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Effect of BRTS on NMT users in Ahmedabad

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Abstract: ***The transit systems being developed up and about all over the country, has multidimensional impacts on economic, environmental and sociological aspects. A perfect transit system would be the one which can bring more people out of their cars to the transit system and which is more equitable, affordable and environmentally friendly. Research is about the BRTS system in Ahmedabad and how much it has affected the way people travel, in short, the mode choice changes that have occurred before and after the BRTS have been analyzed and inferred. The changes for NMT users, who are most vulnerable among all mode users, especially in a city like Ahmedabad, was studied. Random sampling was done for a sample size of 130. The survey was done to know the shifts made by the road users and the reasons for the shifts and the issues they face using stated preference and revealed preference survey.***

Keywords: mode choice, Non-motorized-transit users, BRTS, mobility, mass transit

1. Introduction

India has seen rapid urbanization in the past two decades along with changes in urban structure land prices, increasing migration and widespread technology dualism, especially in the sectors of transport and industry. This has caused a spur in motorized travel demand. (Kumar, Agarwal, & Zimmerman, 2011)The public transport system which is an essential mode of transport for a large section of the population in developing cities has also taken new forms. Its importance is even more significant in third world cities like Ahmedabad, which are characterised by rapid transit demand, poor transport capacities, widespread road congestion, air pollution exceeding the norms and a large proportion of the disadvantaged section especially the urban poor. (Munshi & Dijst, 2004)

The most commonly adopted strategies to mitigate these problems worldwide are improving public and non-motorized transport through a variety of management and operations strategies and infrastructure investments, as well as traffic management. National Urban Transport Policy document suggests the improvement of PT facilities by introducing more efficient PT systems like BRTS, Metro, Mono Rail Etc. and encouraging NMT usage in every city by providing dedicated lanes and NMT plans.

Bus Rapid Transport System, mostly famous in Latin American cities has made its entry in India in 2009 July at Ahmedabad, Gujarat. BRTS is conceived as an integrated system, which includes affordable transport along with infrastructure for pedestrians and cyclists and changes in land use planning, housing policy, road design approach and road space use, and pricing of parking and public transport. (Mahadevia & Joshi , 2013)

The new transit system is getting more and more popular in third world cities mainly due to its low cost of construction and Operation & Maintenance. BRTS network is generally provided with a dedicated NMT corridor. In Ahmedabad BRTS the provision of NMT track is intermittent and inconvenient in most stretches which could be due to issues in managerial or planning or implementation level or a mix of any of these. (Mahadevia & Joshi , 2013) NMT mode is very important to any transit system as it provides an ideal choice for last mile connectivity to the system. It is also the greenest and most sustainable mode available to the people and also has intangible but visible social and physical health benefits. (Woodcock & Tiwari, 2009)

Because of their dense and mixed land use structure and organically evolved road network pattern and the fact that most Indian non-metro cities have an average trip length of less than 5 km which is a comfortable commutable distance for bicycling for most age groups, NMT modes are very relevant in Indian context.

This study revolves around the impacts the BRTS has on the people who are dependent on non-motorized transport modes. With the introduction of a rapid transit system, the effects on the public are two sided. The multiple mode shifts that can occur could either be positive or negative to the environment. The mode choices of people residing near the corridor are influenced by the rapid transit corridor. The right of way adjustments could also improve the NMT infrastructure simultaneously. Also, it may have a positive impact on the environment if the Mass Transit System encourage more people to shift from private modes to PT and discourage shifting from NMT to private modes. To encourage the NMT mode usage the infrastructure provisions are to be continuous and convenient. To understand the context a questionnaire survey was conducted which asked about the mode choice changes and reasons for shifting and major issues NMT users are facing. The provision of Mass Transit System alone cannot help the environment but a major shift towards the Transit system and NMT usage coupled with reduced usage of private modes can. The research looks into the mode choice changes induced by the BRTS intervention, issues faced by the NMT users

2. Ahmedabad BRTS

Ahmedabad city, among the fastest growing cities in India (Forbes magazine, 2010) has a population of 6.35 million (CENSUS, 2011), with a growth rate of 3.5% and an area of

464 Sq. km. (AMC, http://www.egovamc.com/#, 2015). It has AMTS (Ahmedabad Municipal Transport Services) and Janmarg BRTS as the main public transport systems.

Ahmedabad Janmarg Ltd is registered under Companies Act, 1956 and is 100% subsidiary of Ahmedabad Municipal Corporation. In order to provide faster, reliable, eco-friendly and advanced Public Transportation Ahmedabad Janmarg Ltd is committed to operate and run BRTS services for Ahmedabad city. The BRT system has an operational network length of 96 km in length (CEPT, 2015). It has 10 routes and 230 buses (2015) (CEPT, 2015). The transit system has brought about a change in the way people travelled in Ahmedabad. The project has given Ahmedabad a global spotlight and place on the map. It has also won various Accolades and appreciation for the implementation of sustainable BRTS Operation on Global and International level. (AMC, http://www.ahmedabadbrts.org/web/About_JanMarg.html, n.d.)

3. Corridor Selection

The area selected was Narol Naroda BRTS corridor in western Ahmedabad. It is the busiest corridor in Ahmedabad, in terms of boarding and alighting. (CEPT, 2015) It is a 13.2 km stretch and it shares the ROW with NH-8 which passes through the area. The area is known for its industries mainly and also has the highest number of bicyclists.

The main points for survey were

1. Naroda patiya
2. Dhanishdhari
3. Krishna nagar
4. Bapu nagar aproach
5. Virat nagar
6. Soni ni chali
7. CTM
8. Express high way jn.
9. Ghodasar
10. Isanpur
11. Narol

Figure 1: Ahmedabad BRTS corridor

Map 1: Points of survey

Figure 3.12 shows the section at present corridor at Narol-Naroda stretch near Soni Ni Chali junction shows the BRTS carriageway in the middle of the road. The ROW is being shared with the NH 8.the bicycle tracks of 2.5 m width is provided on both the sides. A service lane (3.5m) and a footpath and shoulder are provided. This is not continuous and the bicycle tracks are occupied by private vehicles and the parking is done on service lanes as well. The bicycle users generally use the service lane and the main carriageway (NH-8). The study mainly evaluates the mode shift, reasons and issues. For this purpose, the primary survey was conducted. Questions regarding the following were asked:

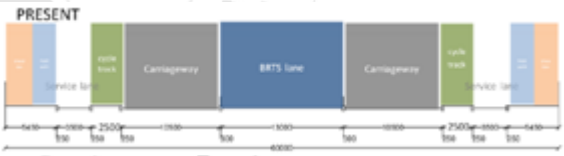

Figure 2: Section of the Narol-Naroda corridor

- The mode usage (current and before BRTS)
- The reason for shifting
- Issues faced by NMT users
- Travel and socio-demographic characteristics

4. Methods used

The travel demand is derived from various factors such as socio- economic factors like age, sex, income etc. and travel related characteristics such as trip purpose, trip length, trip cost etc. For the study we are investigating the possible factors which can be linked to the BRTS introduction and NMT usage. The research looks into the changes with consideration of the increasing registrations of motorized vehicles.

Also, the same data was used to find the change in emission level (CO2). The total trips made before and after BRTS was considered alongside the fuel usage and average fuel efficiency to give the CO2 emission from ASIF matrix method. The data selected was from the road users from the

near the BRTS corridor. A total number of 130 samples were taken from the selected survey locations. The survey was done on a random sampling basis, so that the probability of selection was the same for all. The data is roughly representative of all the people living in the influence area of the BRT corridor. The survey questionnaire had the following questions regarding mode choice and reasons and issues.

1) Which mode did you use before BRTS
2) Which mode do you use now?
3) If shifted what is the reason?
4) If not shifted what is the reason?
5) What are the issues being faces?
6) Socio demographic status, like income, age, vehicle ownership.
7) How much is the daily average Trip length?

5. Descriptive Statistics

5.1 Socio Demographics

The income of the households of the respondents showed a high number of lower middle income group (5000- 10000 INR per month) 40% of the samples taken. Average income is found to be 12165 INR ($175 US) per month.

Table 1: Vehicle ownership percentage

Vehicle Ownership	%
Bicycle	53
Two wheeler	39
Four wheeler	7
Auto	0.9
Others	0.1

Vehicle ownership chart shows a high percentage of respondents (53%) owning bicycles and 2 wheelers (39%). The 4 wheeler ownership is very less (7%). It can be seen that the area has a high potential for shift towards NMT as bicycle ownership is on the higher side.

5.2 Mode usage

The modal split of the sample reveals high number of 2-wheeler share followed by bicycles (26%). The mode split for BRTS is 12%. The share of walking is 7%. The mode split for auto is 21% which is quite high.

Table 2: Mode usage

Mode split in Ahmedabad city*						
Mode	Walk	Bicycle	Auto	PT	2 Wheeler	4 Wheeler
%	13	18.3	8.8	15	35	8.9
Mode split in the study area						
Mode	Walk	Bicycle	Auto	PT	2 Wheeler	4 Wheeler
%	7.4	26.4	20.7	11.6	30.6	3.3

5.3 Trip length

The average trip length can be used to plan and design the facilities for NMT users. The trip length of users varies with the income and mode usage. The low income group who cannot afford any other motorized mode will mostly have a shorter trip length and the private vehicle owners generally have longer trip lengths. The NMT users also have a smaller value generally.

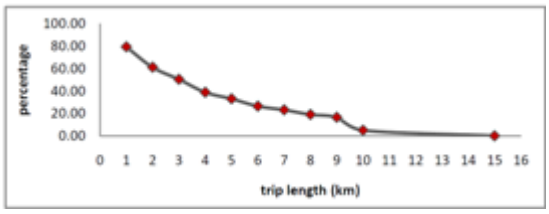

Table 3: Trip length distribution

5.4 Mode usage before and after BRTS

Mode usage analysis revealed that certain mode usage has decreased (walk, bicycle) and some have increased (auto, two wheeler). The changes could be due to mere convenience and consideration of the respondents or maybe due to the convenience and safety factors. The decrease in bicycle trips could be because of the safety concerns and increase in auto trips could be due to the high fare of BRTS and lack of adequate last mile connectivity

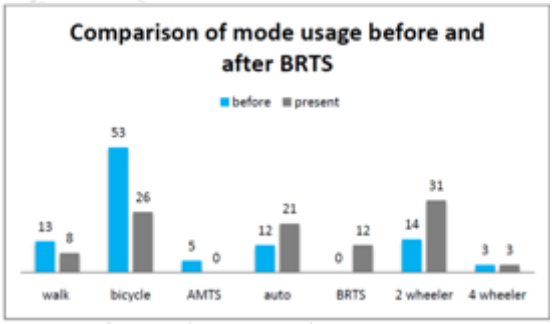

Figure 3: Mode usage comparison

5.5 Mode shift

The mode shifts were categorized in 8 classes for the convenience of analysis.

Table 4: Mode shift

Mode shift	**(%)**
NMT – NMT	32.2
NMT – Private	19.8
Private – Private	14.0
NMT – PT/IPT	12.4
Others – PT	9.9
Auto – Auto	9.1
Other – NMT	1.7
Other	0.8

It showed that a large proportion of people did not shift from their NMT modes (32.2%). This indicates the large number of captive users in the area. It is followed by shifts from NMT mode to Private motorized modes (19.8%). It also illustrates that a high percentage of the samples have not shifted to other modes. 56% of the correspondents have continued in their earlier modes.

This indicates that the modal shift from NMT to other modes are high and the shift from other modes to NMT is minimal. The NMT modes are not attractive to other mode users.

Also the users continuing to use NMT modes are higher (32%) than those continuing in motorized modes (14%)

5.6 Reasons for shifting

The reason for shifting was enquired and the following statistics was formed by ranking the reasons according to their frequency.

Table 5: Reasons for shifting

Reasons for shifting
1. Convenience of current mode
2. Need for mobility
3. Concern due to increased traffic
4. Management issues, Police, maintenance, amenities
5. Less right of way due to BRTS introduction
6. Obstruction
7. Dust and smoke
8. Increase income
9. Lack f NMT facilities
10. Affordability of current mode
11. Nearness of PT/IPT stop

The majority of people have the opinion that the mode they are using currently is more convenient than their previous NMT mode. Another main factor is the need for mobility. The travel times have become more crucial for them. Nearness of PT stop/ IPT stop has not been as strong a reason. 97% have the opinion that the mode choice is based on the convenience it offers.

5.6 Reasons for continuing in NMT modes

The reasons for continuing in the same mode was also asked to find if there is any link to the BRTS intervention. The reasons for continuing in NMT modes are mainly affordability the NMT modes offer and safety. The clean travel route, infrastructure availability and travel time are given least importance was a reason to continue using NMT modes. It concretes the previous conception about NMT users generally being poor. It can be seen that majority of the users did not shift because other modes were too expensive for them and they are forced to continue in the same NMT mode. Among all the correspondents, people who continued using NMT mode were 34.8%. Among them 87% were captive users.

Table 6: Reasons for Not Shifting

Reason for Not Shifting	%
Affordability , NMT mode is more affordable	62
NMT mode is more convenient for multiple destinations	54
Narrow lanes due to construction of BRT lanes	54
Safety	38
Ned for mobility	23
NMT facilities availability	23
Clean route	15

5.7 Reasons for shifting from NMT to Motorized modes

Many people had shifted from NMT to motorized modes. This analysis showed if there is any linkage to this shift and BRTS intervention.

Table 7: Reasons for shifting from NMT to motorized modes

Reason	%
Concern due to increased traffic	93
Current mode is more convenient for multiple destinations	79
Management issues (police, maintenance, amenities)	64
Obstruction	57
Need for faster mode	57
Narrow lanes due to construction of BRT lanes	57
Current mode is cheaper (value for money)	43
Increase in income	29
Dust & smoke	29
NMT facilities not available	29
Poor lighting / surveillance	7

It showed that the majority of the people who shifted from the NMT mode to motorized modes, did so due to the fact that the increased traffic over the past years after the introduction of BRTS (93%), convenience the motorized mode offers over the NMT users (79%) and lack of maintenance and management of NMT transport infrastructure (64%). Also the need for mobility (67%), narrowing of lanes at certain stretches due to the BRTS (67%), need for mobility (57%) are considered as a determinant for the shift. The increase income and poor lighting and surveillance are not as important as expected as the reason for shifting.

6. Issues identified

The basic issues were related to the infrastructure provisions and the safety concerns over exceeding amount of traffic in the mixed traffic condition. There were also issues regarding the smoke and dust. The narrowing of the road due to the introduction of BRTS was found to be an issue.

Table 8: Issues of NMT users

Issues of NMT users	%
Heavy Traffic and safety concern	63
Crossing	22.5
Smoke and Dust	9.5
Obstruction	7.5

It showed that most users are concerned about heavy traffic and secondly the crossing difficulties, especially for women. The heavy traffic seen in peak hours poses the threat of fatal or major accidents to the users. The walking distance increases in most cases. 22.5% had issues with crossing the BRTS corridor. There is a need for foot over bridges as the movement across the road is inevitable to some people. Also the encroachment of the bicycle tracks by parking waste dumping is also an issue. Also there are no public amenities for NMT users like drinking water and toilets. The NMT users most of them being captive users, do not have the luxury to choose the motorized mode. The corridor is not shaded at any point by trees or landscaping, which makes it more difficult for the choice users to shift to NMT considering the hot and dry climate of Ahmedabad.

6.1 ROW changes

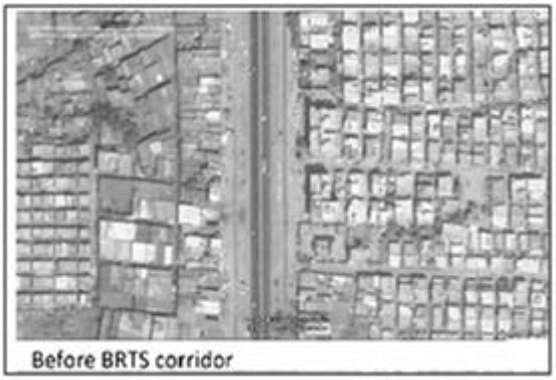

Figure 4: Satellite image before BRTS corridor construction

Before the introduction of BRTS, the shoulders on the sides of the NH-8 were not utilized for traffic purposes but for parking trucks and other vehicles. After the implementation of BRTS, that space was taken up and developed for adjusting the BRTS lane in between the NH lanes. The remaining space was used for NMT track and footpath.

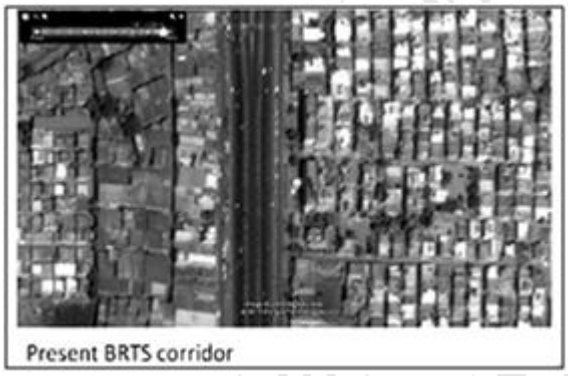

Figure 5: After construction

From the analysis, it could be seen that the change in right of way can be seen was very negligible but the wide shoulders which were used for parking vehicles were taken away during the transit corridor development process. This has caused an increase in load on the service lanes which were used by NMT users. In short, there has been introduction of NMT facilities in the corridor but since the provision is inconsistent in terms of continuity and due to illegal parking and encroachment and waste dumping, the NMT users prefer to use the main highway and service lane in mixed traffic condition

6.2 Carbon dioxide emission

For determining the carbon emission levels difference before and after BRTS corridor development, the trip lengths for reach mode before and after was considered. The ASIF matrix was used to find the emission levels considering unchanged trip lengths and increase in the vehicular registrations over the years. The fuel efficiency of different vehicles is taken; the fuel consumption is then calculated. The emission characteristics of each fuel are taken into consideration to find the emission of CO_2 in tonnes per day in the study area. The population density map was used to calculate the expanded trips from the study area. The population was found to be approximately 85000 in the study area.

Table 9: ASIF Matrix before BRTS

mode	distance	% distance	fuel efficiency	fuel use (litres)	CO2 (tonnes)
2 wheeler	6375	14.05	60	106.25	0.254
4 wheeler	1500	3.31	14	107.14	0.256
walk	5625	12.40		0.00	0.000
(handicapped)bicycle	375	0.83		0.00	0.000
AMTS	2250	4.96	3	750.00	1.689
auto	5250	11.57	19	276.32	0.622
bicycle	24000	52.89		0.00	0.000
total	45375			1239.71	2.822

This shows that the emission levels have increased by around 3.21 tonnes CO_2 per day that is around 1.22 times the earlier emission levels. The possible reasons for increasing emission could be:
People shifted from AMTS to 2 wheelers and autos which increased emissions
The reduction in bicycle users and twice increase in Two wheeler numbers

Table 10: ASIF Matrix after BRTS

mode	distance	% distance	fuel efficiency	fuel use (litres)	CO2 (tonnes)
2 wheeler	13875	30.6	60	231.25	0.55315
4 wheeler	1500	3.3	14	107.14	0.256286
walk	3375	7.4			0
handicapped (bicycle)	375	0.8			0
BRTS	5250	11.6	3	1750.00	4.186
auto	9375	20.7	19	493.42	1.180263
bicycle	11625	25.6			0
total	45375			2581.81	6.175699

7. Conclusion

The mode shifts that have happened after the intervention of BRTS suggest that the overall impact the BRTS has on the mode choice is negative towards the environment considering CO2 emissions and issues faced by the NMT users. More than 32% of the NMT users have continued in the same mode due to issues like affordability and convenience factors it offer to them. Meanwhile the shift towards the newly introduced BRTS is marginally less. The overall load on the road has not been reduced and the air quality is deteriorating. The impact on traffic is coupled with the increase in vehicle registrations every year due to increasing income and more financing options. The NMT users face issues mainly in crossing the BRT corridor and the increased traffic. Also the disruptive bicycle tracks and improperly maintained parking in the bicycle track are discouraging NMT users.

The CO_2 emission have increased after the introduction of BRTS since not all the shifts were in favour to BRTS and NMT but rather towards 2-wheelers and auto rickshaws.

This scenario is not an ideal shift paradigm. The BRTS in short did not deliver an overall positive effect it promised. Mobility for a small section of people is traded off with the inconvenience of a large number of population. Convenience the other modes offer are often preferred over the health benefits off cycling and walking by most people. Motorists‟ resistance to shift to NMT is very reasonable looking at the scenario regarding infrastructure and traffic conditions. So there is a need to consider the NMT users while planning for BRTS systems and the shift should be such that it supported the PT system and discourages private modes. Infrastructure provision alone cannot make a change. It should be supported with proper management regarding illegal parking and encroachment and conscious planning considering NMT users' perspective.

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