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Integration of Transportation Systems for a Sustainable Growth of Urban Transportation System in Indian Cities

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Abstract—*Urban Sprawling always have had a direct impact on intra-urban, sub-urban and inter-urban mobility. A city can function efficiently if both people and goods are transported through optimal utilization of transport systems, infrastructure and services at minimal investment and operating cost. Passenger mobility is predominantly based on road and rail based transport. This paper deals with integration of various public transportation modes, identification of passenger's behaviors and route planning with the help of Geographical Information System (GIS) and developing a smart transportation network across the city. The case study of Bopal area of Ahmedabad has been included for integrating transportation system. The smart transportation planning will ultimately result in sustainable transportation system.*

Keywords: *GIS, urban infrastructure, public transportation integration*

1. INTRODUCTION

For many decades public transport has been subordinated in the policy priorities of dispersed cities in developing nations. But public transport is increasingly recognized as a crucial component of a sustainable and functional city. Long term neglect has left urban public transport networks in such cities suffering from poor service quality marked by weakly integrated services with limited capacity to serve a wide array of potential customer travel demands. Much contemporary planning theory holds that land-use is the determinant of public transport use such that improvements to public transport services will fail on patronage and financial criteria unless they are paired with extensive changes to adjacent land-uses. The result is that many existing dispersed contexts, especially those found in the extensive suburban realms of such cities are not receiving the requisite improvements in services that could assist them to overcome their current levels of car dependence and the sustainability, climate and resource deficits this dependence implies.

In contrast a new literature has emerged over the past decade which demonstrates that public transport can provide a well patronized and financially sustainable service within suburban contexts without relying on land-use changes. However by considering the daily increment in environmental emission, specifically air pollution produced by vehicles, and the limitation of natural resources, it is obvious that increasing of car-based trips is a critical threat to the global environment. In addition, the congestion is a big issue in urban areas which negatively affects the people's lives in different aspects. With this in mind, the improvement of public transport systems, as a sustainable alternative to car-based trips, is becoming more and more crucial amongst decision makers. Although there is a wide range of factors which affect the performance of public transport systems, 'integration' is considered as a key factor that can make the public transport as a competitive alternatives to private cars.

This paper presents the concept of integration in public transport systems by exploring the associated literature and investigates its different aspects and levels.

2. MOBILITY PATTERNS IN INDIAN CITIES

Early Indian cities were designed for walk, bicycles, cycle rickshaws and public transport (bus). Gradually, road based transport in cities became saturated and was not able to cope with the increasing Transport demand. Further, a single mode of transport is neither viable nor economical and efficient due to extension and expansion of city boundaries, ¡n a linear city like Mumbai, and a ring and radial city like Delhi, the normal trip length from home to work may be 25-30 km or more, whereas in a relatively compact city like Chennai or Hyderabad such a trip length may be 15-20 km or more. Similarly, a typical home to work trip for a male office goer in Mumbai from a northern residential suburb to the Central

business District (CBD) in the southern part may comprise the following modes:

1) Home to Intermediate ParaTransit(IPT) Stand by walk
2) IPT stand to suburban railway station by IPT mood
3) Railway station to CBD by suburban rail and
4) CBD to office by walk

In the return direction however, the suburban railway station to home trip may be performed by bus on account of time availability, cost, and the need to shop for daily essential in the vicinity of the suburban railway station. For a female office goer performing the same trip, the home to bus stop trip may be performed by walk and upto suburban railway station by bus on account of cost and security issues.

A typical student trip from a home (south Delhi) to the university campus (north Delhi) may be performed as follows:
1) Home to bus stop by walk
2) Bus stop to metro station by feeder bus
3) Metro station to university station by Delhi metro
4) University station to college/ department by walk primarily on account of cost considerations.

Based on these facts, the mobility by the public transport is supplemented and complimented by non-motorized, intermediate para transit and feeder modes which enable performing a complete trip from origin to destination depending on time cost, weather conditions and the level of comfort desired. In this context, integration and improvements with the broader objectives of efficient mobility, has multi-dimensional effects for value additions to public transport.

3. CONCEPT OF INTEGRATED AND IMPROVED PUBLIC TRANSPORT

A study on "Traffic and Transportation" conducted byM/S Wilbur Smith Associates across 30 cities in India shows that the public transport share has decreased from 78% (1994) to 54% (2007) in cities having 8 million plus population. The average journey speed has reduced to 17 kmph (2007) which will further reduce to 6 kmph by 2031, if corrective steps are not taken. Therefore, the share of public transport needs to be improved to promote for environmental and sustainable transport in Indian cities. The concept of integration is defined as measures for improving the overall quality of services to the commuters which attracts more people to use public transport. The integrated system through modal, physical, and network, institutional and financial integration as a whole provides seamless journey to the commuter.

An integrated public transport system also needs improvement in demand and supply side management measures. A commuter while choosing a bus route/metro corridor prefers minimum travel time, maximum comfort and proper connections to reach the desired destination and ensure all safety and security. The options may be either a direct bus route from origin to destination or integrated route comprising both metro and bus. Commuters always prefers a route and mode which connects the destination directly and completely. Commuters may prefer metro if the trip requires minimum effort for interchange and shorter travel time and provides maximum comfort, even if its composite fare is high. An integrated public transport connects education, health, housing sector, etc. to achieve harmonious and Inclusive society. Public transport not only provides accessibility to school going children, patients and disabled persons but also promotes development along the transit corridor. In fact, it enhances the socio-economic characteristics of the areas served.

Public transport requires improvements in terms of reliability and attractiveness so that the commuter shifts to public transport. It should also meet the needs of the weaker sections of the society by providing affordable fare and covering outskirts of the city. Further, public transport should be available from origin to destination with the least transfer options.

3.1 Objective of integration in public transport

The public transportation integration is aimed to increase the ridership of public transport systems in competition with private cars. Hence, it should be noted that integration is not a target by itself and implementation of it is not an end. In contrast integration is a package of policies and activities that can improve public transportation system connectivity and reliability and make it more attractive travel alternative to the cars.

3.2 Aspects of integration in public transportation system

There is a variety of measures and practices to increase the integration within and amongst public transport systems. However, these measures and activities can be classified into five broad categories as follow:

3.2.1 Physical integration: The close and ease of access at mode interchanges can enhance public transport services significantly. This not only includes the physical connections between public transport modes but alsorefers to the connectivity of public transport modes and areas surrounding the stations and stops. As every trip begins and ends on foot, walking should be appropriately integrated as one of the transport modes to the public transport systems. In this term, interchanges between transport modes are where the most barriers exist.

Therefore, the main aim in this case is to minimize the obstaclesrelated to the transfers. Walkways should be carefully designed to facilitate the transfer of passengersfrom one mode to another [2]. Facilitating of transferring between modes by reducing the walkingdistances and providing well-designed ramps and stairs can guarantee ease and safety of transfersamongst modes.

3.2.2Network integration: Generally, public transport services are more attractive when they are given over a comprehensivenetwork. Network integration is often interpreted as the formation of a structure where performs a specific role in the system, making use of its relative benefits. This concept is also referred to thecoordination and the links between long-distance public transport networks and local public transport networks. Based on this principle, the various modes have to be utilized according to their relative advantages by accumulating streams of passengers to higher ranking modes, like railway systems.

Moreover, it plays as important role at the service planning stage, which consists of route and timetable design, by ensuring that services provide attractive 'connection' to each other in both terms of time and transfer conditions. Therefore, this aspect is classified to the integration of route network and timetable (scheduling).

3.2.3 Fare integration: This aspect of integration is simply referred to use a single fare ticket or card for multiple services which facilitates the transfer between modes. The two distinct issues of tariff and ticket integration are often considered as almost the same to the concept of integration itself. In fact, ticketing integrationand fare integration are meant to facilitate traveling from the view of passengers. In other words, it is to remove the obstacles of using different services, such as different prices between similar journeys provided by a single of multiple operators or the different ticket types between two or more transport modes.

3.2.4. Information integration: A comprehensive. Easy-to-use passenger travel guide is a critical element of a successful multi modal travel. Stations and stops are decision making points over the public transport networks. Therefore, the signage should be appropriately designed at bus and rail stations to convey effective information to passengers.

Information Technology (IT) and Intelligent Transport Systems (ITS) can playimportant roles in this aspect of integration by providing clear, brief and timely information. Theinformation should be clear, brief and timely. Furthermore, giving special attention to the elderly and the disable is a key point in terms of information integration.

3.2.5 Institutional integration: Although the operational integration in public transport, like integration of fares, informationand services and infrastructure, have always been crucial, a further form of integration is required tofacilitate and guarantee implementation of other integration aspects. This form is directly relevantto strategy formulation. Institutional integration, which is sometimes entitled 'wider integration',considerably affects other aspects of integration mentioned in the previous points. This is involved intwo main issues. At the lower level, it means the integration of public transport systems in their own right; between different modes and operators; and also with other transport systems (e.g. private cars,taxis. cycling and walking), at the stages of investment, service planning and operation. At the higher level, it is referred to the integration with other policy frameworks which are associated with transport policies, including urban planning, environmental policies and social systems (e.g. health, social services and educational systems).

A common institutional framework is the key instrument land-use planning, travel demand management and integrated public transport services. This integration is vitally important to improve the cooperation and coordination amongst authorities /governmental agencies and public transportsectors and also between private and public operators. Such integration can occur in four extensive ways:

- Integration between policy instruments involving different modes
- Integration between policy instruments involving infrastructure provision, management, information and pricing
- Integration between transport measures and land use planning policies.

3.3 Integration Effects

There has been an increasing recognition over the past two decades that public transport operates most successfully when it is planned as a unified network to provide seamless multi-destination travel rather than individual lines that only serve single trips. The planning of public transport systems as seamless integrated networksrather than as a series of individual routes is critical in order to enable these systems to compete withprivate cars and attract as car users as possible.

4. CASE STUDY: INTEGRATED ROUTE PLANNING OF BOPAL AREA

4.1 Introduction

Bopal is a satellite town residing in the outskirts of Ahmedabad city of Gujarat state, India. It is a part of rural Ahmedabad in DaskroiTaluka.

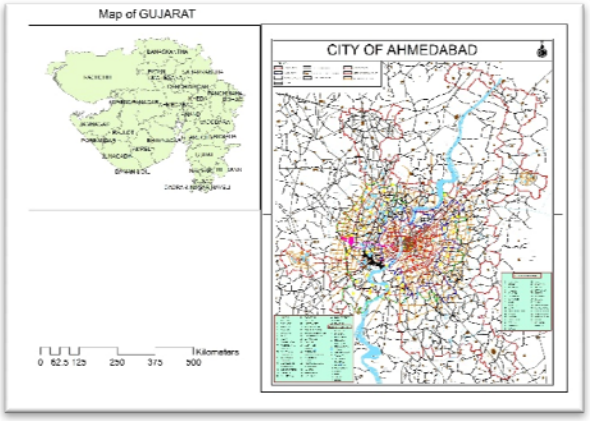

Fig. 4.1

Based on the census 2001, Bopal consist of 12,181 population, of which 53% constitute male and 47% female. Bopal has seen average literacy rate of 80%, higher than the national average literacy rate i.e. 59.5%.

In last few years, Bopal has seen a vast growth of development in all sector. As the population has increased, the need of new and improved facilities have increased. To fulfill them, all possible infrastructure development has been take care of like Proper drainage system, water supply line, roadways etc.

Bopal area consist of many schools and institutions mainly engineering college, which almost comprises of few thousand students on an average. Since, higher number of student, higher number of vehicles (irrespective of mode of transport), and therefore heavy traffic during the peak time i.e. 9:00 AM& 5:00 PM.

To overcome this traffic, AUDA has declared a flyover to be built near S.P Ring road at bopal cross road and a BRTS route from Bopal to Sun City. These two solution will help to ease the traffic congestion.

4.2 Need for Planned Route

Bopal is a new developing area in the town, it lies near about 15 km away from the center of the city, this distance consist of inner roads which cannot handle the traffic flow, to simplify this and to connect the city few more new roads are needed to be defined.

Bopal is around 3 km to Ambli, 6 km to Ramdevnagar& 7 km to Prahladnagar.These nearby towns are the population concerned town with maximum employees and students, so a connectivity of centre of the city and bopal via these towns will not only help distributing the traffic but also will help linking these parts of city too.

Nehrunagar being the host of the traffic distribution residing in the new city or the west part of city, is the best destination for the new route. Nehrunagar distributes the traffic toward four direction i.e

1) toward old city(railway station)
2) toward Anjali
3) towards university road
4) towards S.G Ring road.

4.3 New Integrated Planned Route

A planned route from bopal to nehrunagar will help us achieve a conjestion free environment.

The distance between Bopal and Nehrunagar is approximately 10km, which takes average of 20 mins to 45 mins depending upon the traffic. This route normally comprise of vikramnagar, satellite and bimannagar.

We have proposed two route:

4.3.1 Route-1: Bopal-Prahladnagar-Nehrunagar

Bopal to Prahladnagar, the distance is roughly 7 km and distance between Prahladnagar and nehrunagar is 3 km, with the average of distance 10 km from Bopal to Nehrunagar, the distance is almost the same as of the old route, but the most important difference is the junction across this route and the time consumed is less.

This route consist of Bopal-Ambli-Prahladnagar-Nehrunagar. The fig. 4.2 shows the map of the proposed route-1

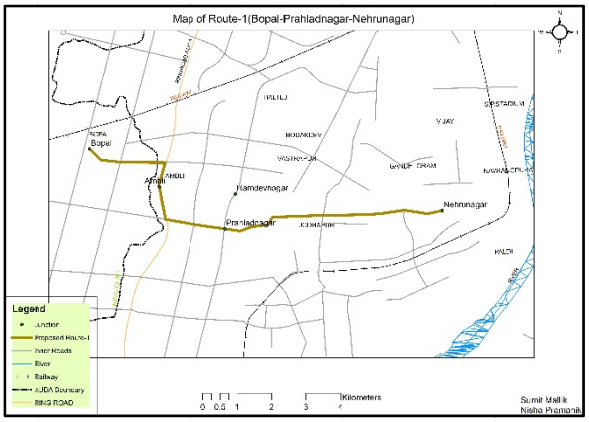

Fig 4.2

4.3.2 Route-2: Bopal-Ramdevnagar-Nehrunagar

Same as the Route-1, the distance between Bopal and ramdevnagar is 6 km and distance between Ramdevnagar and Nehrunagar is 3 Km. Thus the distance between Bopal to Nehrunagar via Shivranjni is near about 9 km.

This route not only show the decrease in distance but also time consumption will be less.

This route will comprise of Bopal-Ambli-Ramdevnagar-Shivranjni-Nehrunagar

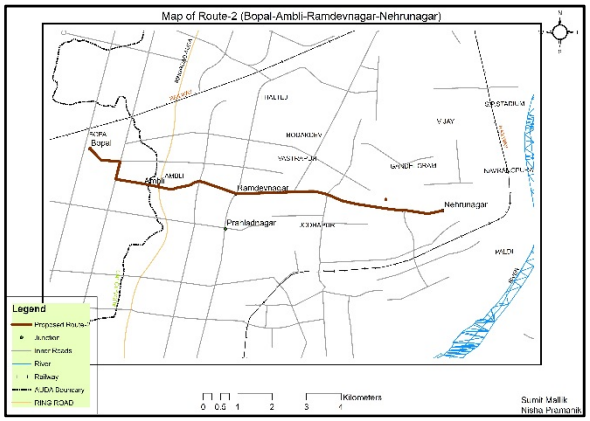

Fig 4.3

5. CONCLUSION

From the literature review and present studies of Indian cities, it can be concluded that provision of infrastructure facility alone cannot be the solution of transport problems faced across Indian cities, hence in order to cater the huge traffic growth, systematic planned and integrated transportation system has to be provided. Through the case study, an attempt of GIS based transportation planning is done which results in two most likely route connecting bopal and nehrunagar area of Ahmedabad. This routes will incorporate the integration of public transportation be it BRTS or municipal bus services. Hence we have attempted to plan and integrate the public transportation route.

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