

Fuel Wastage Analysis and Sustainable Transport Planning in Surat's Metropolitan Corridors

Dr. Khushbu Bhatt¹, Ankita Sharma¹

1. Assistant Professor, Department of Civil Engineering Department, PIET, Parul University, Vadodara

ABSTRACT: Urbanization is the outcome of social and economic developments that lead to urban concentration and growth of large cities, changes in land use, and travel pattern in metropolitan city. The socio-economic behavior also changes and leads to phenomenal growth of private vehicles which resulted in drastic changes in traffic as well as travel characteristics. This heavy growth of traffic will worsen transport scenario, which needs *sustainable transport planning*.

The research work studies the travel behavior of people in metropolitan Surat City. For the present study field surveys are done to analyze *wastage of fuel* at a congested corridor of Surat city. For residential zone surveys adopted are Traffic Volume Count to get the peak hour. To study various other aspects of fuel consumption, analysis was done during the peak hours by finding the idling of vehicles at a junction.

Based on the above studies, it is been found that use of private vehicles is high as compared to *public transport* due to which planning refines the travel pattern and effects the environment. So as a result some traffic management techniques have been suggested as a conclusion of the paper.

Key Word: Fuel Wastage, Travel demand, Congestion, Vehicle delay

1. INTRODUCTION:

Urbanization, is defined as the shift from a rural to an urban society, and involves an increase in the number of people in urban areas. Urbanization is the outcome of social and economic developments that lead to urban concentration and growth of large cities, changes in land use, and travel pattern in metropolitan city. The socio-economic behaviour also changes and leads to phenomenal growth of private vehicles which resulted in drastic changes in traffic as well as travel characteristics. This heavy growth of traffic will worsen transport scenario, which needs sustainable transport planning. The present study is focus on the travel behavior characteristic study for residential land use of Surat. It is seventh fast developing metro cities of India with best infrastructure and development opportunity for further, growth, employment, and good living conditions, Contrary, this leads to congestion on road networks pollution, accidents etc. The study is carried out in residential zone of Surat. The traffic volume at bridges connecting the west zone to various other zones is been observed at the peak hours.

2. LITERATURE REVIEW:

The literature review for this work comprises of the study of available literature on the travel behavior of the people for mode choice and use of public transportation system. A hypothesis for changing socio-economic characteristics and land use pattern in Agartala City concluded that the utility of private motorized mode was to be decreasing with the increasing land use mix at the origin [13]. Analysis on increase in income increases the vehicle ownership results in traffic congestion. A strong need is felt for policy reforms to promote use of public transport sector like, modernization (ITS) [4]. Moreover, focus on traffic growth trend due to rapid urbanization. She concluded that to achieve sustainability for decentralized planning strong transportation routes plays vital role [1]. Some of them have discussed about impacts of substituting car trips with more sustainable alternatives and effect on trip frequency, public transport, and private vehicle

dependency of socio-economic transport and land use characteristics. The results confirm that living in low density increases the tendency to use the private vehicles [9] [11]. The major issue between pedestrians, cycle rickshaws, and motorized traffic due to lack of proper infrastructure and urban roads, a case study of Ranchi [2]. Using IRC 86-1983 and IRC 103-1988 the development of infrastructure and construction of footpaths is recommended. Transportation issues in developing countries, to resolve these issues, land-use and transportation systems should be integrated, with an appropriate combination of push and pull measures [9]. The traveler's attitude to public transport and psychological demands are measured using discrete choice model and based on the result the advised to improve service of public transportation like safety, comfort, economic travel, quick arrival etc. [7]. The public transportation i.e. bus travel time and spatial distribution features of individual travel behavior was analyzed on the basis of model (BL) found that age, gender, occupation effects the use of public transit system and also travel time and travel cost [22]. Travel choice behaviour of commuters using binary logit model which shows increase in fuel consumption due to frequent use of car as compared to bus [5]. Urban transportation sustainability can greatly enhanced if there is changes in urban structures and activities which can slow the growth in use of private vehicles. There must be comprehensive approach using land use, transportation planning pricing, technology and management innovations will fulfill goal of sustainability [20]. Coordination between public transportation and urban development and recommendation for the public transport pattern based on the size of the city [18]. Different traffic demand and factors the most influencing factors is travel speed of the vehicle which reduces the private car travel has been analyzed [21]. A model was constructed to allow the prediction of pedestrian walking speeds along sidewalks pavements in the United Kingdom and to understand the dependence on a variety of characteristics reflecting the use of the surroundings, the layout of the physical environment, those of pedestrians using the area, and weather and seasonal variables [12].

3. STUDY AREA:

Surat city is located on the western part of India in the state of Gujarat. It is one of the most dynamic city of India with one of the fastest growth rate due to immigration from various part of Gujarat and other states of India. Prior to 1961, Surat's area was only 8.12 sq. km. while in 2009 it had expanded to 326.5 sq. km. The population has increased from 2876374 in 2001 to 4466826 in 2011. The population density as per 2011 census is 13680 persons/sq.km. For the present work West Zone of Surat city is selected as a study area.

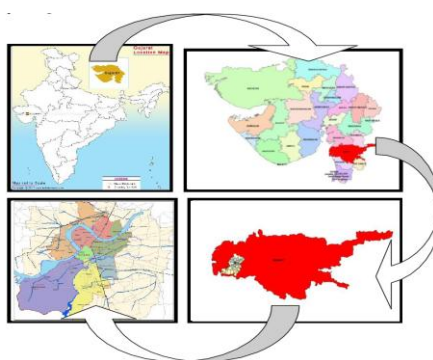
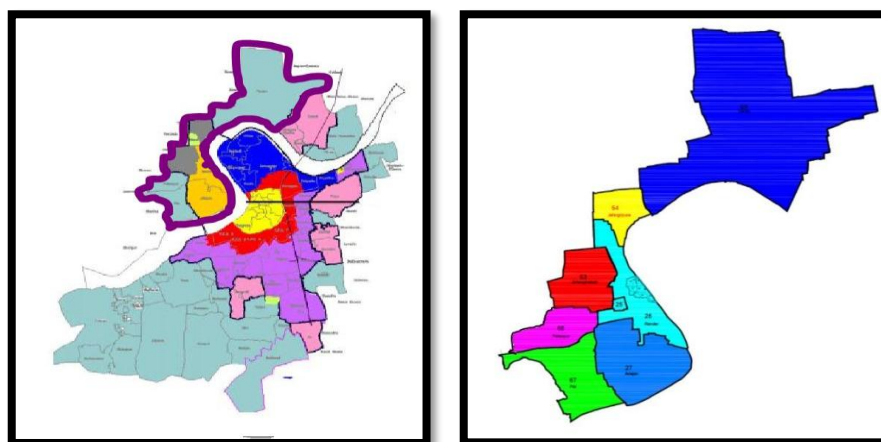


Fig 1. Location of Surat



(Source: SMC Website)

Fig 2. Location and Details of West Zone



Fig 3. Location of three Bridge and Major Junction

Table 1. Ward wise Area, Population Density and Growth rate of West Zone

Ward No.	Name of Area	Area in Sq. Km.	Population		Density (ppha)		Decadal Growth Rate	
			2001	2011	2001	2011	2001	2011
14-26	Rander	5.120	86047	114632	168.06	223.89	44.50	33.22
27	Adajan	6.730	152274	19670	226.26	292.67	143.18	29.35
63	Jahangirabad	4.160	9288	27813	22.32	66.86	179	199.55
64	Jahangirpura	2.920	1120	2165	3.83	7.41	9.11	93.47
65	Pisad	0.696	1751	4057	25.15	58.29	618.57	131.76
67	Pal	6.045	11165	36107	18.46	59.73	150.47	223.56
68	Palanpor	3.008	11496	23514	38.21	78.17	571.52	104.57
69	Variyav	22.6	14003	19728	6.19	8.72	65.06	40.87
TOTAL		51.279	287144	424986				

(Source: Surat Municipal Corporation –Website)

4. DATA ANALYSIS:

To get accurate data and actual condition of study area field survey was conducted and further data is analyzed. The data were collected for traffic volume, household survey and vehicle delay time due to idling and analysis is shown below:-

- Traffic Volume Survey
- Origin Destination Survey
- Vehicle Delay Analysis

4.1. Traffic volume survey

Traffic Volume is the number of vehicles crossing a section of road per unit time at any selected period. Traffic volume is used as a quantity measure flow; the commonly used units are vehicles per day and vehicles per hour. Knowing the flow characteristic one can easily determine whether a particular section of the road is handling traffic much above or below its capacity. If traffic is heavy, the road suffers from congestion with consequent loss in journey speeds. Congestion also leads to traffic hazards. There for traffic volume data are require to draw up schemes for improvement of road network and also to allocate the scare economic resources most advantageously.

The traffic volume survey was carried out at Sardar Bridge, as it connects the west zone with the other various zones of Surat. The survey is carried out for 8 hour/day for two days i.e. one weekday and one weekend (9.00am to 1.00pm and 4.00 pm to 8.00 pm).

4.2. O-D Survey

The aim of this survey was to collect data of origins and destinations, trip purposes, and travel characteristics of West Zone residents. The survey was conducted manually by interview at the Sardar Bridge to get the vehicle data such as number of trips, purpose of trip, mode of travel, vehicle occupancy etc. The survey was carried out during the peak hour which is been derived from traffic volume survey. The total 600 number of samples which include both way traffic in the morning and evening at Sardar Bridge were collected. Additionally, desire line diagram is plotted to analyze trip distribution within zones of Surat city. The result is been used to make the desire line diagram.

4.3. Vehicle Delay Analysis

Vehicle delay time is calculated at the divergence of Sardar Bridge and Flyover Bridge where there is stop of vehicle for particular time period. In this Survey 5 Samples are collected at an interval of an hour in which the time is counted for the vehicles are been stopped due to congestion at the point of divergence of flyover at Sardar Bridge. The purpose of calculating the delay time is to analyze the wastage of fuel for the time during the stop of vehicle at Sardar Bridge.

Vehicular pollution and fuel wastage is directly or indirectly linked with the population. Due to increasing population, numbers of vehicles are increasing, which results in increasing fuel consumption. This is also responsible for road traffic problems. Increasing traffic problems not only responsible for degrading of our atmosphere, it is also responsible for wastage of fuels. The survey was conducted to calculate the time period for vehicles that are been idle at the bottleneck of the Sardar Bridge where congestion is maximum due to divergence of traffic. Taking the average time of stop and traffic volume, the amount of fuel wastage is calculated using the formula,

Amount of fuel wastage =

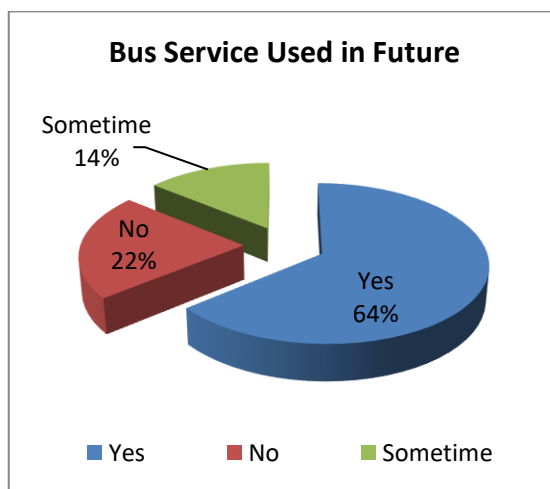
(No. of idle vehicle) X (time of idling) X (idle fuel consumption factor in ml/sec).

Table 3. Amount of Fuel Wastage at Peak Hour and Per Day

Vehicle Type	Two-Wheeler	Auto Richkshaw	Four Wheeler	Bus /Truck	
Peak Hour (9.30am -10.30am)	6156	747	1554	29	
Idle time for Vehicle Stops	185	185	185	185	
Fuel Consumption Factor (ml/Hr)	200	522	661	2076	
Fuel Wastage (Litres)	63.27	20.03	52.78	3.09	
Rate of Fuel (Rs/lit)	73	46	70	70	
Total Amount Wasted per hour (Rs)	4618.71	921.76	3695.04	216.56	9452.082 Rs.
Traffic Volume (8 hour)	42486	6226	14332	334	
Fuel Wastage (Litres) in 8 hrs	436.66	167.012	486.83	35.63	
Total Amount Wasted per day(Rs)	31876.30	7682.57	34078.11	2494.25	76131.24 Rs.

Source: Fuel Consumption Factor- [8]

The total amount of Rs. 76131* 365 = Rs. 2, 77, 87,903 (Rs. 2.77 crores) per year can be saved if at this junction idling of vehicles is eliminated.



5. CONCLUSION:

From the above surveys and analysis the following conclusions are derived that the major drawback of urbanization is urban sprawl which leads to expansion of the city due to migration of people from rural to urban area which directly enhance the number of private vehicles due to lack of public transportation system in the sprawled area of the city. The increase in number of private vehicles leads to congestion at bottleneck of the road network. The idling of vehicles in peak hour wastes approximately Rs 2.7 crore of fuel per at a particular junction.

Based on the conclusions arrived after the study a list of various primary measures to be implemented are highlighted by means of recommendation below.

6. RECOMMENDATIONS:

The various recommendations for the above mentioned issues are as follows:-

- A. The use of public transportation need to be enhanced and as per the household survey 64% of the people are ready to shift from private to public transport.
- B. The cost of Rs 1.77 Crore is saved if the 64% of public start travelling with public mode.

7. REFERENCES:

1. Arati S. Petkar and Rushikesh R. Deshmukh (2012), "Urbanisation & Traffic Growth Trends in Pimpri-Chinchwad Municipal Corporation Area", *National Conference and Workshop on Recent Advances in Traffic Engineering, 2012*, pp-35-41.
2. Dave Mahek J, Dave Pratik J. (2012), "Urbanization, Traffic Growth and Declining Public Transport, *National Conference And Workshop on Recent Advances in Traffic Engineering, 2012*, pp-25-29.
3. Dawei PAN, Wei DENG, Yanjie JI, and Fei SHAO, "Research on The Travel Choice Mode Based on The Analysis of Travel Time Value", *International Conference of Chinese Transportation Professionals , ASCE 2011*, pp 606-614.
4. Dr. Kenneth Button (2013), "Travel Behaviour and Travel Demand" *Handbook of Reginal Science, 2013*, pp 685-703
5. Fang fang SHAO, "Travel Behaviour of Commuters Based on Logit Model", *COTA International Conference of Transportation Professionals 2012, ASCE*, pp 1345-1349.
6. Fengjiao ZOU, Zhi DONG, and Bing WU (2014), "Inter-city Urban Traveler Behaviour Characteristics and Travel Demand Analyses: A Case Study of Yangtze River Delta Urban Agglomeration ,*CICTP 2014: Safe, Smart, and Sustainable Multimodal Transportation Systems, ASCE 2014*, pp. 3654-3665
7. Huanhuan YIN, Juan LI, and Hongzheng Zhao (2012), "Public Transportation Travel Mode Choice Behaviour Research" *COTA International Conference of Transportation Professionals 2012 , ASCE*, pp 1337-1344
8. K P Tiwari , R N Singh, J B Balwanshi (2013), "Fuel Wastage and Emission due to Idling of Vehicles at Road Traffic Signals, *International Journal of Research in Engineering and Technology, ISSN: 2321-7308, Vol 02 issue 10* pp 43-53
9. Kitamura, R., Patricia L.M., & Laura L. (1997). A Micro-Analysis of Land Use and Travel in Five Neighborhoods in the San Francisco Bay Area. *Transportation Research Record* 24 (2), pp 125-158.
10. Kumares C. Sinha (2003), "Sustainability and Urban Public Transportation" *Journal of Transportation Engineering, ASCE 2003*, 129:331-341.
11. La Paix, Monzón and Cherchi(2010) "Location Effects On Trip Generation: Evidence From Madrid Metropolitan Area", *12th WCTR, July ,Lisbon, Portugal*.

12. Marwan Al-Azzawi (2007), "Modeling Pedestrian Walking Speeds on Sidewalks", *J. Urban Plann. Dev.* 2007, Vol 133, pp 211 -219.
13. Partha Pratim Sarkar A, C. Mallikarjuna (2013), Effect of Land Use on Travel Behaviour: A Case Study of Agartala City, *2nd Conference of Transportation Research Group of India (2nd CTRG) Procedia - Social and Behavioural Sciences* 104 ,pp 533 – 542
14. Pinjari, A. R., Pendyala, R.M., Bhat, C.R., & Waddell, P.A. (2007). Modeling Residential Sorting effects to understand the Impact of the Built Environment on Commute Mode Choice. *Transportation* 34 (5), 557 573.
15. Prof. H.M. Shivanand Swamy "Integrated Urban Land Use Transport Planning (IULTP)"
16. Quan Liang (2012), "Study of Priority Mode Development for Public Transportation", *COTA International Conference of Transportation Professionals 2012* , ASCE, pp 1432-1341
17. Rajamani, J., Bhat, C.R., & Handy, S.L. (2003). Assessing Impact of Urban Form Measures on Non-work Trip Mode Choice after Controlling for Demographic and Level-Of-Service Effects", *Transportation Research Record* 1831, pp158 165.
18. Ravi Sekhara, Pranoy Rajb, Purnima Parida, S.Gangopadhyay (2013), "Estimation of Delay and Fuel Loss during Idling of Vehicles at Signalized Intersection in Ahmedabad", *2nd Conference of Transportation Research Group of India, Social and Behavioral Sciences* 104, pp 1178 – 1187
19. Rohan Shah, P. Vedagiri (2012), "Modelling the Route Choice Behaviour of Public Transit Bus Commuters in Mumbai City", *National Conference and Workshop on Recent Advances in Traffic Engineering, 2012*, pp-307-313.
20. Srinivasan, S., (2000), Linking land use and transportation: measuring the impact of neighborhood-scale spatial patterns on travel behavior, *Thesis submitted to the Department of Urban Studies and Planning, Harvard University*.
21. Stecher, C. C., Brickas, S., Goldenberg, L., (1996) Travel Behaviour Survey Data Collection Instruments", *Transportation Research Board Conference Proceedings-10, Washington, DC*, 154-169.
22. WAN Xia, CHEN Jun, WANG Wei (2009), "Travel Characteristics and Mode Choice Behavior of Public Transport in China " *International Conference on Transportation Engineering*, pp-2195
23. Xuemei ZHOU, Xiaoguang YANG, and Yunteng LAO, (2007) "Public Transport Service Level Influence On Travel Mode Choice", *International Conference on Transportation Engineering 2007*.