office dismissal hours, most people return for their home all at once, generating more volume of traffic.
Another remarkable observation is that the evening volume of traffic departing from Rajdhani is not in compliance with that of the immediate next intersection of Doyaganj. A huge amount of traffic is observed in the evening peak at Rajdhani intersection which does not reach Doyaganj intersection. The destination of the traffic may be the residential areas between Doyaganj and Rajdhani intersections, such as Wari and Motijheel, or it may be dispersed to other connecting roads.
Again, in the case of Fotulla and Chashara, the reverse pattern is observed. In the evening peak, a low volume is generated in Fotulla intersection but a high volume is found in Chashara intersection. This means that traffic in Chashara intersection is generated from elsewhere. This may happen as the traffic merges with the road from the various institutional and commercial land uses in the area. It may also join the road via some other route.

6.1.1.4 Analysis of Traffic Volume for Route: Narayanganj to Dhaka (via Signboard):

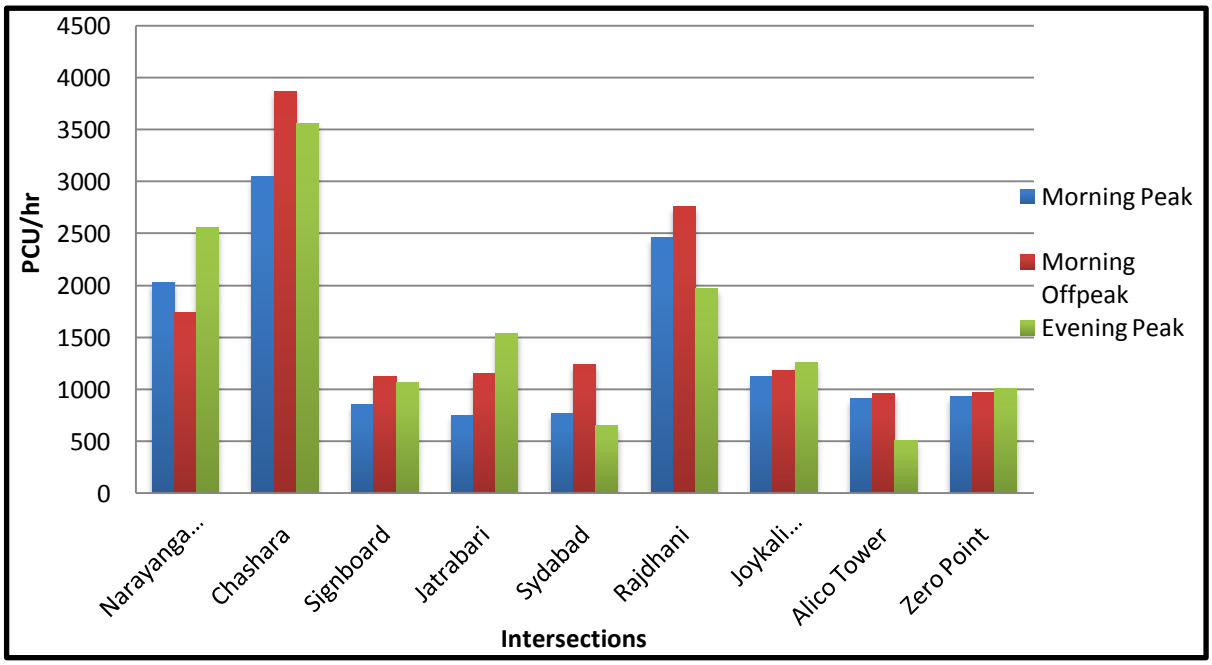
This Route is consisted with total nine intersections. This route provides not only internal traffic in the capital but also the traffic which are originated from the outskirt Narayanganj to the capital Dhaka. The intersections through which this route is connected are: Narayanganj Railgate, Chashara Station, Signboard, Jatrabari, Sydabad, Rajdhani, Joykali Temple, Alico Tower and Zero Point. The origin of the route is Narayanganj and the destination is Gulistan (Appendix B, Map3.4).

- **Traffic Volume Analysis of Intersections:**

The traffic volume for each intersection at three different peaks shows a very diversified and ups and down flow of traffic (Figure 6.4). The highest volume of traffic is seen in Chashara for all the three peaks (Morning Peak, Morning off Peak and Evening Peak); Second highest volume is seen in Rajdhani and the third highest flow is observed in Narayanganj Railgate intersection. Presence of urban residential area and residential-commercial mixed use near the intersection can be the cause of huge number of traffic flow in Chashara intersection. As Rajdhani intersection is after Sydabad, so many vehicles are merged from the middle section from Sydabad and Rajdhani and all these vehicles added in the volume of Rajdhani which directly enter into the capital along this route.

- **Comparison for Morning Peak and Morning off Peak:**

An interesting observation from the intersections (except Narayanganj Railgate) of this route is that at Morning Off peak the volume is greater than the Morning Peak (Figure 6.4). One reason behind it can be the unofficial activities like shopping of daily necessities, bank activities of general people etc starts after the morning peak and also most of the businessmen start at this time for their business as they have no fixed time schedule to avoid traffic congestion.



Source: Field Survey, 2013

Figure 6.4: Traffic Volume of all the intersections of Route-Narayanganj to Dhaka (via Signboard)

In Narayanganj Railgate the peak flow is greater than off peak. The reason may be the official people who mainly move from this route and want to reach timely at their destination.

- **Comparison for Morning Peak and Evening Peak:**

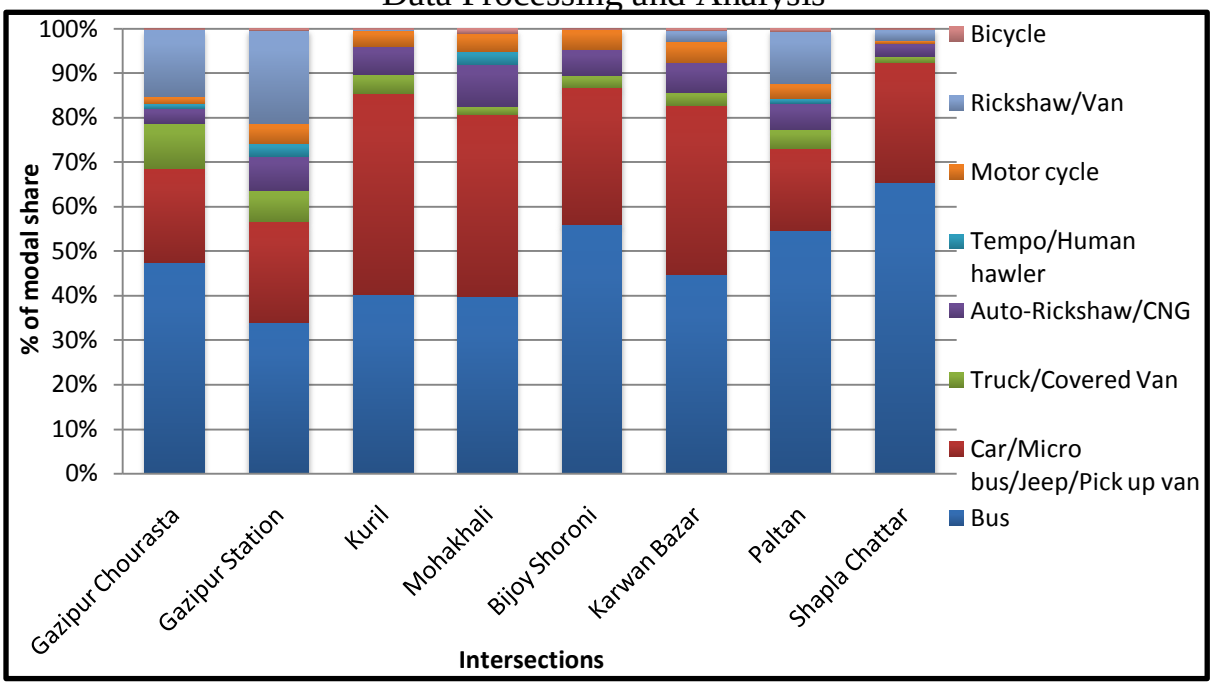
A great diversified picture is observed from the comparison of morning and evening peak. In Morning Peak people of this route start their journey from Narayanganj and in Evening peak from Gulistan. In some intersections it is observed that the volume in morning peak is greater and in some cases the evening peak volume is greater (Figure 6.4). For example in Narayanganj Railgate from where the journey of commuters start at morning peak reflects that in morning peak the volume is less than the evening peak. The reason can be the commuters and people from other part of the Narayanganj city work mainly in the northern eastern portion of this intersection as functional and official land uses are located at this direction. So at evening peak vehicular pressure is high. Again in Zero point from where the journey of the commuters start in evening peak for reaching home, the traffic volume is greater at this peak than in morning peak. Again in comparison with other intersections in Chashara and Rajdhani intersections both the morning and evening peak the volume is greater than the others and also in morning peak, the volume is greater than that of evening peak.

6.1.2 Analysis of Modal Composition:

This part of analysis is based on the data gathered from Volume survey regarding composition of modes.

6.1.2.1 Modal Composition Analysis of the Intersections for Route- Joydevpur to Dhaka (via Mohakhali): At intersections different types of modes move for the purpose of travelling. But the mode used in significant amount at an intersection may be found to be insignificant at other intersection.

- **At Morning peak:** For Gazipur Chourasta intersection, in the morning peak bus dominates because of travel via this mode for going and returning from working. In Gazipur Station intersection, during morning peak, bus goes through carrying commuter. Mini bus/ cars and rickshaws are seen to have a good share of mode which has been to going for offices and other local work places in Gazipur through Gazipur station intersection.



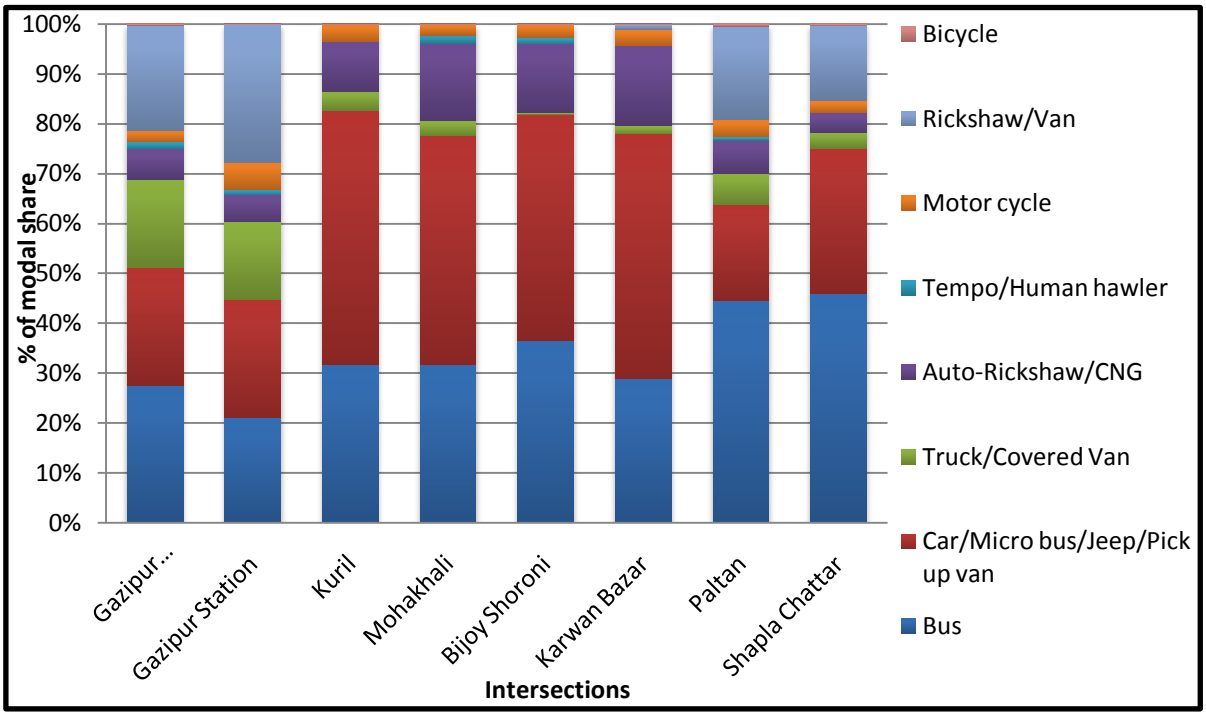
Source: Field survey, 2013

Figure 6.5: Comparison of modal share percentage at all intersections at morning peak of route - Joydevpur to Dhaka (via Mohakhali)

Mohakhali, Bijoy Sarani, Kawranbazaar, Paltan, Shapla Chattar has a good share of bus as it is used by people for going work in the morning peak. Kuril intersection has a major share of car in the morning peak as may be many cars join in the traffic flow DOHS, Niketan etc. In Paltan, greater number of share of rickshaw than other inner Dhaka area is seen because it is upper middle income area (Figure 6.5).

- **At Afternoon off peak**:

Gazipur chourasta and gazipur station intersection has a wide variation in mode composition in off peak hours. All this modes bus, micro bus/car, rickshaw are used for local movement. Bus share has reduced because of reduced number of work trip within peripheral area and to the Dhaka city. Rickshaw is high during this period in Gazipur Station area as may be many school breaks up within this time and student use rickshaw to go home.



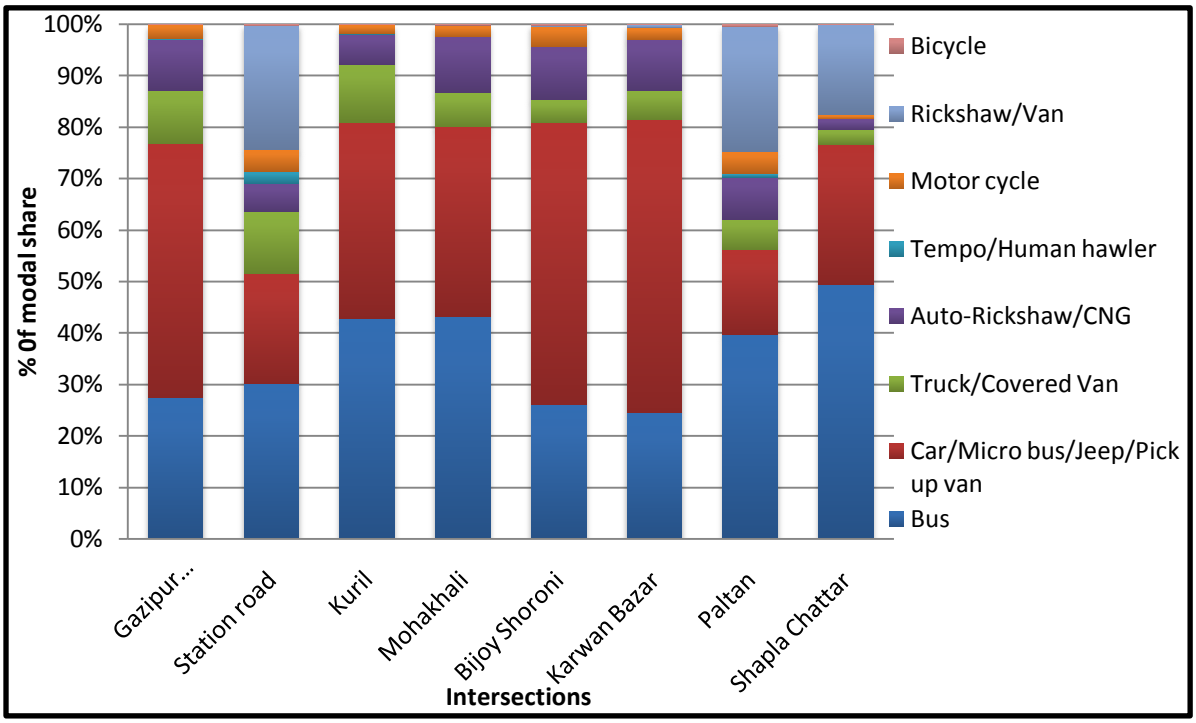
Source: Field survey, 2013

Figure 6.6: Comparison of modal share percentage at all intersections at morning off peak of Route- Joydevpur to Dhaka(via Mohakhali)

Kuril, Mohakhali and Bijoy Sarani intersection have higher car/ micro bus share may be due to reduction of working trip by bus and generation of many non-working trip such as coming from school, shopping etc which are subjected to car use. In Kawran bazaar intersection the bus share is low because the buses do not want to cross around the roundabout and because of residential land use generated non home based traffic. In off peak Paltan and Shapla Chattar has relatively good share of rickshaw and bus and low share cars as surrounding area Mothijheel and Paltan being a middle income area (Figure 6.6).

- **At Evening peak**:

In the evening bus share is high is Motijheel and Paltan as many people return home job by bus. At Kawran bazaar intersection the bus share is low because the buses do not want to cross around the roundabout. Mohakhali and Kuril intersection have dominant share in both car/microbus and bus because the buses towards the peripheral area goes through this route carrying commuters and residential land uses generate car driven traffic from local activities.



Source: Field Survey, 2013

Figure 6.7: Comparison of modal share percentage at all intersections at evening peak of route - Joydevpur to Dhaka (via Mohakhali)

Gazipur Station intersection and Gazipur Chourasta intersection has lower share of bus because local people use car, rickshaw, CNG for going to recreational purposes to two local cinema hall, markets etc. Commuters' buses cover the significant portion of bus plying in this intersection.

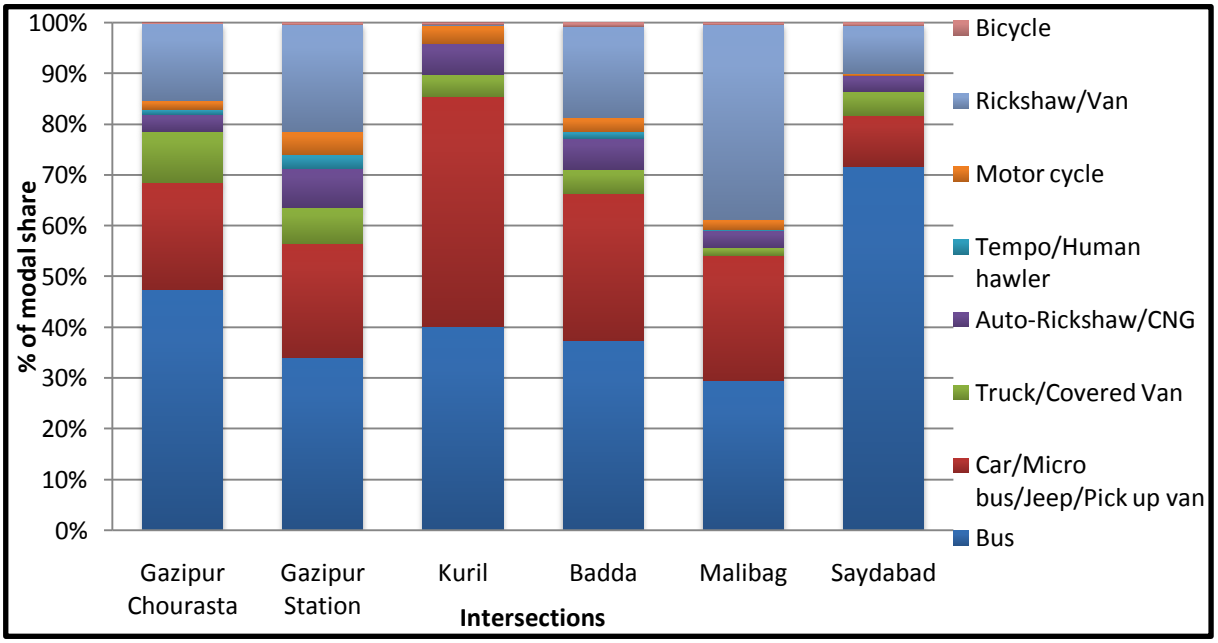
One of the important factors behind no existence of rickshaw in some intersections like Bijoy Sarani was banning of rickshaw (Figure 6.7).

6.1.2.2 Modal Composition Analysis of the Intersections for Route- Joydevpur to Dhaka (via Kuril):

At intersections different types of modes move for the purpose of travelling. But the mode used in significant amount at an intersection may be found to be insignificant at other intersection which varies with time, destination and land use and of course the economic condition of the users passing through the intersection.

- **At Morning Peak:**

Now from Figure 6.8 it is observed that during the morning peak period the prior modes at different intersections were bus, car category vehicles and rickshaw.



Source: Field Survey, 2013

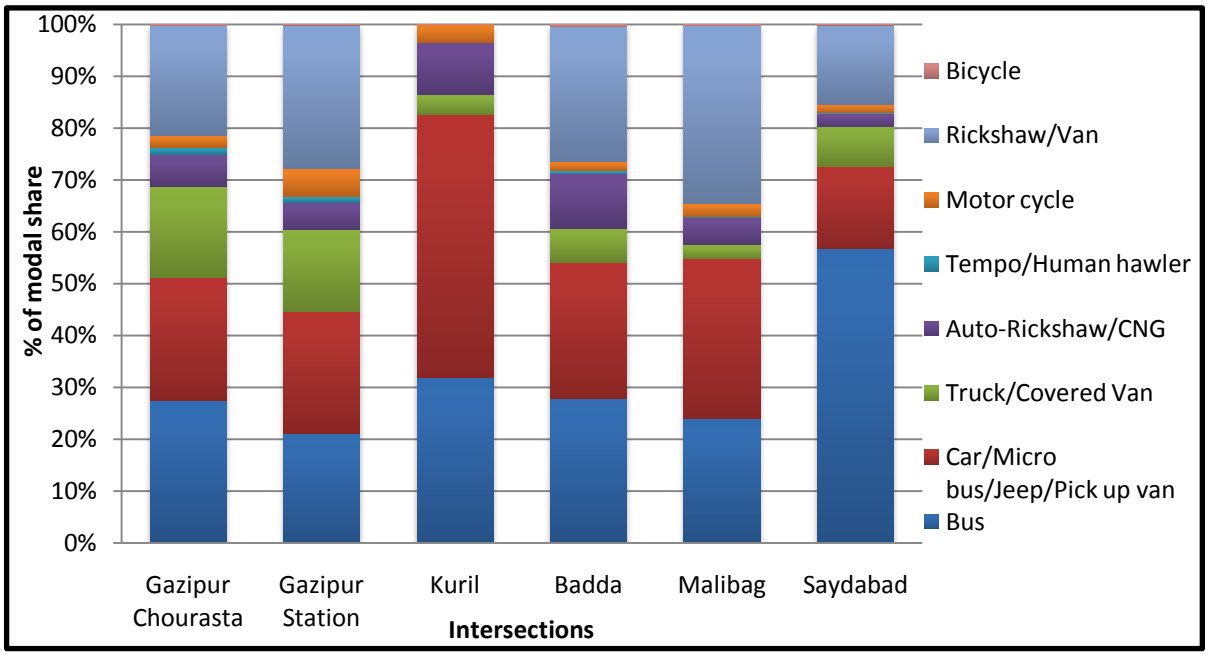
Figure 6.8: Comparison of modal share percentage at all intersections at morning peak of route - Joydevpur to Dhaka (via Kuril)

Firstly at Gazipur Chowrashta intersection bus and cars are mainly used to reach the administrative buildings nearby and Gazipur station to catch train and to commute Dhaka for work purpose. At Gazipur Station road overall flow seems to be dominated by rickshaw and bus where rickshaws are used in the left direction to reach office, industries and a portion of it goes to Tongi station to reach Dhaka by commuting by train.

But in case of Kuril Intersection major mode is car type vehicle as the surrounding area is both a middle income and posh residential area where people useown car to reach destination and commuters from Sayedabad and local people reach Mohakahali and Badda commercial areas using commuter buses. Besides the movement of intercity buses always keep the intersection busy. A significant portion of the Kuril intersection comes to Badda to the roadside commercial buildings in there and besides these highway buses, port vehicles use this road. At Malibag intersection bus, car and rickshaw is mainly used where the use of rickshaw is comparatively high due to the use of local people to reach nearby destinations like commercial buildings, school etc. And finally at Sayedabad intersection Bus is the highly dominating mode due to the presence of Syadabad bus terminal which sometimes creates congested situation.

- **At Morning off Peak:**

Now from figure 6.8 of dominant mode during morning off peak period it is found that there wasn't much variation in use mode of during these two times, but PCU percentage has changed for those modes that are used for short distance travelling. Here at Gazipur Station



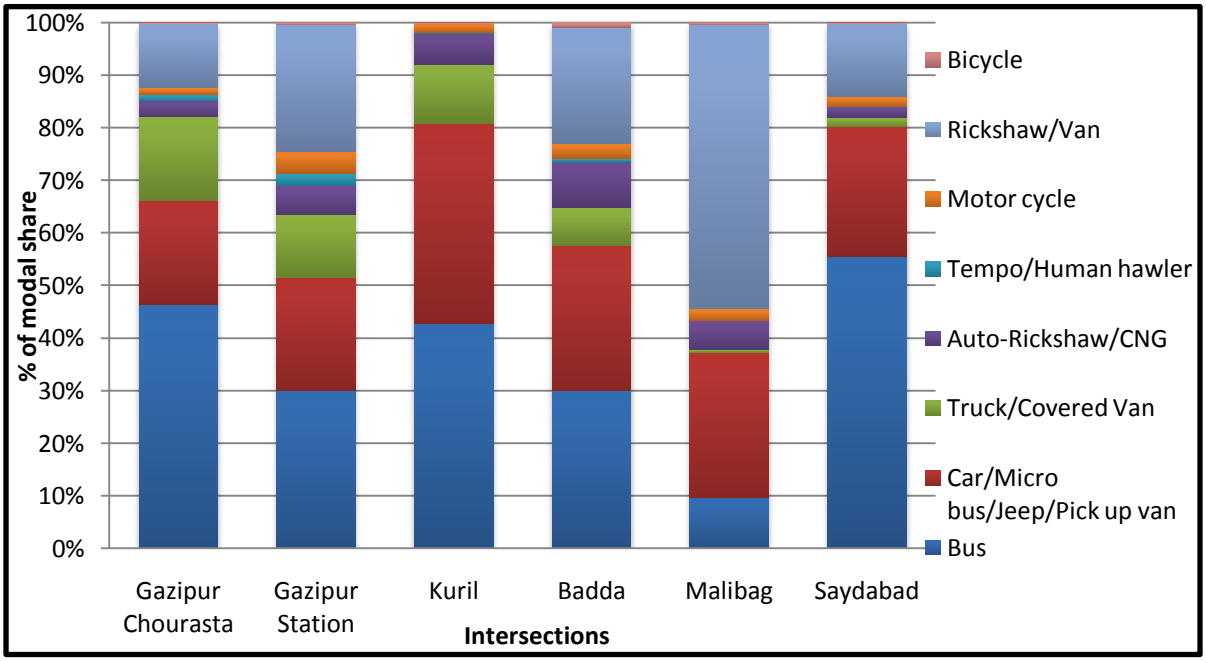
Source: Field Survey, 2013

Figure 6.8: Comparison of modal share percentage at all intersections at morning off peak of route -Joydevpur to Dhaka (via Kuril)

Road intersection the flow of bus decreased with the increase in car's modal share. This time too car is serving people at nearby places who are not commuters.

Within Dhaka city at Kuril intersection car's share increased to 50% with the decreased share of bus.It means that during this off peak time flow from outskirts became less but internal flow increases with time. So from all perspective it is clear that during morning off peak period internal flows mainly keeps the intersections busy.

- **At Evening Peak:** But in the evening some significant changes are noticed different from the off peak scenario. At this time bus became the significant mode at Gazipur Chourasta intersection to serve local traffic. Besides at Station Road intersection bus became the major mode to meet the travel demand of commuters from Dhaka.

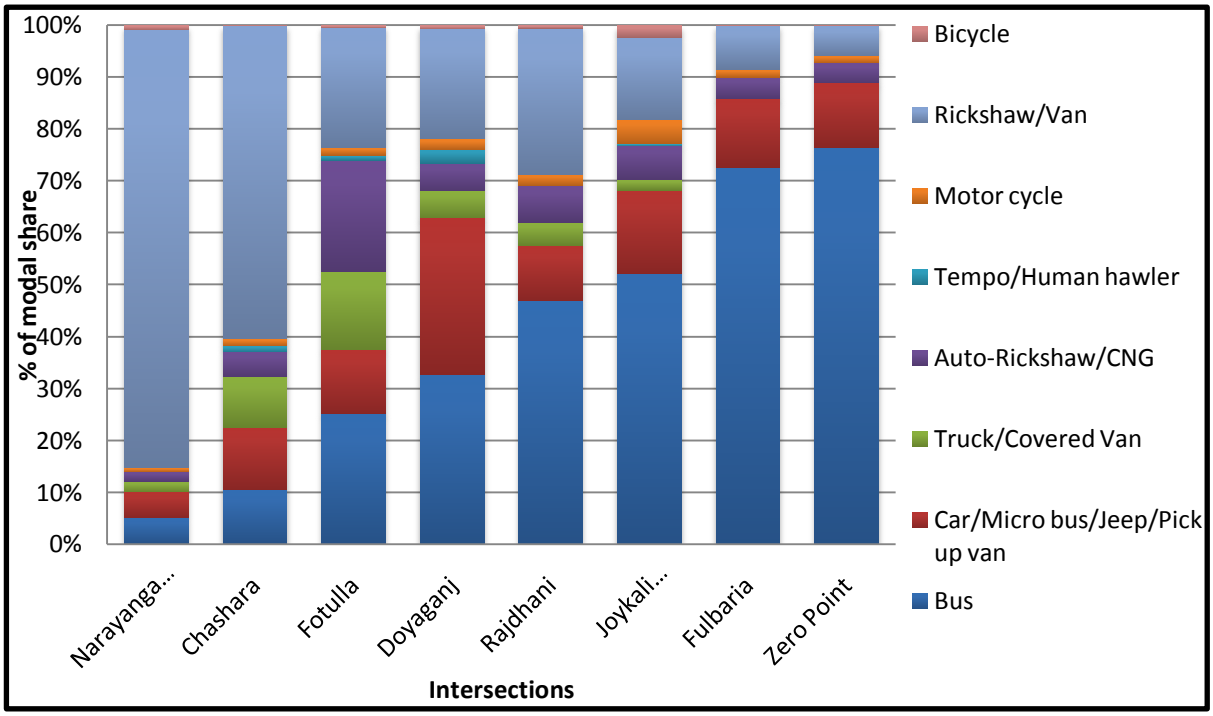


Source: Field Survey, 2013

Figure 6.9: Comparison of modal share percentage at all intersections at evening peak of route - Joydevpur to Dhaka (via Kuril)

At Malibag rickshaw use became more dominant to meet local people's travel demand where a new mode to serve people nearby places at Sayedabad is noticed. So it is conspicuous that at these time all the possible modes that serve local and outside people to reach home move on the roads (Figure 6.9).

6.1.2.3 Modal Composition Analysis of the Intersections for Route- Narayanganj to Dhaka (via Doyaganj):



Source: Field Survey, 2013

Figure 6.10: Comparison of modal share percentage at all intersections at morning peak of route - Narayanganj to Dhaka (via Doyaganj)

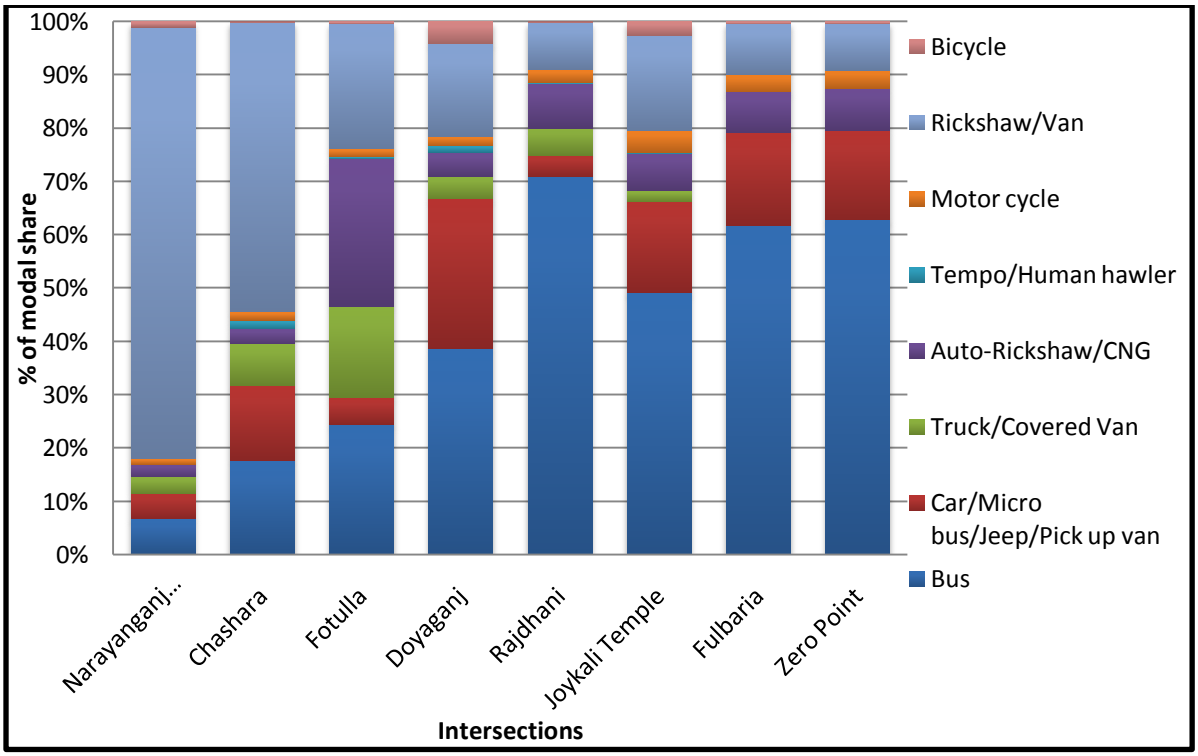
- **At Morning Peak:** From Figure 6.10, it can be seen that the modal share of rickshaws/vans is highest at Narayanganj Railgate and lowest at Zero Point. There is almost a gradual decrease in the modal share of rickshaws from Narayanganj to Gulistan. This may happen because there is high number of residential and institutional facilities near Narayanganj Railgate and Chashara intersections and the people may access these places by rickshaws. This indicates the local trips are dominant in that area. There is some share of rickshaws in Fotulla, Doyaganj and Rajdhani intersections. The Rajdhani Super Market also may attract a large share of customers who use rickshaws. But from there it decreases gradually up to Zero Point. Rickshaw trips mostly occur via access and secondary roads in Gulistan area. The main road remains very busy and is unsafe for rickshaws.

  On the other hand, the modal share of buses gradually increases from Narayanganj to Gulistan. The reason for this may be because there is a bus stand in Chashara. Buses depart from there towards Dhaka which accumulates at the intersections of Rajdhani,

Joykali Temple, Fulbaria and Zero Point. Furthermore, there is also a bus terminal in Fulbaria which further contributes to the increasing share of buses inside Dhaka city.

- **At Morning off Peak and Evening Peak:**

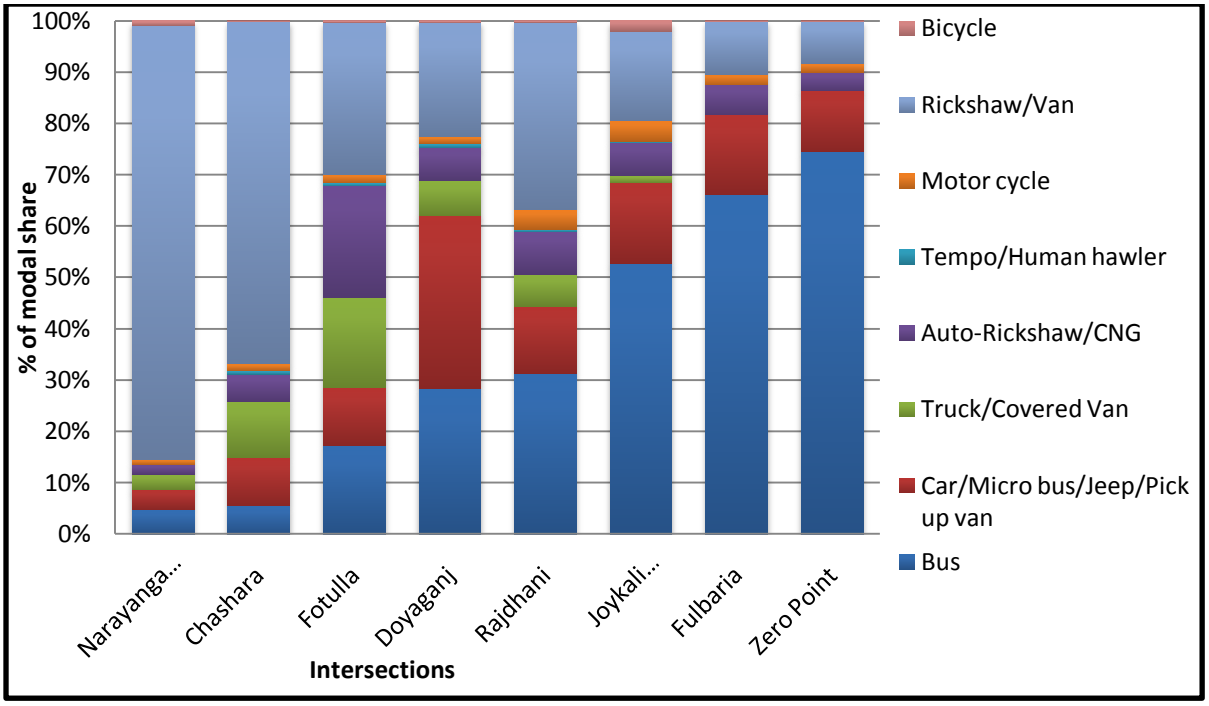
Figure 6.11 shows the morning off-peak modal shares in this route. It is very much similar to that of the morning peak and the reasons may be similarly interpreted.



Source: Field Survey, 2013

Figure 6.11: Modal share percentage at all intersections at morning off peak of route-Narayanganj to Dhaka (via Doyaganj)

Figure 6.12 displays the modal shares in this route during the evening peak. In this case, the flow of vehicles has been enumerated from the reverse direction, i.e. from Zero Point to Narayanganj. It can be easily seen from the graph that again, in Zero Point, buses are the dominant modes which steadily decreases towards Narayanganj. This may happen because very few buses are going in the direction of Narayanganj at this hour. Most buses are dispersed in the other routes inside the city in some other direction.

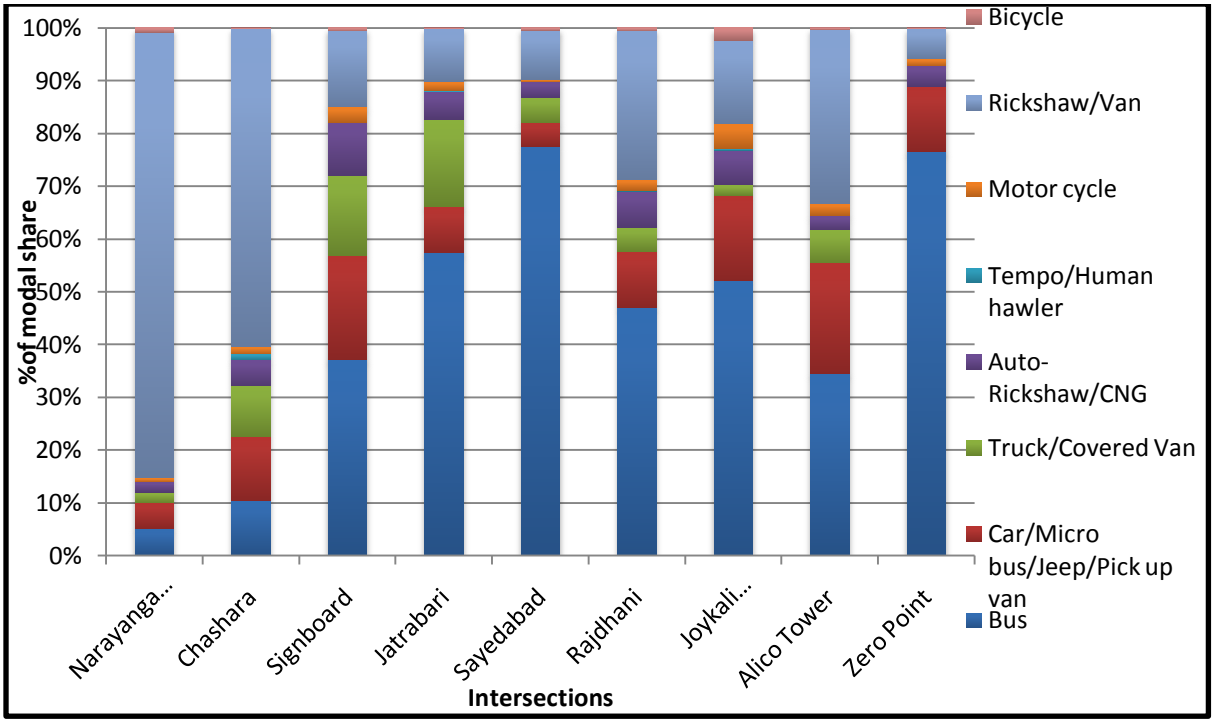


Source: Field Survey, 2013

Figure 6.12: Comparison of modal share percentage in PCU/hr at all intersections at evening peak of route -Narayanganj to Dhaka (via Doyaganj)

Again, it can be seen rickshaws/vans comprise a small percentage in Dhaka but become dominant in Narayanganj Railgate and Chashara. The reasons may be that local trips are frequent in vicinity of Narayanganj whereas rickshaw trips occur mostly by access and secondary roads in Gulistan area.

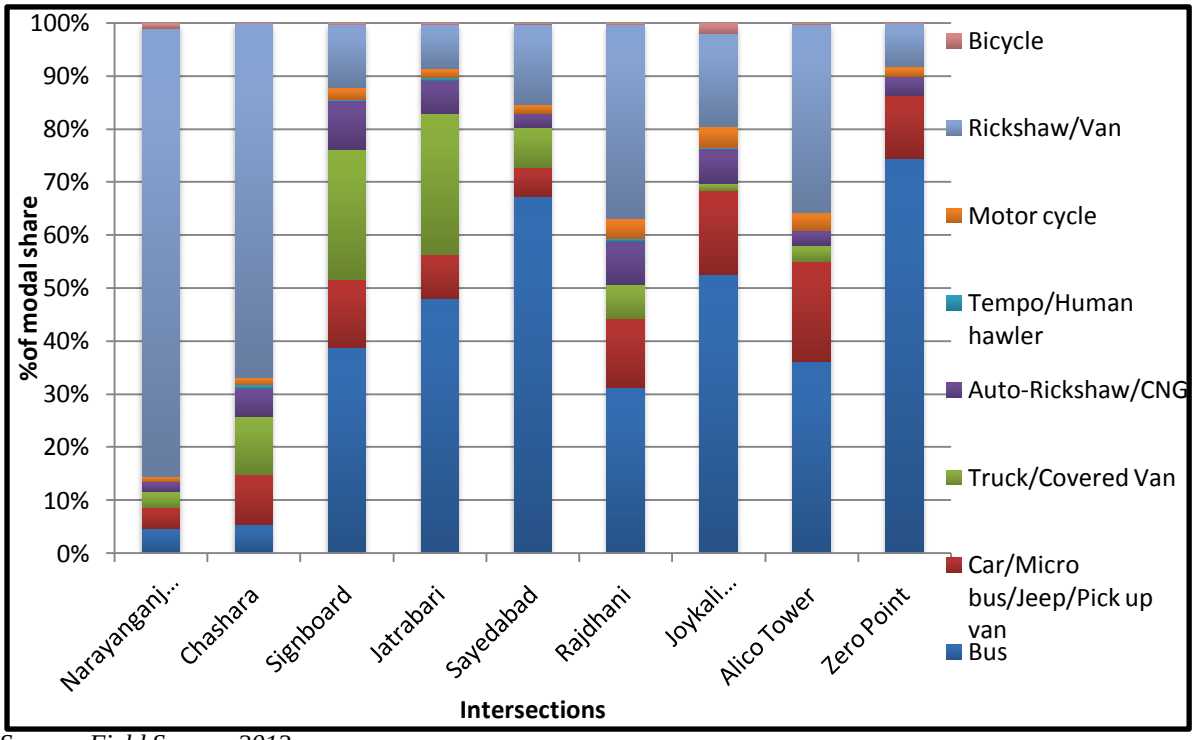
6.1.2.4 Modal Composition Analysis of the Intersections for Route- Narayanganj to Dhaka (via Doyaganj): At Morning off Peak and Evening Peak it is observed that among the three dominant modes Bus, Car and Rickshaw percentage of Bus is the highest expect Narayanganj Railgate and Chashara (Figure 6.13, 6.14 &6.15).



Source: Field Survey, 2013

Figure 6.13: Comparison of modal share percentage at all intersections at morning peak of route - Narayanganj to Dhaka (via Signboard)

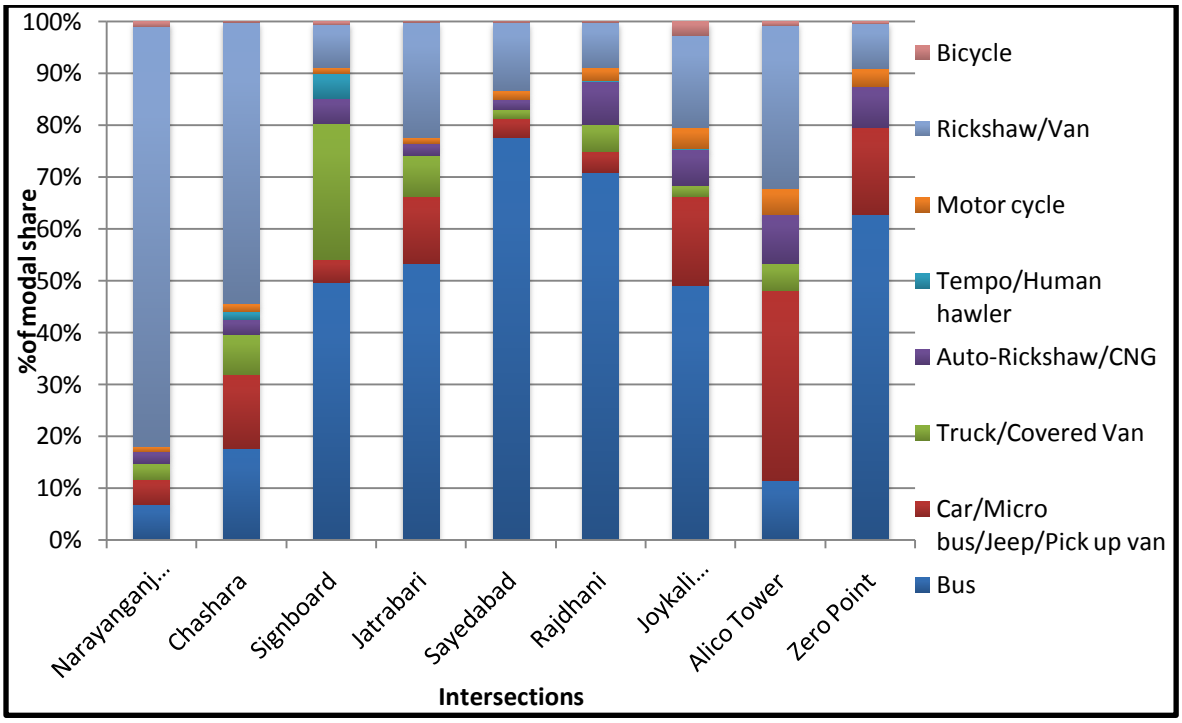
Flow is directly influenced by the increase of the flow of rickshaw in Narayanganj Railgate intersection. To reach the important land uses in the area people use mainly rickshaw. So, it can be a reason behind the high share of rickshaw in this intersection. Then, at Chashara intersection the most dominating mode seems to be rickshaw which is used by the local people to go to their nearby destinations within Chashara and Fatulla.



Source: Field Survey, 2013

Figure 6.14: Comparison of modal share percentage at all intersections at morning off peak of route -Narayanganj to Dhaka (via Signboard)

The land uses served are academic institution, office and the nearby Chashara station for people using train to leave for Dhaka.



Source: Field Survey, 2013

Figure 6.15: Comparison of modal share percentage at all intersections at morning peak of route -Narayanganj to Dhaka (via Signboard)

In other intersections the greater percentage of mode is local Bus percentage of which is highest in Sydabad (Bus dominated traffic may be due to Sydabad terminal), Jatrabari, Joy kali Temple, Rajdhani and Zero point intersection (as it is the destination, so most of the people come here mainly by Bus).

6.1.3 Analysis of Directional Variation:

The analysis reveals the modal variation in different directions at three peaks, which has been found in volume survey.

6.1.3.1Directional traffic volume analysis of the Intersections for Route- Joydevpur to Dhaka (via Mohakhali):

Commuters' journey starts from Gazipur Chourasta towards Dhaka. For this reason in the morning peak is highest for straight direction towards through Dhaka-Mymensingh Highway. Traffic flow towards straight reduces in the off peak as commuters travel reduces in this direction. Highest flow may be towards in the straight direction in evening peak because of return of the commuters.

The flow from Gazipur Chourasta continues to the Gazipur Station road towards Dhaka in straight ahead and has highest flow in straight direction in the morning peak. Highest flow may be in the straight on evening peak because of return of the commuters from Dhaka.

Vehicle turning straight is relatively same in Kuril intersection is same for both morning peak towards Tejgaon to enter inside Dhaka and towards Joydevpur in evening peak to return to outskirt area after work. There is no significant flow towards right in the morning and left in the evening because in this no access road exists. Flow towards Badda is less may be because of traffic congestion created in railway line.

In Mohakhali intersection in both peak and off peak period greater volume occurs to and from Moghbazaar. This may be because a large number of traffic is attracted by BRAC University, National Hospital of Chest Disease etc.

In Bijoy Sarani intersection, more traffic in right direction to the Sanghshad Bhabahan area may be to reach to the Dhanmondi Govt high school, Islamia Eye Hospital etc. Whereas less traffic to the left direction to reach to Tejgaon Residential area.

Less traffic exists in left direction for Kawran Bazar North to South to Tejgaon residential area in morning and right direction to Panthapath in the in the evening due to residential land use existence only. Straight flow is greater may be to enter city centre.

For Paltan intersection, highest traffic flow is in straight direction in evening peak due to home bounding traffic to outskirt of the city. This flow is coming from Mothijeel. In the

morning the highest traffic flow was occurring in straight direction to the CBD area of Dhaka city Motijheel. In Mothijeel intersection, morning off peak flow to the straight is greater may be because of larger home bounding traffic (Appendix A, Table 6.1).

6.1.3.2 Directional traffic volume analysis of the Intersections for route - Joydevpur to Dhaka (via Kuril):

From Table 6.2 (Appendix A, Table 6.2) it is seen that all the legs of an intersection is not equally active. Here from figure 8 it is seen that only at morning peak period at Gazipur Chowrasta intersection there was traffic in all direction but very insignificant portion at the right. For the rest of the behavior of the intersections may be narrow road.

From the perspective of overall scenario it is seen that some intersection like Badda, Sayedabad do not have any left turning traffic in the morning and right turning traffic in the evening. Gazipur Station Road, Kuril, Malibag do not have any right turning traffic in morning and left turning in evening. Sayedabad intersection serves traffic only toward straight direction in the evening the reason behind such overall traffic pattern is that neither these routes attract people through its land use nearby nor it serves residential purpose or lead toward destinations.

6.1.3.3 Directional traffic volume analysis of the Intersections for Route- Narayanganj to Dhaka (via Doyaganj):

As in total five intersections namely Narayanganj railgate ,Chashara, Rajdhani, Joykali Temple and Zero Point are also present in this route, so the directional flow as in route 4 (Appendix A, Table 6.3). Among the other intersections in morning peak only Fulbaria intersection has three directional flows the reason may be it serves through traffic and its adjacent land uses.

In morning off peak Fulbaria having more traffic volume at all the three directions than in morning peak and it can be because of for adjacent retail and wholesale land use. Fotulla and Dayaganj are not so much significant intersection and because of this reason very less traffic volume towars only two directions

In evening peak the intersections shows the same directional characteristics as in morning peak (Appendix A, Table 6.3).

6.1.3.4 Directional traffic volume analysis of the Intersections for Route-Narayanganj to Dhaka (via Signboard):

The survey has been conducted at each intersection of the route and in total three directions (Left, Right and Straight) the data has been collected. At morning peak, morning off peak and evening peak it has been observed that in most of the intersections the traffic flow was only in two directions.

- **Morning Peak and Morning off Peak:**

At both morning peak and morning off peak except Narayanganj Railgate, Chashara and Zero Point all the other intersections of this route have only two directional flows (Appendix A, Table 4.4). Narayanganj Railgate (South to North) is the first intersection for the commuters coming from the origin which is Narayanganj and for that reason mainly there is seen traffic flow in all the directions. In this intersection lowest number of vehicle flow is observed in this left and highest in the straight direction in morning peak and off peak and most frequent vehicle is rickshaw. The reasons may be: presence of a narrow road left direction and buses do not have any route as there is no important land use in this western portion of this intersection. At straight significant amount of bus that leave for Dhaka from the stoppage located at the right side (east) use this route together with the large amount of Rickshaw increases the volume of traffic. At right, most of the important land use located in this direction (Growth center (Digu babur bazar), Bus stoppage, Rail station etc and to reach these land uses people use rickshaw.

After Narayanganj Railgate, at straight direction towards the capital Chashara (South to North) comes. In this intersection highest number of vehicle flow is in the straight direction both in morning peak and off peak and flow of rickshaw is tremendously high in this area may be because of mixed land use near the intersection.

Zero Point (West to East) is the destination of morning peak and off peak flow of traffic. So, from this intersection the total traffic disaggregated towards three directions. In this intersection highest number of vehicle flow is in the right direction both in morning peak and off peak and flow of bus is high in this area towards right and straight direction.

- **Evening Peak:**

At evening peak only Zero Point (which is the origin at that time for the commuters) and Narayanganj Railgate (which is the destination at that time for the commuters) have traffic flow at left, right and straight direction (Appendix A, Table 6.4).

At Zero Point (East to West) traffic volume is highest towards straight direction to Narayanganj and the flow of Bus is the highest here as the commuters mainly use local transport for reaching their destination. On the other hand, at Narayanganj Railgate (North to South) traffic volume is highest towards straight direction to the actual destination Narayanganj. Here Rickshaw is the highest flowing vehicle. A reason can be that: for reaching home people mainly use Rickshaw from this intersection.

6.2 ANALYSIS OF SPEED AND DELAY OF JOURNEY:

6.2.1 Comparison of Speed between Bus and Train:

Among the two routes between Dhaka-Gazipur, Dhaka to Joydebpur via Badda route is more efficient in speedy movement. Among the two routes between Dhaka-Naraynganj,Dhaka-Narayanganj via Doyaganj route is more efficient in speedy movement. Whereas train can gain more speed on its Right of Way (ROW) due having no interference by other vehicle (Table 6.5).

Table 6.5: Comparison between bus and train in terms of speed

Mode	Route	Distance(km)	Average Travel Time(hr)	Average speed (Km/hr)
Bus	**Bus Route**			
	Dhaka-Joydevpur			
	Dhaka to Joydevpur via Mohakhali	32.7	2.26	14.47
	Dhaka to Joydevpur via Kuril	32.32	1.15	28.1
Train	**Train Routes**			
	Dhaka-Joydevpur	38	0.67	**57**
Bus	**Bus Route**			
	Dhaka-Narayanganj			
	Dhaka-Narayanganj via Signboad	17.4	2.1	8.29
	Dhaka-Narayanganj via Doyaganj	16.94	1.19	14.24
Train	**Train Routes**			
	Dhaka-Narayanganj	16.1	1	**16.1**

Source: Field Survey, 2013

6.2.2 Comparison of Delay of Journey between Bus and Train:

6.2.2.1Joydevpur to Dhaka:

- **Bus Route- Joydevpur to Dhaka (via Mohakhali):** The PCU/hr values in Gazipur Chourasta, Kuril intersections are marginally larger than the others during all three periods. It can be implied that the vehicles in these intersections have to wait in traffic jam for a considerable duration of time before reaching their destinations. A journey by bus on a working day takes around two. As a result, the average speed of the bus remains around 14.47 km/hr (Table 6.5). This low speed of the bus can be attributed, to a large extent, to the delays that occur in the intersections.
- **Bus Route- Joydevpur to Dhaka (via Kuril):** The PCU/hr values in Gazipur Chourasta, Kuril, Badda intersections are marginally larger than the others during

all three periods. It can be implied that the vehicles in these intersections have to wait in traffic jam for a considerable duration of time before reaching their destinations. Apart from these three intersections, a sizeable traffic jam is often generated in the Station Road, Malibag and Syedabad intersections. A journey by bus on a working day takes around two to two and half hours. As a result, the average speed of the bus remains around 28.1km/hr (Table 6.5). This low speed of the bus can be attributed, to a large extent, to the delays that occur in the intersections.

- **Train Route- (Joydevpur to Dhaka):** Without operational delay in some intersecting points there is no delay in train route.

6.2.2.2 Narayanganj to Dhaka:

- **Bus Route- Narayanganj to Dhaka (via Doyaganj):** The PCU/hr values in Narayanganj Railgate, Chashara and Rajdhani intersections are marginally larger than the others during all three periods. It can be implied that the vehicles in these intersections have to wait in traffic jam for a considerable duration of time before reaching their destinations. Apart from these three intersections, a sizeable traffic jam is often generated in the Joykali Temple, Fulbaria and Zero Point intersections.

  A journey by bus on a working day at the route takes around two hours. As a result, the average speed of the bus remains around 14.24 km/hr (Table 6.5). This low speed of the bus can be attributed, to a large extent, to the delays that occur in the intersections.

- **Bus Route- Narayanganj to Dhaka (via Signboard):** The PCU/hr values in Narayanganj Railgate, Chashara and Rajdhani intersections are marginally larger than the others during all three periods. It can be implied that the vehicles in these intersections have to wait in traffic jam for a considerable duration of time before reaching their destinations. Apart from these three intersections, a sizeable traffic jam is often generated in the Rajdhani, Jatrabari, Joykali Temple and Zero Point intersections.

  A journey by bus on a working day takes around two to two and half hours. As a result, the average speed of the bus remains around 8.29 km/hr (Table 6.5). This low speed of the bus can be attributed, to a large extent, to the delays that occur in the intersections.

- **Train Route- (Narayanganj to Dhaka):** Without operational delay and difficulties in crossing some intersection points there are no other delays in train route.

6.3 ANALYSIS OF LEVEL OF SERVICE OF THE INTERSECTIONS OF SURVEYED ROUTES:

6.3.1 Bus route- Dhaka to Joydebpur:

6.3.1.1 Dhaka to Joydehpur via Mohakhali:

There has been deterioration from best level of service in 11 incidents among 24. So, LOS is worsening 45.88% cases (Appendix A, Table 6.6).

- **Morning peak:** In this instant, 3 intersections have deviation from LOS A. Among them Gazipur Station Road is in the worse condition with LOS F. It seems to be very traffic congested. Mohakhali and Bijoy Sarani are than two other intersections to have deviation for LOS A in morning.
- **Afternoon off peak:** Three intersections have deviation from LOS A in morning off peak. Among them Bijoy Sarani is in the worse condition with LOS E. It seems to be very traffic congested. Mohakhali and Gazipur Chourasta Road are than two other intersections to have deviation from LOS A.
- **Evening peak:** In the evening traffic condition is worst with deviation from LOS A in 62.5% intersections. Gazipur Chourasta is worst condition with LOS F. Mohakhali, kawran Bazar, Kuril and Bijoy Sarani are in worse condition as they have deviation from LOS A.

6.3.1.2 Dhaka-Joydebpur via Kuril:

There has been deterioration from best level of service in 8 incidents among 18. So, LOS is worsening 44.44% cases (Appendix A, Table 6.7).

- **Morning peak:** In this instant, two intersections have deviation from LOS A. Badda and Malibagh are the two link road having deterioration from LOS A.
- **Afternoon off peak:** In the afternoon, three intersections have deviation from LOS A. Badda, Gazipur Chourasta and Syadabad has the deviation from LOS A.
- **Evening peak:** In the afternoon, three intersections have deviation from LOS A. Badda, Gazipur Chourasta and Malibagh has the deviation from LOS A.

6.3.2 Bus route- Dhaka to Naryanganj:

6.3.2.1 Dhaka to Naryanganj via Dayaganj:

There has been deviation from best level of service in 10 incidents among 24. So, LOS is worsening 41.67% cases (Appendix A, Table 6.8).

- **Morning peak:** In this instant, 4 intersections have deviation from LOS A. Naryanganj Railgate 2, Chasara, Joykali Temple and Rajdhani are the intersections having deterioration from LOS A. Among them Chasara Road is in the worse condition with LOS E.
- **Afternoon off peak:** In afternoon, 3 intersections have deviation from LOS A. Chasara, Joykali Temple and Rajdhani are the intersections having deterioration from LOS A. Chasara and Rajdhani has poor LOS F and E respectively.
- **Evening peak:** In this instant, 4 intersections have deviation from LOS A. Naryanganj Railgate 2, Chasara, Joykali Temple and Rajdhani are the intersections having deterioration from LOS A. Among them Chasara Road is in the worse condition with LOS F. Joykali Temple road has poor LOS of E.

6.3.2.2 Dhaka-Narayanganj via Signboard:

There has been deviation from best level of service in 8 incidents among 18. So, LOS is worsening 41.44% cases (Appendix A, Table 6.9).

- **Morning peak:** In this instant, 3 intersections have deviation from LOS A. Naryanganj Railgate, Chasara, Joykali Temple are the intersections having deterioration from LOS A. Among them Chasara Road is in the worse condition with LOS E.
- **Afternoon off peak:** In afternoon, three intersections have deviation from LOS A. Chasara, Syadabad and Rajdhani are the intersections having deterioration from LOS A. Chasara and Rajdhani has poor LOS F in afternoon off peak.
- **Evening peak:** In this instant, four intersections have deviation from LOS A. Naryanganj Railgate, Chasara, Jatrabai and Rajdhani are the intersections having deterioration from LOS A. Among them Chasara Road is in the worse condition with LOS F. Rajdhani intersection has poor LOS of E.

6.4 COMPARISON OF EFFICIENCY BETWEEN THE BUS ROUTES:

The efficiency of any route depends on total travel time needed to reach from origin to destination using the route; travel cost on the route and also on the Level of Service which can be determined using capacity of the route intersections.

6.4.1Route - Joydevpur to Dhaka (via Mohakhali):

Total length of this route is 32.7 km and on an average time needed for the journey along the route is 2.26 hours. Using these two data the average speed of the route is calculated: 14.47 km per hour. The fare of this route is Tk 55 per person (Field Survey, 2013). When using the capacity and effective road width, Level of service (LOS) of the route is determined it is seen that level of service A is found in 54.45% cases (Appendix A, Table 6.6).

6.4.2 Route - Joydevpur to Dhaka (via Kuril):

Total length of this route is 33.2 km and on an average time needed for the journey along the route is 1.15 hours. Using these two data the average speed of the route is calculated: 28.1 km per hour. The fare of this route is Tk 50 per person (Field Survey, 2013). When using the capacity and effective road width, Level of service of the route is determined it is seen that LOS A in 55.33% cases (Appendix A, Table 6.7).

6.4.3 Comparison between Route- Joydevpur to Dhaka (via Mohakhali) and Route- Joydevpur to Dhaka (via Kuril):

Journey time and cost at Route -Joydevpur to Motijheel (via Mohakhali) is more than in Route- Joydevpur to Kamalapur (via Kuril). Again if compared between Level of Service it is clear that almost all the intersections at three peaks of Route- Joydevpur to Dhaka (via Kuril) is at Level of Service “A”, whereas Route- Joydevpur to Dhaka (via Mohakhali) shows diversified scenario. Besides, the average speed (28.1 km/hr) of Route- Joydevpur to Dhaka via Kuril) is much more than average speed (14.47 km/hr) of Route- Joydevpur to Motijheel via Mohakhali).

So, from the above comparison it can be said that Route-Joydevpur to Kamalapur (via Kuril) is more efficient than Route- Joydevpur to Motijheel (via Mohakhali).

6.4.4 Route - Narayanganj to Dhaka (via Doyaganj):

Total length of this route is 16.94 km and on an average time needed for the journey along the route is 1.19 hour. Using these two data the average speed of the route is calculated: 14.24

km per hour. The fare of this route is Tk 30 per person (Field Survey, 2013). When using the capacity and effective road width, Level of service of the route is determined it is seen that LOS A in 58.33% cases (Appendix A, Table 6.8).

6.4.5 Route-Narayanganj to Dhaka (via Signboard):

Total length of this route is 17.4 km and on an average time needed for the journey along the route is 2.1 hours. Using these two data the average speed of the route is calculated: 8.29 km per hour. The fare of this route is Tk 30 per person (Field Survey, 2013). When using the capacity and effective road width, Level of service of the route is determined it is seen that LOS A in 58.56% cases (Appendix A, Table 6.9).

6.4.6 Comparison between Route-Narayanganj to Dhaka (via Doyaganj) and Route-Narayanganj to Dhaka (via Signboard):

Journey time at Route-Narayanganj to Dhaka (via Doyaganj) is less than in Route-Narayanganj to Dhaka (via Signboard) whereas the costs of two routes are same. Again if compared between Level of Service it is clear that most of the intersections in Route-Narayanganj to Dhaka (via Signboard) is at Level of Service "A". In Route -Narayanganj to Dhaka (via Doyaganj) Level of services is less than Route- Narayanganj to Dhaka (via Signboard). Besides, the average speed (14.24 km/hr) of Route-Narayanganj to Dhaka (via Doyaganj) is much more than average speed (8.29 km/hr) of Route-Narayanganj to Dhaka (via Signboard).

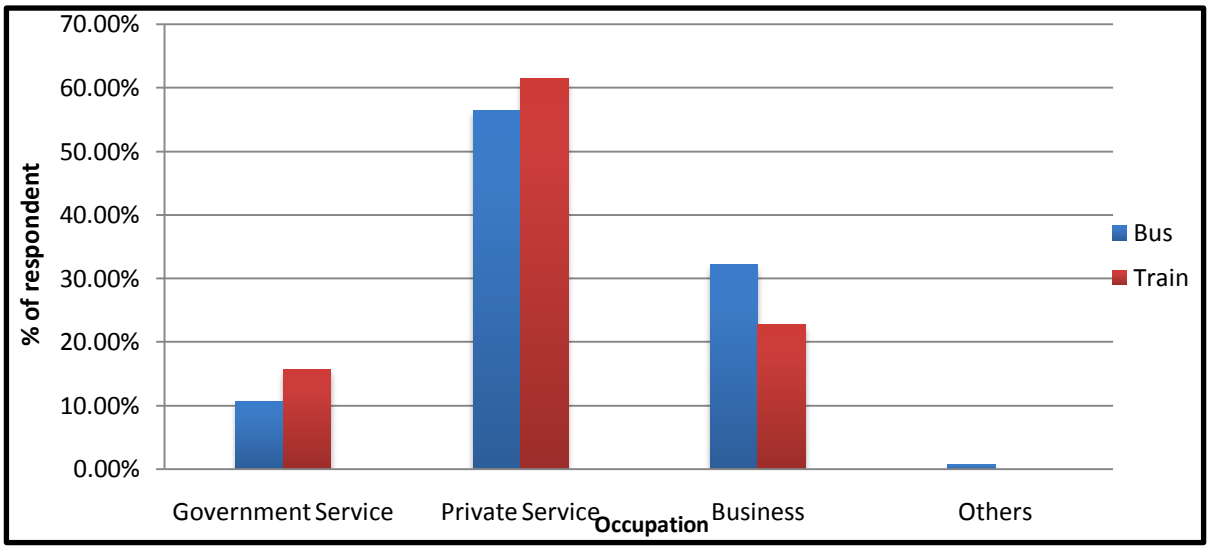
So, from the above comparison it can be said that Route- Narayanganj to Dhaka (via Doyaganj) is more efficient than Route- Narayanganj to Dhaka (via Signboard) in terms of speed and Route- Narayanganj to Dhaka (via Signboard) is more efficient than Route-Narayanganj to Dhaka (via Doyaganj) in terms of Level of Service. As the percentage of Level of service in this two routes are similar, so it can be said that Route- Narayanganj to Dhaka (via Doyaganj) is the efficient than the other as it is speedier.

6.5 ANALYSIS OF DEMOGRAPHIC CHARACTERISTICS OF THE COMMUTERS:

When analyzing the demographic characteristics of the commuters firstly age distribution of the commuters travelling on bus or train has been identified. Mainly working people aged range of 30-44 years commute on bus or train. Above 60% of commutes aged between this range (Appendix A, Table 6.11). From the survey it has found that most of the commuters are male (about 92%) (Appendix A, Table 6.12). The reason behind it may be the distance and

safety is not in very much favorable condition on the perspective of our country for female passengers.

Commuters mainly generate work trip from origin to destination are from different occupations. For the purpose of survey and convenience the occupations are divided among four categories: Government Service, Private Service, Business and others. From the analysis it has been revealed that majority of the commuters are occupied in Private Services and then in Business.



Source: Field Survey, 2013

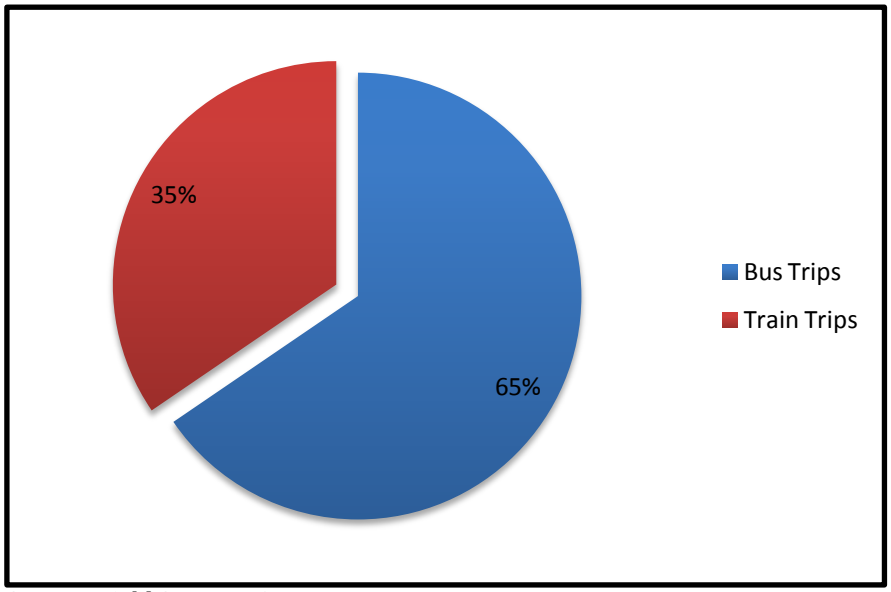
Figure 6.16: Percentage of surveyed commuters occupied in different occupations

Among 140 bus commuters more than 50% are involved in Private services whereas among 70 train commuters above 60% are involved in private services. Then majority of the business men are bus commuters. Government officials have been found less as commuters both in Bus and Train (Figure 6.16).

When income level of the commuters has been observed different categories level are seen. Mainly the income range of the commuters is 20000-30000 taka per month, more than 30000 tk per month also is seen From the Table 4.13 (Appendix A, Table 6.13). As from the above figure (Figure 6.16) it is clear that most of the commuters are involved in private services and in business, the income range of those people are generally medium to high level. The other income groups of people like 10000-15000 or 15000-20000 are not also less in amount. So it is clear that different income group travel in commuter Bus and Train for their working purpose.

6.6 ANALYSIS OF MODAL SHARE DISTRIBUTION:

It is found that the modal share of bus trips is larger than the share of train which is almost two times of trips made through bus. Based on five working days in a week and the number of trips made by a user in every week is considered as 10. Though the share of bus trips is larger but people opine that train is a better mode than bus. If train service could be more effective they would have travel in train.



Source: Field Survey, 2013

Figure 6.17: Distribution of Modal Share of Commuters

6.7 ANALYSIS OF FACTORS GOVERNING MODAL CHOICE OF COMMUTERS:

In case of choosing any mode factors like total travel time, travel cost, accessibility etc. are usually considered by the user which may vary in different situations. According to the view of the users the average weight age of the importance of the factors affecting modal choice is calculated using the principle of weighted mean where a higher number represents more importance (Table 6.14).

Table 6.14: Weighted mean of factors affecting modal choice

Factors	Overall Weighted mean (∑f.w/∑f)	Weighted mean (∑f.w/∑f) for Bus	Weighted mean (∑f.w/∑f) for Train
Cost	3.93	3.82	4.19
Travel Time	4.63	4.53	4.82
Safety	3.46	3.51	3.35
Environment	0.2	4	3.66
Accessibility	3.9	3.25	3.52
Comfort	3.34	3.35	3.06
Reliability	3.27	3.5	2.75
Behavior	0.16	3.08	0
Total		**29.04**	**25.35**

Source: Field Survey, 2013

Travel time holds the average highest priority of ranking for selecting any mode. Travel time in the same time includes journey time, waiting time and mode exchange time. Besides travel time has a direct connection with mental image and the before and after scheduling of the journey. Travel cost is the next important consideration. It has a strong relation with travel time as people treads off between travel time and money in different situations. Accessibility is a crucial factor to make a mode popular, convenient and efficient. Safety, Comfort and reliability comes next as they are important in some respect but sometimes are overlooked in our country (Table 6.14).

6.8 ANALYSIS OF TRAVEL PATTERN:

6.8.1 Analysis of Travel Time:

6.8.1.1 Dhaka to Joydevpur Route:

- **Bus routes:** Among the two considered routes Dhaka to Joydevpur via Mohakhali route has a travel time of 136.5 minutes and Dhaka to Joydevpur via Badda has a travel time of 68.79. Travel time on the Dhaka to Joydebvur via Badda route of relatively low. It is occurring as both O-D and D-O journey time is less for the Dhaka to Joydevpur via Badda route (Table 6.15).
- **Train routes:** Dhaka to Joydevpur train route has travel time for commuters are 40 minutes. So, travel time in the Dhaka-Joydevpur train route is smaller than both bus routes. It is occurring as travel time on both O-D and D-O journey is less for the train route (Table 6.15).

6.8.1.2 Dhaka to Narayanganj route:

- **Bus routes:** Among the two considered routes Dhaka to Narayanganj via Signboard route has a travel time of 126 minutes and Dhaka to Narayanganj via Dayaganj has a travel time of 71.96. Travel time on the Dhaka to Narayanganj via Dayaganj route of relatively low. It is occurring as travel on both O-D and D-O journey is less for the second route (Table 6.15).
- **Train routes:** Dhaka to Narayanganj train route has travel time for commuters are 61.75 minutes. So, travel time in the Dhaka to Narayanganj train route occupy less travel time than both bus routes. It is happening as travel time on both O-D and D-O journey is less for the train route (Table 6.15).

- **Overall comparison of travel time:**

  Train on average has a travel time 55.38 and for bus it is 100 minute on average. It is evident from this comparison; train has smaller travel time than bus in both routes. So, train is more efficient as a faster mode for commuting (Table 6.15).

Table 6.15: Comparsion of travel time between bus and train routes of Dhaka-joydebpur and Dhaka-Narayanganj connecting transport routes

Route	Travel Time(Min)		Average Travel Time(min)
Bus	**O-D**	**D-O**	
Dhaka-Joydevpur route			
Dhaka to Joydevpur via Mohakhali	132	141	136.5
Dhaka to Joydevpur via Badda	66.41	71.17	68.79
Average of two routes			**102**
Dhaka-Narayanganj route			
Dhaka-Narayanganj via Signboad	111	141	126
Dhaka-Narayanganj via Dayaganj	83.57	60.354	71.962
Average of two routes			**98**
Average of four routes			**100**
Train			
Dhaka-Narayanganj	62.3	61.5	61.75
Dhaka-Joydebpur	40	40	40
Average of two routes			**55.375**

Source: Field Survey, 2013

6.8.2 Analysis of Waiting Time:

6.8.2.1Dhaka-Joydebpur Route:

- **Bus routes:** Among the two considered routes Dhaka-Joydebpur via Mohakhali route has a waiting time of 12.87 minutes and Dhaka to Joydebpur via Badda has a waiting time of 8.06 minutes. Average waiting time on the Dhaka to Joydebpur via Badda route is low. It is occurring as waiting time on both O-D and D-O journey is less for this route (Table 6.16).
- **Train routes:** Dhaka-Joydebpur train route has waiting time for commuters are 28.43 minutes. So, travel time in the Dhaka-Joydebpur train route is greater than both bus routes (Table 6.16).

6.8.2.2 Dhaka-Narayanganj route:

- **Bus routes:** Among the two considered routes Dhaka-Narayanganj via Signboad route has a waiting time of 12.86 minutes and Dhaka-Narayanganj via Dayaganj has a travel time of 8.06 minutes. Waiting time on the Dhaka-Narayanganj via Dayaganj route of relatively low. It is occurring as travel on both O-D and D-O journey is less for the second route (Table 6.16).
- **Train routes:** Dhaka-Narayanganj train route has waiting time of 15.55 minutes for commuters are 28.83 minutes. So, waiting time in the Dhaka-Joydebpur train route is smaller than both bus routes. It is happening as waiting time on both O-D and D-O journey is less for the train route (Table 6.16).

- **Overall comparison of waiting time:**

It is evident from the above comparison; train has greater waiting time than bus in both routes People usually comes to the rail station early before than the arrival of the train and that's makes waiting time of train is greater than bus. So, bus is efficient (Table 6.16).

Table 6.16: Comparsion of waiting time between bus and train routes of Dhaka-joydebpur and Dhaka-Naryanganj connecting transport routes

Route	Waiting Time(Min)		Average waiting Time(min)
Bus	**O-D**	**D-O**	
Dhaka-Joydevpur route			
Dhaka to Joydevpur via Mohakhali	8.31	13.33	10.82
Dhaka to Joydevpur via Badda	9.44	8.39	8.915
Average of two routes			**9.45**
Dhaka-Narayanganj route			
Dhaka-Narayanganj via Signboad	12.37	13.37	12.87
Dhaka-Narayanganj via Dayaganj	9.58	6.54	8.06
Average of two routes			**10.46**
Average of four routes			**9.95**
Train			
Dhaka-Narayanganj	18.24	12.86	15.55
Dhaka-Joydebpur	26.59	29.87	28.43
Average of two routes			**22**

Source: Field Survey, 2013

6.8.3 Analysis of Travel cost:

6.8.3.1 Dhaka to Joydebpur Route:

- **Bus routes:** Among the two considered routes Dhaka to Joydebpur via Mohakhali route has a travel cost of 42 Taka and Dhaka to Joydebpur via Badda has a travel cost of 45 Taka. Travel cost on the Dhaka to Joydebpur via Badda route of is relatively low. It is occurring as both O-D and D-O travel cost is higher for the Dhaka to Joydebpur via Badda route (Table 6.17).
- **Train routes:** Dhaka to Joydebpur train route has travel cost for commuters are 16.61 taka. So, travel cost in the Dhaka to Joydebpur train route is less than both bus routes. It is occurring that travel cost on both O-D and D-O journey is less for the train route (Table 6.17).

6.8.3.2 Dhaka to Narayanganj route:

- **Bus routes:** Among the two considered routes Dhaka to Narayanganj (via Signboard) route has a travel cost of 37.28 Tk and Dhaka to Narayanganj (via Doyaganj) has a travel cost of 38.645 Tk. Travel cost on the Dhaka to Narayanganj (via Doyaganj route of relatively low. It is occurring as travel cost on both O-D and D-O journey is less for Dhaka to Narayanganj via Doyaganj route (Table 6.17).
- **Train routes:** Dhaka to Narayanganj train route has travel cost for commuters are 10 taka. So, travel cost in the Dhaka to Narayanganj train route is less than both bus routes (Table 6.17).

- **Overall comparison of travel cost:**

Train on average has a travel cost 13.3 and for bus it is 33.38 minute on average. It is evident from the comparison, train has smaller travel cost than bus in both routes. So, train is more efficient as a cheaper mode for commuting (Table 6.17).

Table 6.17: Comparsion of Travel Cost between bus and train routes of Dhaka-joydebpur and Dhaka-Naryanganj connecting transport routes

Route	Travel cost (Tk)		Average travel cost(Tk)	Travel Cost/km
Bus	**O-D**	**D-O**		
Dhaka-Joydevpur route				
Dhaka to Joydevpur via Mohakhali	31.33	53.5	42.415	1.29
Dhaka to Joydevpur via Badda	45.78	45.58	45.68	1.38
Average of two routes			**43.5**	**1.33**
Dhaka-Narayanganj route				
Dhaka-Narayanganj via Signboad	57.31	17.25	37.28	2.2
Dhaka-Narayanganj via Dayaganj	10.76	30	20.38	1.22
Average of two routes			**33.79**	**1.61**
Average of four bus routes			**38.645**	**1.47**
Train				
Dhaka-Narayanganj	10	10	10	0.62
Dhaka-Joydevpur	15.56	17.76	16.61	0.26
Average of two rail routes			**13.3**	**0.44**

Source: Field Survey, 2013

6.8.4 Analysis of Accessibility and Modal Integration:

- **Composition of Primary Mode:** Primary for providing access to the rail and train station is mainly walk and rickshaw. Bus has arrived in competition in order to provide access mainly to train station in station-destination (Table 6.18).

Table 6.18: Composition of Primary Mode of integration between bus and train

Commuting Mode	Primary Mode	Percentage			
Bus	**Primary Mode of integration**	**Origin-Station**	**Station-Origin**	**Station-Destination**	**Destination-Station**
	Walk	100	48.73	73.02	64.86
	Rickshaw		47.89	22.5	31.5
	CNG		3.3	1.3	3.6
	Para transit			1.2	
	Bus			0.1	
Train	**Primary Mode of integration**	**Origin-Station**	**Station-origin**	**Station-Destination**	**Destination-Station**
	Walk	41.4	42.5	27	20.7
	Rickshaw	46	43.6	33.3	42.5
	CNG	5.7		2.3	4.6
	Para transit	6.9	6.9	4.6	1.1
	Bus		5.9	32.2	31

Source: Field Survey, 2013

6.8.5 Analysis of Impedance on Modal Integration:

6.8.5.1 Travel Time:

- **Travel time to reach station by walking:**
- **Dhaka to Joydevpur Route:**
  - **Bus routes:** Among the two considered routes Dhaka to Joydebpur via Mohakhali route has a time to have access to station by walking is 9.06 minutes and Dhaka to Joydebpur via Badda has a travel time of 6.67 minutes. Travel time to reach station by walking on the Dhaka to Joydebpur via Badda route is relatively low (Table 6.19).

- **Train routes:** Dhaka-Joydebpur train route has travel time to reach station by walking for commuters are 11.15 minutes. So, travel time to access station in the Dhaka-Joydebpur train route is larger than both bus routes for walking (Table 6.19).

➢ **Dhaka-Narayanganj route:**

- **Bus routes:** Among the two considered routes Dhaka-Narayanganj via Signboad route has a travel time to reach station by walking is 11.28 minutes and Dhaka-Narayanganj via Dayaganj has a travel time of 8.54 minutes. Travel time by walking on the Dhaka-Narayanganj via Dayaganj route of relatively low. It is occurring as travel time on both O-D and D-O journey is less for the Dhaka-Narayanganj via Dayaganj route(Table 6.19).
- **Train routes:** Dhaka-Narayanganj train route has travel time for commuters to reach train station by walking is 6.94 minutes. So, travel time to reach railway station by walking to the Dhaka-Narayanganj train route is smaller than both bus routes. It is happening as travel time to reach train station on both O-D and D-O journey is less for the train route (Table 6.19).

Overall comparison of travel time to reach station by walking:

Train on average has a travel time of reaching station by rickshaw is 9.09 minutes and for bus it is 8.5 minute on average. It is evident from the comparision, train has greater travel time to reach station by walking than bus in both routes. So, bus is well integrated mode by walking (Table 6.19).

Table 6.19: Average travel time to reach station by walking

Access Mode	Travel Time (Min)					Average Travel Time(min)
	Routes	**origin-station**	**Station-destination**	**Destination-station**	**Station-origin**	
Walk	**Bus**					
	Dhaka-Joydebpur route					
	Dhaka to Joydebpur via Mohakhali	8.8	10.57	8.64	8.25	9.065
	Dhaka to Joydebpur via Badda	7	6.18	6.76	6.76	6.675
	Average of two routes					**7.09**
	Dhaka-Narayanganj route					
	Dhaka-Narayanganj via Signboad	13.53	14.34	9	8.25	11.28
	Dhaka-Narayanganj via Dayaganj	11.454	10.59	6.63	5.5	8.5435
	Average of two routes					**9.91**
	Average of four routes					**8.5**
Walk	**Train**					
	Dhaka-Narayanganj	6	5	16.76		6.94
	Dhaka-Joydebpur			12.05	8.25	11.15
	Average of two routes					**9.095**

Source: Field Survey, 2013

- **Travel time to reach station by rickshaw:**

- **Dhaka-Joydebpur Route:**

  - **Bus routes:** Among the two considered routes Dhaka-Joydebpur via Mohakhali route has a travel time to have access to station is 10.7 minutes by rickshaw and Dhaka to Joydebpur via Badda has a travel time of 14.5 minutes to be accessed by rickshaw. Travel time to reach station by rickshaw on the Dhaka to Joydebpur via Badda route of relatively greater than the other road (Table 6.20).
  - **Train routes:** Dhaka-Joydebpur train route has travel time to reach station by rickshaw for commuters are 15.53 minutes. So, travel time to access station in the Dhaka-Joydebpur train route is larger than both bus routes in case of rickshaw (Table 6.20).

- **Dhaka-Narayanganj route:**

  - **Bus routes:** Among the two considered routes Dhaka-Narayanganj via Signboad route has a travel time to reach station by rickshaw is 15.1 minutes and Dhaka-Narayanganj via Dayaganj has a travel time of 10.89 minutes. Travel time on the Dhaka-Narayanganj via Dayaganj route of relatively higher. It is occurring as travel on both O-D and D-O journey is less for the Dhaka-Narayanganj via Dayaganj route (Table 6.20).
  - **Train routes:** Dhaka-Narayanganj train route has travel time for commuters to reach train station by rickshaw is 6.94 minutes. So, travel time to reach railway station by rickshaw in the Dhaka-Narayanganj train route is smaller than both bus routes. It is happening as travel time to reach station by rickshaw on both O-D and D-O journey is higher for the train route (Table 6.20).

- **Overall comparison of travel time to reach station by rickshaw:**

Train on average has a travel time of reaching station by rickshaw is 9.09 and for bus it is 8.5 minute on average. It is evident from the comparison; train has greater travel time to reach station by walking than bus in both routes. So, bus is well integrated mode by walking (Table 6.20).

Table 6.20: Average travel time to reach station by rickshaw

Access Mode	Travel Time (Min)					Average Travel Time(min)
	Route	origin-station	Station-destination	Destination-station	Station-origin	
Rickshaw	**Bus**					
	Dhaka-Joydevpur route					
	Dhaka to Joydevpur via Mohakhali	11.34	10.57	10.67	10.39	10.7425
	Dhaka to Joydevpur via Badda	14.45	14.57	14.64	14.36	14.505
	Average of two routes					**12.62**
	Dhaka-Narayanganj route					
	Dhaka-Narayanganj via Signboad	13.53	14.34	13.25	19.34	15.115
	Dhaka-Narayanganj via Dayaganj	11.454	10.59	10.93	10.59	10.891
	Average of two routes					**13.01**
	Average of four routes					**12.81**
Rickshaw	**Train**					
	Dhaka-Narayanganj	11.45	6.59	19.94	24.54	15.62
	Dhaka-Joydevpur			12.53	19.34	15.93
	Average of two routes					**16.72**

Source: Field Survey, 2013

6.8.5.2Travel Cost:

- **Travel cost to reach station by rickshaw:**

➢ **Dhaka-Joydebpur Route:**

- **Bus routes:** Among the two considered routes Dhaka-Joydebpur via Mohakhali route has a travel cost to have access to station is 11.65 taka by rickshaw and Dhaka to Joydebpur via Badda has a travel cost of 10.89 Taka. Travel cost to reach station by rickshaw on the Dhaka to Joydebpur via Badda route is relatively low than the other road (Table 6.21).
- **Train routes:** Dhaka-Joydebpur train route has travel cost to reach station by rickshaw for commuters are 14.36 taka. So, travel cost to access station in the Dhaka-Joydevpur train route is larger than both bus routes (Table 6.21).

➢ **Dhaka-Narayanganj route:**

- **Bus routes:** Among the two considered routes Dhaka-Narayanganj via Signboad route has a travel cost to reach station by rockshaw is 15.27 taka and Dhaka-Narayanganj via Dayaganj has a travel cost of 12.75 taka for the same. Travel cost on the Dhaka-Narayanganj via Dayaganj route is relatively lower. It is occurring as travel cost on both O-D and D-O journey is less for the second route (Table 6.21).
- **Train routes:** Dhaka-Narayanganj train route has travel cost for commuters to reach train station by rickshaw is tk 19.169. So, travel cost to reach railway station in the Dhaka-Narayanganj train route is greater than both bus routes (Table 6.21).

- **Overall comparison of travel cost to reach station by rickshaw:**

Train on average has a travel cost of reaching station by rickshaw is 16.69 taka and for bus it is 14.69 taka on average. It is evident from the comparison; train has greater travel cost to reach station by rickshaw than bus in both routes. So, bus is well integrated mode by rickshaw (Table 6.21).

Table 6.21: Average travel cost to reach station by rickshaw

Mode of Integration	Route	Travel cost(Tk) origin-station	Station-destination	Destination-station	Station-origin	Average Travel cost(Tk)
Rickshaw	**Bus**					
	Dhaka –Joydevpur route					
	Dhaka to Joydevpur via Mohakhali	13.75	13.42	13.33	6.11	11.65
	Dhaka to Joydevpur via Badda	21.11	19.12	21	19.11	20.11
	Average of two routes					**15.88**
	Dhaka-Narayanganj route					
	Dhaka-Narayanganj via Signboad	11.66	18.88			15.27
	Dhaka-Narayanganj via Dayaganj	11.45	10.59		15.65	12.75
	Average of two routes					**14.01**
	Average of four routes					**14.9**
Rickshaw	**Train**					
	Dhaka-Narayanganj	16.676	21.66			19.168
	Dhaka-Joydevpur	15.65	12.85	11.66	18.33	14.6225
	Average of two routes					**16.69**

Source: Field Survey, 2013

6.9 COMPARATIVE ANALYSIS OF LEVEL OF SATISFACTION OF BUS AND TRAIN COMMUTERS:

People traveling on different modes usually have different opinions about the level of service provided by each mode and thus their satisfaction level also doesn't remain the same. The better the service provided the higher the level of satisfaction found. In order to get an over view of the comparative satisfaction level for bus and train travelers for some factors satisfaction index in calculated. The higher the index value the higher the satisfaction level for any particular factor.

From the table of satisfaction index it is found that for some particular factors the satisfaction level of both bus and train commuters are the same. It is found that for waiting time at station, comfort, safety, regularity and luggage capacity within the traveling mode the index value remains within the range of 2 and 3. So it is understood from the value that both passengers of bus and train are not satisfied at all with the level of service for the above factors. Again for toilet facility at bus and train station seems to be very low in both cases, which means that travelers do feel the necessity of toilet at stations which is not merely a concern of the authority.

Besides the above factors, there are some other factors like waiting time for ticket, frequency of the travelling mode and ticketing system which commuters find to be moderately satisfactory (Table 6.22).

But the above factors are not the dominant factors that affect people's decision regarding selecting a mode for traveling from outskirts to the city centre. Those are actually the factors where satisfaction level varies drastically from one mode to another. Now from the above table some factors are found that do have varying index value. They are-travel time, fare, seating capacity, total delay, Schedule maintenance, waiting area, convenience and integration with other modes. Among these factors train travelers are found very satisfied regarding waiting area, travel time and fare, while on the other hand bus travelers are found to be unsatisfied about the both factors' level of service. As the travel time and fare both are very reasonably low in case of train service. But bus travelers think that because of the insufficient road capacity delay takes place which causes long travel time; moreover different bus service charges different fare for same distance which causes dissatisfaction among the bus travelers e.g. BRTC charges more fare than private buses on the same root (Table 6.22).

Table 6.22: Comparison between the satisfaction level of bus and train users using satisfaction index

Factors	Satisfaction Index	
	Bus	**Train**
Travel Time	2.01	**4.44**
Fare	2.91	**4.33**
Ticketing System	3.05	**3.09**
Seating Capacity	**2.19**	1.21
Total Delay	1.93	**3.07**
Time Schedule Maintenance	2.64	**3.00**
Waiting Time at the station	2.77	**2.90**
Waiting Time for ticket	**3.39**	3.13
Waiting Area	2.87	**3.23**
Comfort	2.39	**2.94**
Frequency	3.08	**3.16**
Safety	**2.92**	2.90
Luggage Capacity	2.19	**2.37**
Toilet Facility	**1.73**	1.47
Regularity	**2.99**	2.94
Integration with other Modes	3.28	**2.87**
Convenience	2.86	**3.79**
Total Score	**45.2**	**48.84**

Source: Field Survey, 2013

Again for total delay, schedule maintenance and convenience train travelers find train service to be moderately satisfactory. But on the other hand bus travelers find schedule maintenance and overall convenience unsatisfactory while they think total delay caused by traffic jam is not satisfactory at all. Besides about integration with other modes and seating capacity bus travelers are moderately satisfied while train travelers consider it unsatisfactory, as at the train station always other modes are not available to reach destination and usually destinations are located at distant places from the station because of route inflexibility. And finally train travelers find seating capacity of trains not satisfactory at all as because of economic fare and less travel time people of all strata prefer train more over bus. But bus travelers are unsatisfied too with the seating capacity as so many times they have to travel standing (Table 6.22).

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So from the above comparative analysis of bus and train user's satisfaction level it is clear that the factors which affect the decision of choosing traveling mode are not at same satisfaction level for both modes. So for these factors, higher the satisfaction level the greater the possibility to use that mode. Thus while developing any of the modes the dissatisfactory factors need to be taken into account so that the efficient mode can be developed proficiently.

6.10 ANALYSIS OF PROBLEMS RELATED TO MODES:

Some of the problems observed are common to each of the modes while some of them are mode specific or in different intensity depending on modes. The average weight age is calculated using the principles of weighted mean where a higher number represents more problematic.

The acceptability index (Das 1998) will be calculated using the following formula-

$I= \sum(fW)/N$

I= Index of Performance (for a service attribute)

f = Frequency of the respondents giving the rating from lowest to highest

W= Weight of the rating from the lowest to the highest

N = Summation of the frequencies of the respondents = $\sum f$

6.10.1 Overcrowding: The common problem of both of the mode is overcrowding. All of the study routes except the Dhaka-Narayanganj bus routes have higher demand of passenger than the service capacity. As a result overloading and overcrowding is a common outcome.

Table 6.23: Weighted mean of Problems

Problems	Bus	Train
Inadequate Number of Bus/ Train	**3.26**	4.16
Over loading and Crowdedness	**4.12**	4.34
Long Travel Time	**4.44**	1.91
Long Waiting Time	**3.3**	2.85
Unpleasant Waiting Area	**2.79**	2.48
Excess Fare	**3.82**	1.73
Uncomfortable Journey	3.51	**3.7**
Problems of Ticketing System	**2.71**	2.16
Problems in Maintenance of Time Schedule / reliability	**3.33**	2.45
Problems related to Safety	3	**3.46**
Lack of facilities- toilets, lights, fans	2.52	**3.11**
Total Score	**36.8**	**32.35**

Source: Field Survey, 2013

6.10.2 Inadequate Number of Bus/ Train: For train inadequate number of trains is a problem of higher dissatisfaction level (>4).Most often commuters have to wait for the train more than 15 minutes (Table 6.23).

6.10.3 Safety and Comfort: Safety and comfort is a common problem with moderate dissatisfaction level. Safety issue is hindered by mugging, hijacking incident or vulnerability to accident (Table 6.23).

6.10.4 Fare, Time schedule and Travel Time: the dissatisfaction level is low for fare, time schedule and travel time. Compared to train bus passenger faces more problem for an excessive journey time. It is because train is more speedy travel mode than bus and is never subjected traffic congestion (Table 6.23).

6.10.5 Facilities: Bus has a higher dissatisfaction level than train except in lack of facilities.
If an overall scenario is considered train is claimed as less problematic for users as it has lower total score. Again users gives more importance in factors like travel time, travel cost and accessibility where train is in a far better position than bus. If the carrying capacity, scheduling and reliability are considered in the same time train is more recommended (Table 6.23).

6.11 ANALYSIS OF FINANCIAL ASPECTS:

6.11.1 Revenue per Kilometer per Day per Vehicle:

6.11.1.1 For Bus Routes:

- **Route- Dhaka to Joydevpur:**

  Revenue from a bus in Dhaka-Joydebpur route= No of trips per bus* carrying capacity*fare =4*40*55

  =8800 Tk/day/bus

  Average revenue per day per km per bus= 8800/33.3

  =264.26 Tk/km/day/bus

- **Route-Dhaka to Narayanganj via Signboard:**

  Revenue from a bus =4*55*30

  =6600 Tk/day/bus

  Average revenue per day per km per bus= 6600/17.4

  =379.31 Tk/km/day/bus

- **Route-Dhaka to Narayanganj via Doyaganj:**

  Revenue from a bus =4*41*30

  =4920 Tk/day/bus

  Average revenue per day per km per bus= 4920/17.92

  =274.55 Tk/km/day/bus

  Average revenue per day per km per bus for four routes=306.04 Tk/km/day/bus

6.11.1.2 For Train routes:

- **Route- Dhaka-Joydevpur:**

Revenue per day per train=fare* commuters carried (seating and standing)

= 10*560

=5600 Tk/day

- **Route- Dhaka to Narayanganj:**

Revenue per day per train=fare* commuters carried (seating and standing)

= 10*560

=5600 Tk/day

Average revenue per day per km per train= ((5600/38)+(5600/16))/2

=248.68 Tk/km/day/train

So, from above calculation it is observed that average revenue per bus per km per day is greater than average revenue per train per km per day (Field Survey, 2013).
So, bus has greater revenue earning potentiality.

6.11.2 Fuel Cost:

According to the information provided by Mr Toufiq Elahi Chowdhury, Assistant Engineer of Fuel and Locomotive department of Kamalapur Railway Station, "*For normal conventional trains' 120 liters diesel are required per trip. The railway authority procures the fuel at a cost of 67 TK per liter and 8040 Tk. Per day. For bus, fuel cost, lubricant cost, etc. per bus ranges from 1600 to 2800 taka per day.*"

Average fuel cost/km for rail is 333.60 Tk/km. Average fuel cost/km for bus is 58.79 - 102.56 Tk/km. So, in terms of fuel cost train is lagging in comparision to bus.

6.11.3. Route permit:

No route permit cost is required for train whereas it ranges from 7500-9000 Takas per year. So, train is in a financially benefitted in term of route permit cost.

6.12 TRAVEL DEMAND MEETING CAPABILITY OF BUS AND TRAIN:

6.12.1 Passenger Carrying Capacity and Passenger per kilometer:

Buses that are running on the selected have a capacity to within the range of 40-55 seats per bus. Whereas a single train carry passenger of 560. So, the carrying capacity of train is more than 10 times greater than the bus. So, a single train has better travel demand meeting capacity and provides more travel supply to the travel demand than a bus.

Passenger-km-hr is calculated by multiplying passenger capacity by hours travel and kilometer distance covered.

Passenger-km-hr=Passenger carried *travel time*kilometer distance covered

Passenger-km-hr for a train is 3.09 times greater than bus. This implies train can carry larger number of commuters within same journey time and covering same distances that of bus (Field Survey, 2013).

Table 6.24: Passenger -km of Bus and Train Services

Bus route	Passenger per trip by bus in a day	Average length(km)	Passenger-km	Average Travel Time	Passenger-km/hr/single mode
Dhaka-Joyudebpur	104	17.15	1713.6	1.65	2826.45
Dhaka-Narayanganj via Dayaganj	205	32.32	6625.6	1.38	9164
Dhaka-Naraynganj via Signboard	220	32.7	7194	1.83	13036
Average					**8343**
Train route					
Dhaka-Joyudebpur	1030	38	39140	1.0339531	39531
Dhaka-Narayanganj	1120	16.1	18032	0.67	12081
Average					**25806**

Source: Field Survey, 2013

6.13 ANALYSIS OF FACTORS GOVERNING REFUSAL OF SUBSTITUTE MODE:

In case of choosing any mode factors like total travel time, travel cost, accessibility etc. are usually considered by the user while for refusing any mode the mismatch of that factors becomes the causes of refusal of any mode. The factors of choosing any mode and the causes of refusing the other mode are in a direct relation but in reverse direction. They act like mirror images in choosing or refusing any mode. For example, people who consider travel cost as a determinant factor of choosing a particular mode will refuse the other mode for excess fare. According to the view of the users the average weight age of the importance of the causes affecting refusal of a mode is calculated using the principle of weighted mean where a lower number represents more importance as it was designed using rank order.

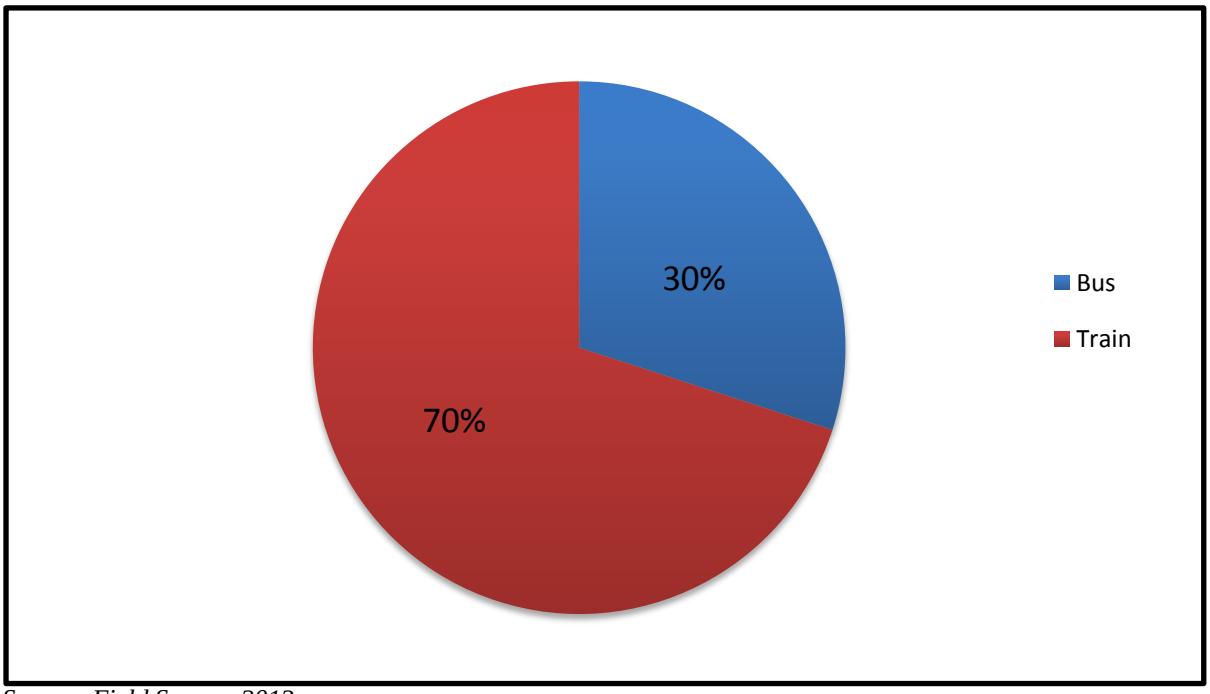
Table 6.25: Factors for refusal of Modes

Factors	Bus	Train	Overall
Increased Time (to avoid traffic congestion)	4.33	**2**	3.55
Excess fare	4.84	**2.08**	3.91
Lack of Maintenance of Proper Schedule	3.38	3.91	3.55
Uncomfortable Journey	3.15	4.52	3.6
Lack of Accessibily and integration with other modes	**1.89**	5.04	2.95
Safety	3.38	3.42	3.39

Source: Field Survey, 2013

Almost all of the causes have weighted rank value between 3.5 to 3.9. In case of increased time or increased travel time and fare for travel the users give much priority on them. It means train is chosen for its travel time savings and amount of fare while bus is refused in this case. Integration with other modes is an important factor in which bus is in a better position for choosing it and refusing train

6.14 RESPONDENTS' CHOICE OF MODE FOR GOVERNMENT INVESTMENT:



Source: Field Survey, 2013

Figure 6.18: Commuters preference for mode to be developed by government

Among the total people surveyed there were 66.67% bus commuters and the left were the commuters who reach the city centre using train. But among these both type of commuters from Figure 6.18 it is seen that 70% commuters think that the government should develop the

train service as an efficient mode of travel for the future convenience of commuter who travel for working purpose to city centre. Among the bus traveler was 56.23% prefer improvement of train service, and the rest 43.57% bus travelers think that bus is basically the best option for commuters if some problems can be solved (Field survey, 2013). These people who think bus service should be improved for the purpose of commuting to CBD consider the insufficient road capacity which causes long delay thus increased total travel time; inadequate seating capacity which causes discomfort and finally insufficient luggage capacity inside the bus are the major causes that they face in their day-to-day life. From figure 6.18, it is thus evident the about the above factors bus commuters' satisfaction level is very low(unsatisfied or not satisfied at all) They think if these interrelated problems can be solved then people would be more encouraged to use bus as they are more accessible, frequent, safe and regular commuting mode.

But majority of the commuters consider that the development in train service only can introduce the most efficient mode to the commuters. Around 95.7% of train travelers support the development of train service as they are economic, reaches stations without delay and convenient as a mode and around 50% of them are very satisfied (highly satisfied and satisfied) with these factors as considering them advantages over bus service (Field Survey, 2013). But still the rigid transport route reduces accessibility toward destination and sometimes the fixed route causes people to travel a certain distance to reach stations. Sometimes because of its less accessibility overall travel cost exceeds that of a bus traveler toward the same destination which takes a greater overall travel time.

Besides from user opin9ion survey it is found that toilet facility at the station and the seating capacity inside train is found to be very unsatisfactory to the commuters as a huge number of people get into train because of its economic fare. Thus in order to improve train service it is required to improve its capacity as well as accessibility. To increase accessibility new route design would be required. Thus if the accessibility and capacity problem can be solved then train can be introduced as the most efficient mode for commuters from outskirts of Dhaka city.

From the opinion of the commuters it is clear that, most of the commuters give preference on Train as a mode for commuting including those commuters who travel by Bus.

6.15 DECISION REGARDING EFFICIENT MODE:

In order to identify the efficient mode, it is necessary to weight the factors regarding its efficiency. In this study it "Unweighted 0-1 Factor Model" has been employed. It was not possible to apply Analytical Hierarchy process or Delphi method as no expert opinion was collected to weight the factors.

In the table 6.26, value 1has been assigned to the factors for which any mode is favorable for the commuters from the findings of field survey. Value 0 has been assigned to the factors for which any mode is unfavorable for the commuters from the findings of field survey.

Table 6.26: Identification of Efficient mode Based on "Unweighted 0-1 Factor Model"

Factors of Efficiency	Bus	Train
Operational Characteristics		
Travel Time	0	1
Travel Cost	0	1
Waiting Time	1	0
Delay	1	0
Speed	0	1
Accessibility and Integration		
Travel Time to reach station by walking and rickshaw	1	0
Travel cost to reach station by rickshaw	1	0
Productivity		
Passenger carrying capacity(Person/vehicle)	0	1
Passenger-km-hr	0	1
Financial Aspects		
Revenue per km per vehicle per day	1	0
Fuel Cost	1	0
Route permit	0	1
Service Quality		
Comfort	0	1
Convenience	0	1
Reliability	0	1

Frequency	1	0
Waiting Area	0	1
Ticketing System		
Waiting Time for ticket	0	1
Ticket Collection process	0	1
Total Score	**7**	**10**
Percentage	**41.17%**	**58.83%**

Source: Field Survey, 2013

From the table 6.26, it is observed that among the considered criteria bus is in a better state in 7 and train is in 10. So, train has better condition in 58.83% criteria and bus has better position in 41.17% criteria. So, in respect of the selected criteria train is a better transport mode for the commuters.

Chapter 07
Major Findings and Recommendation

In the data analysis chapter (Chapter 6), using different indicators and factors, the efficiency of the considered two modes bus and train is determined. From the whole analysis it is seen that each of the two modes is found efficient under some of the predefined factors.

7.1 MAJOR FINDINGS:

The major findings got from the whole analysis to find out the efficient mode are summarized here:

7.1.1 Travel Pattern and Travel Cost:

7.1.1.1Speed of Bus and Train:

The speed of train is greater than that of bus. This makes train a faster vehicle for the commuters. Train is in a better condition in respect of speedy movement than bus.

7.1.1.2Travel Time by Bus and Train:

Travel time taken for commuting by train is greater than travel time for bus. So, commuters can reach Dhaka quickly by using train. As train is speedier mode than bus and it is never subjected to delay (except due to mechanical problem) or traffic jam due to dedicated rights of way, so it can move faster and bring commuters to Dhaka earlier in comparison to bus. So, if we compare travel time by bus and train, train is a favorable mode for commuter's journey (Field Survey, 2013).

7.1.1.3 Waiting Time for Bus and Train:

Waiting time for bus is less than that of train. People are usually seen to wait for train for a long time. It is because interval between times to reach station of two trains on average is greater than difference of time (usually 10-15 minutes) between two consecutive buses reaching station. Greater waiting time for train makes bus a favorable mode for commuters (Field Survey 2013,).

7.1.1.4 Travel Cost of Bus and Train:

Average travel cost of train is less than that of travel cost of bus. Trains are provided by the government institution without any profit motive but in case of bus service there are many bus companies with profit. For this, the fare of buses is relative higher than that of train. So, commuters prefer train as it is cheaper than bus.

7.1.1.5 Delay Time:

As the train is not subjected to traffic congestion, it rarely faces any delay. So, train is favorable for commuters as it does not face delay.

7.1.1.6 Overall Comparative Scenario between Bus and Train:

It has been identified in this study before commuters emphasizes more on travel time and travel cost than any other factors. From this view point, train is a favorable mode for commuters, train has better operational characteristics in terms of travel time and travel cost.

7.1.2 Accessibility and Modal Integration:

7.1.2.1 Travel Time to Reach Bus and Train Station:

Travel time to reach rail station with is higher than that of bus station for both who have access to station by walk and rickshaw. Travel time to reach the train station is greater because numbers of train station are less than numbers of bus stations. So, it can be interpreted that distance between two consecutive train stops are greater than bus stations. So, commuters have to travel more distance to reach train station which increase travel time. In terms of travel time to reach station is bus is in a advantageous position than train.

7.1.2.2 Travel Cost to Reach Bus and Train Station:

Travel cost to reach rail station with is higher than that of bus station for both who have access to station by rickshaw. It is because commuters have to pay more fare to the rickshaw puller as they have to travel greater distance than bus which increases the travel fare to be paid for the journey by the rickshaw to reach station. In terms of travel cost to reach station bus is in a better position than train.

7.1.2.3 Overall Comparative Scenario between Bus and Train:

Comparing accessibility and modal integration with bus and train stations with respect to travel time and cost, bus is a better mode than train.

7.1.3 Productivity of Bus and Train:

7.1.3.1 Carrying Capacity (passenger-vehicle) and Travel Supply:

Carrying capacity of the train is very much greater than the bus. So, travel supply of a train is larger than a bus. So, train is in a better capacity to meet the travel demand than bus.

7.1.3.2 Passenger-km-hr:

Passenger-km-hr is larger for train than that of bus. So, train can meet the travel demand of the larger numbers of people within same travel distance by serving a certain time period than that of a bus with same distance (origin and destination of same distance of train) for the same time period.

7.1.3.3 Overall Comparative Scenario between Bus and Train:

As train can ensure greater travel supply than bus and can meet more travel demand. So, train is better than bus in the aspect of productivity.

7.1.4 Ticketing System:

7.1.4.1 Process of Collection:

Process of collection of ticket of train is more satisfactory than bus.

7.1.4.2 Waiting Time in Ticket Counter:

Waiting time for getting ticket is also less for train than bus.

7.1.4.3 Overall Comparative Scenario between Bus and Train:

Train has a better ticketing system than bus.

7.1.5 Financial Aspect of Bus and Train Service Operation:

7.1.5.1 Revenue per Km for a Bus and Train:

Bus has greater revenue per km than train has. It implies earning from bus sector is greater than train. But however as train has greater passenger carrying capacity than bus, thus train is lagging behind in this aspect because interval between two consecutive train (1-1.5 hours) arrivals at station is greater than that of bus (10-15 minutes). This low frequency is hindering the revenue earning potentiality of train.

7.1.5.2 Fuel Cost:

Fuel cost for bus is less than that of train. So, bus is in a winning position than train in fuel cost.

7.1.5.3 Route Permit Cost:

As there is no route cost for train, in this case train has a financial benefit over bus.

7.1.5.4 Overall Comparative Scenario between Bus and Train:

Bus is in a better position in financial aspects than train.

7.1.6 Service Quality:

7.1.6.1 Comfort and Convenience:

For comfort and convenience factors like overcrowding, toilet and other facility, bus service is in a better state than train.

7.1.6.2 Reliability:

In terms of reliability, train is in a winning position over bus.

7.1.6.3 Frequency:

In case of frequency train is lagging behind than bus as time interval between two consecutive buses are smaller than train.

7.1.6.4 Waiting Area:

The waiting area of bus station is in a poor state than that of train station.

7.1.6.5 Overall Comparative Scenario between Bus and Train:

If total score of existing problematic conditions of various factors related to service quality is calculated, then train is in a better position than bus.

7.1.7 Final Decision Taken Regarding Efficient Mode:

As train has better score in majority of the mode efficiency indicators so train is the efficient mode for the commuters travel to Dhaka city.

7.8 RECOMMENDATION:

As train is found the efficient mode between bus and train for Dhaka to Narayanganj and Dhaka to Gazipur route the following recommendations will be helpful for reducing the existing problem, increasing efficiency and making it advanced in future.

- Train fare structure can be reviewed and be more subsidized to make it more affordable to people. In this case efficient fuel system can be a major help. The amount of revenue can be increased by providing more bus service to passengers.
- Time schedule of train should be maintained properly. The delay time for line exchange can be reduced through proper maintenance. The delay for changing direction of movement can be reduced by introducing trains with engine at both ends. Time schedule can be reviewed to increase the number of trips.
- The overall seating arrangement standard, quality and regular cleaning may induce people to use train.
- The inside environment of trains, platform and stations should be improved accordingly.
- Private investment should be encouraged to introduce new trains, to take the ledge of any route or to provide facilities.
- Train is deficient in case of integration with other modes. By introducing an integrated efficient modal system transport planning and multi modal integration can sort out the problem. Transit stations should be integrated with rail stations.
- Loading and unloading of passengers and goods should be operated with safety.
- If government has adequate fund to invest, then they can introduce a new rail route in a more effective way.

From the above findings, it is observed that for majority of the services to commuters train provides better service than bus does. Though bus becomes better in terms of some factors, but from the overall consideration of significant factors it is visible that train is the efficient mode for commuter living outside Dhaka. If the above recommendations which are based on the analysis and major findings can be applied, the train services will be more improved in terms of service facilities and the other factors which are responsible for modal choice of commuters.

Chapter 08
Conclusion

Commuters contribute to the economy of a country not only by playing significant role in economic activities but also by adding revenue in its transport sector. Thus it is a vital issue to solve the transport problem of travelers who commute to the Central Business District every day. In this study the focus is to find out the efficient commuting mode between bus and train for the outskirt people of Dhaka city, who basically come from Joydevpur and Narayanganj. From the study by analyzing a number of related and very significant factors to take modal choice decision, it has been determined that train is the most efficient mode. Train is considered as the better option because of its economic fare, journey without delay thus less travel time and many other reasons. But still rail service lacks excellencies in many services like accessibility, comfort, seating capacity, safety etc. which induce a major portion of the commuter to use bus service. So to achieve the goal of the study it can be recommended that the government should introduce more trains to provide better service and also need to enhance the quality of service so that people from all strata of life can enjoy the rail service daily. Thus if the transport problems of commuters can be solved by introducing an efficient rail services to the commuters then not only their travel problem will be solved but also it will help to reduce pressure on traffic in Dhaka city. In order to ensure a better living standard of the people who were previously compelled to live in the city centre and make their traveling joyful and hassle free, train service should be improved immediately.

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