BUS RAPID TRANSIT SYSTEM CASE STUDIES

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Abstract - This paper attempts to review the implementation of BRTS in cities in India, also examining Janmarg: Ahmedabad's BRTS. The goal of the work is to consider the growing demand for urban public transport that several cities in India are addressing, and discuss the needs, advantages and limitations, and obstacles for establishing a rapid transit system and its development in a country like India. We have also analysed some BRTS routes and have come up with significant improvisations that could make the system more efficient for the passangers. We also discussed various innovations related to BRTS in India, and provided with the most suitable design features and some suggestions from past experiences to ensure passenger safety.

Keywords: BRTS, urban, public transport, rapid transit, design features, passanger safety,

1.INTRODUCTION

Bus Rapid Transit System is a pioneering, high-capability, affordable public transportation solution that can suggestively improve urban transportation. Implementing BRTS by creating isolated bus lanes and redesigning intersections can reduce conflicts between buses and other motorized traffic, and significantly reduce the number of bus and other motor vehicle accidents and fatalities.In addition to reducing accidents, during peak travel periods, dedicated bus lanes carry more people than adjacent public lanes. This report analyzes the status of some approved BRT projects in Indian cities and their features . In this study, data for all cities were collected from different sources, such as the websites of local authorities, organizations participating in the project, published reports and studies, and media impressions.

2. LITERATURE REVIEW

1. Levinson et al. (2003) reported that users still want the system to be easily accessible, highly reliable, fast, comfortable and secure.

2. Project TCRP A-23 (2006): stated that BRT is a flexible, pneumatic rapid transportation method that combines stations, vehicles, services, operating methods and ITS elements in a strong positive image and identity.

3. Liu et al (2007) : discussed the benefits of BRT dedicated lanes, analyzed the changes in vehicle passing capacity and passenger carrying capacity

4. Study of Bus Rapid Transit system In Respect to Growing Cities of India1 Ajay Mishra, 2 Saxena Anil Kumar, 3 Purohit Pradeep (2013)This paper has reviewed and summarized the infrastructural and operational features of Bus Rapid Transit

3.INSTITUTIONAL STRUCTURE OF BRTS IN INDIA

With the exception of the Delhi BRT, all systems are funded by JnNURM, where support from the center is 50% and support from municipalities is 20%. SPV (Special Purpose Vehicle) is also planned for Ahmedabad, Indore, Pune and Jaipur. BRTs in 9 out of 10 cities are being developed under the Jawaharlal Nehru National Urban Renewal Mission.

4. SYSTEM RELIABILITY

Travel Time Reliability is a function of travel time variation . Measuring TT Variation also gives you ideas for TTR.Various reliability according to travel time: *Coefficient of Variation (Cv), 95 Percentile or Planned Time, T90-T10, λ var, λ Skew, Buffer Time Indicator*, *Planned Time Index*

These measures are used to improve Regional Transport Planning

5. AHMEDABAD BRTS

Ahmedabad is having a population of 55 lakhs approx and its decade growth is 20%.The total length of the network is 82km.

The initially executed passageway of Phase-I from RTO to Chandranagar was spread out on the internal ring street in the western piece of the city, which had a current street width of 40 m and sensible traffic volumes of 3,000-6,000 PCU (Passenger Car Unit) on the vast majority of the stretch and 6,000- 9,000 PCU somewhere else.

Partial ring and radial trunk BRT Network Type

Route No.	Routes names	Length of route(km)
1	Narol to Naroda	13.8
2	Anjali to Naroda	19.1
3	RTO to Naroda	9.74
4	Maninagar to Iskon	12.1
5	Ajithmil to SP ring road	4.16
6	SLP to science city	9.84
7	Maninagar to Visat	22

Table -1: Study Routes of Janmarg

Travel Time Reliability Analysis of Janmarg Routes

The statistical range and TTR measurements for each BRT paths of Janmarg were calculated. The coefficient of variation (Cv) value during the non-peak hours of Route 3 can be observed to have low .TTV and large fluctuation in path 5. High values for the planned time (95th percentile) were observed at the peak of Path 3 at 13.7 minutes / km. On the other hand, route 2 was observed with a shorter planning time, which is 2.9 min/km. PTI (planned time index) was observed to be high at both peak and non-peak times of Route 1which is 1.60 This shows that, at its peak, passengers need to plan 60% more travel time than their normal travel time to secure 95% of their arrival time. BTI values (buffer time index) are the highest of 0.60 and the minimum BTI value of 0.04 was observed at the highest level at the peak time of the routes 1 and the route 3. A BTI value of 0.60 indicates the need to reserve an additional 18 minutes of buffer time for an average peak trip of 30 minutes to ensure passengers arrive on time. λvar shows the highest value outside the peak time zone of Route 5. The highest λskew value, which means the probability of a heavy travel time, is observed during non-peak hours on Route 2. λvar shows the highest value outside the peak time zone of Route 5, which means that the width of the travel time distribution of the same path is as follows. It was the highest time, not the peak equated to other routes. Factor values for T90-T10 were observed highest during peak hours on Route 3. This means that the spreading is the highest on this route and has the lowest Travel Time Reliability

6. AMRITSAR BRTS

Amritsar is having a population of 11 lakhs approx and daily passangers are 60000.The total length of the network is 31 km.

Key features : Auto opening doors, Dedicated Lanes for Vendors that do not hinder BRTS, Overhead bridges for pedastrians , lane network

Corridor Name	Corridor length (km)
Atari Road	12
Jalandhar Road	6
Verka Road	13

Indicator	Value	Date
GDP per capita (US$)	1,942	2017
Population, city	1,132,761	2011
Population, metro area	1,183,705	2011
Population density, metropolitan area	6,700	2011
Modal split % public transport	26,7	2011
Modal split % private transport	32,5	2011
Modal split % non motorized	40,4	2011
System name	Amritsar Metro bus	
Corridors	3	2019
Year system commenced	2019	
Transit agency	Punjab Infrastructure Development Board	

Table -2: System Indicators of Amritsar BRTS

7. RAINBOW BRTS (PUNE-PRIMPI-CHINCHWAD)

Pune is having a population of 48 lakhs approx and daily passangers are 67000.The total length of the network is 29 km.

Network type is Grid Pattern

Cross Sectional Characteristics of Pune BRTS

45.5 M ROW
Type-median two way mid block
1.07 M-pedestrian pathway I
1.80 M-pedestrian pathway II
2.50 M-cycle track
4.50 M-service lane
3.3 M-BRT lane
0.75 M-separator I
0.30 M-separator II
0.75 M-separator III
6.75 M-mix traffic carriageway

Why Pune Rainbow BRTS Failed?

13 years after the Bus Rapid Transit System (BRTS) was launched in December 2006, the Bus Rapid Transit System (BRTS) was stopped as city police opened corridors built exclusively for buses for all vehicular traffic. When the project started, it was advertised as the first BRTS in the country. However, both Pune Municipal Corporation (PMC)

and Pune Mahanagaru Pariva Port Mahamadaru Corporation (PMPML) are issuing anti-aircraft guns as they have not been able to operate smoothly. . Police argued that it would be difficult to negotiate narrow road sections due to the presence of BRTS as urban traffic increased. "BRTS will not work until Metro work progresses. This is done to keep commuters safe and avoid traffic jams," K Venkatesham, the police chief, told The Indian Expres. "BRTS has completely failed in Pune City. PMC cannot provide adequate infrastructure, but PMMML cannot provide quality bus frequent service, well-trained staff," says Prashant Inamdar, organizer of Pedestrians First. He said that close to 1.5 billion rupees was spent on the BRTS, but in Pune the project may have been blocked.

7. BHOPAL BRTS (MY BUS - INDIA)

Bhopal is having a population of 18 lakhs approx and daily passangers are 77000.The total length of the network is 24 km.

Trunk with Feeder Network type

Innovative Measures

Advertisement on BCLL buses as well as bus stops, LED panels inside the buses, Subsidized smart passes known as "Mahapor Smart Pass" ,Advertisement on ticket rolls.

Bus priority signaling system

There are generally two types of signaling systems.

• Manual traffic signal priority

.• Active traffic signal priority

BRTS Bhopal has proposed the installation of an active bus priority signaling system. The signal is synchronized with the sensor and overrides the BRTS bus.

Operating Corridors

1. Corridor -1 : Bairaga - Misroddo - (23 KM)
2. Corridor -2: Roshanpura-ORR (14 KM)
3. Corridor -3: Board Office - Reysen Road (2.94KM)
4. Corridor -4: Barato Tariki-Tamodul Mass Masjid (3.33KM)

8. INDORE BRTS

Indore is having a population of 19 lakhs approx and daily passangers are 45000.The total length of the network is 11 km.

Partial ring and radial pattern with diametrical lines

Traffic Characteristics During Rush Hours (Data Collection & Analysis)

It is observed that the traffic volume of different intersections ranges from 80,500 PCU (117,170 vehicles) in Palasia to 63000 PCU`s (83191 vehicles) in Vijay Nagar.The morning rush hour traffic was from 7000 PCU in Palasia to 5600 PCU in Vijay nagar and the flow in afternoon rush hour changed from 7750 PCU in Palasia ro to 5850 PCU in Vijay nagar. The morning peak is from 10:00 to 11:30, and the afternoon peak is from 18:30 to 20:30.

9. RECOMMENDATIONS AND DESIGNINGS

Introducing a multi-utility (MU) strip

This is a strip on each side of the road that can be used to accommodate all unrelated road elements.The MU band has an additional advantage; It can adjust according to the different width of the line. The Multi Utility band width is chosen as 3 meters. The MU strip height varies between 0 and 0.15 m. When functioning as a traffic lane kerb edge, the height of the MU strip will be 0.15 m

Footpath: We recommend a minimum footpath width of 3.2 m for an urban corridor with extensive edge development..The recommended footpath kerb height is 0.12 m

Divider : A divider of minimum 0.5 meters width is recommended to be placed between the mixed traffic lanes and the BRT lane.

BRT Lane : BRT Lane selection is recommended to be 3.5 meters wide. This is consistent with the width of the world's BRT lanes.

Pedestrian crossing signals: Assuming a walking speed of 1.2 m per second, you can cross 32 meters of a crosswalk in about 27 seconds. Also 3 seconds is added because the pedestrian's movement is slow taking into account the pedestrian's reaction time.

Signal Plan : It is recommended to signal every U-turn . According to our research, a right turn without a traffic light across the BRT lane is very dangerous. Any lateral movement across the BRT lane must be signaled.

Signal Timing Design: The pedestrian delay formula is listed below

$$dp = \frac{C - g_{walk,mi}}{2C}$$

Where d_p is pedestrian delay, C is the cycle length, and $g_{walk,mi}$ is the effective walk time for pedestrians (generally calculated as the length of the green phase plus four, all measured in seconds.

Station Capacity For Centre Lane Corridors

We developed four different scenarios for estimating station capacity.

Scenario 1*: Single lane BRT with one platform per station per direction and no overtaking lanes or convoying (Janmarg BRT, Ahmedabad)*

Scenario 2*: Single lane BRT with two platforms per station per direction and use of convoys without coordinated*

dispatch, and different services in each platform (Delhi Busway)

***Scenario 3**: Single lane BRT with one platform per station per direction, with express services and overtaking lanes*

***Scenario 4**: (High capacity) BRT with two sub- stops per station, two platforms per sub-stop, and overtaking lanes.*

10. CONCLUSION

Janmarg has a total of 127 stations, which is the maximum number of stations in India's urban BRT system. BRTS stop spacings are 525-710 meters for all systems.In the context of regulation, India has adopted major reforms by establishing SPV companies in several cities. It was observed that Ahmedabad has the highest average operating speeds whereas Delhi has the lowest when assessing the operating characteristics of the system. Bhopal BRTS has the lowest frequency.BRTS Reliability measures are majorly divided into three categories i.e. waiting time, headway regularity and TT Reliability measure. Out of these measure Travel Time Reliability measures were used in this study.

SUGGESTIONS FOR IMPLEMENTATION IN FUTURE

1. Street Vendors inclusion in the BRTS system so that future problem like in the case of Ahmedabad BRTS does not arise.
2. Proper planning and research of the nature of city must be done prior to the selection of type of BRTS i.e. Open or Closed. The open BRT was the main reason for the failure of BRT in Delhi.
3. Coordination must be maintained with the Metro Transit System of the city.
4. Fares should be decided in accordance with the other small public transports systems like Tempo, rickshaws
5. A Mobile application should be developed for the tracking of bus location for the convenience of the passangers.
6. Like Bhopal BRTS special emphasis on the signalling systems should be laid as they yield very good results in accident reduction.
7. Elevated Bus Stands at intersections with heavy traffic could be considered for designing.
8. E-ticketing technology from the mobile app can be implemented easily.

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