**International Journal of Pure and Applied Mathematics**
**Volume 118 No. 24 2018**
ISSN: 1314-3395 (on-line version)
**url:** http://www.acadpubl.eu/hub/
Special Issue

http://www.acadpubl.eu/hub/

# Analysis of Autorickshaw as an Intermediate Paratransit system

Tushar R Bagul[1], Kiran Patil[2],
Alka Kote[3], B.S.Balpgold[4],
Ravindra Kumare[5], Rakesh Kumar[6],
[1]Associate Professor,[34]Professor
[134]DYPCOE College of Engineering
Akurdi,Pune
[2]Assistant professor
AISSMS College of Engineering Pune
[5] Principal Scientist
CSIR-Central Road Research Institute,
New Delhi 110020, India. [6]Associate Professor,
S.V. National Institute of Technology,
Surat 39500, India

May 23, 2018

**Abstract**

The paratransit system becomes indispensable transport mode due to its easy maneuvering on congested urban roads in India. The utility of three wheelers as a paratransit system study was undertaken in typical three regions of cities namely; central business district, developed, and developing. This study shows details the overall role of three-wheeler Autorickshaw service as it provides complete flexibility to reach the destination defined by the passenger. The operators and passengers survey was conducted by considering major nodes on arterial, sub-arterial, collector and local roads of the

particular regions to developed multinomial logit model based on disaggregated data. The explanatory variables included in the model are the demographic and socioeconomic characteristics of individuals, trip/travel characteristics, and Autorickshaw operational attributes.

The findings from the present study revealed that as low and medium class population income (80.5%) prefer to use shared Autorickshaw as Intermediate Paratransit Mode as compared to other Paratransit modes such as a bicycle, demand responsive modes. Autorickshaw serves overall 30 to 40 % of total commuting populations of daily users for fixed destination. The speed-time profile estimated using V-box by onboard analysis methods. The paper also highlights that motorized three wheelers are one of the principal paratransit modes and should be integrated with the public transit.

# 1 Introduction

An Autorickshaw popular parlance is a common form of public transportation in many countries around the world and the most popular vehicles in developing Asian countries, due to their small size, cheaper, and maneuverability, Used of only for transportation in the major urban centers (Mohammed Abu Mallouh et.al 2010). Routinly, millions of auto-rickshaws are to come with mass of people from place to another. They provide transport facility to locality where buses or trains can not come; they provide employment for millions of drivers. Nine percent of train commuters using Autorickshaw to access the station (MMRDA.,2008). Autorickshaws fill the gaps in the weak networks of conventional public transport in urban areas of the developing world and for many people; Autorickshaws are indispensable for their mobility. The world population of vehicles is increased drastically in last two decades, in 2012 the population growth to about 777.323 million (Davis et al., 2014, Adak et. al., 2015). In India, Autorickshaw is a widespread and relatively homogenous vehicle type across many Indian cities alone there are more than 2.5 million Autorickshaw currently on the road, and

250,000 new vehicles are sold each year (Navi Vala et.al. 2007). A recent publication highlights the role of Autorickshaw can play in Indian cities in promoting sustainable urban transport, as part of ASI framework (Mani Pai and Aggarwal, 2012). In particular, the study shows that Autorickshaws can help catalyze the shift from private vehicles to more sustainable transport modes, by i) providing access to public transport such as buses and trains, and ii) serving as an alternative to private vehicles for more occasional trips requiring on-demand, door-to-door connectivity. (Emma Shales, 2013). The present study is being carried out to check the viability of Autorickshaw as a paratransit mode in Surat City. These studies highlight the role that auto-rickshaw can play in promoting sustainable urban mobility.

## 2 Study Area

In existing situation, Surat city having 88188 Autorickshaws are on the road, in 2014-15, there were 3700 Autorickshaws registered compared to previous year, there has been startling 54% increase in the number for the first time, higher than in the three preceding years. Between April to August 2015 alone, around 1,500 new Auto rickshaws were registered. The study area is divided into three different regions like central business district (CBD), developed region and developing region. Each study area is a well-connected network of Arterial, Sub-arterial, collector and Local road as shown in Figure 1. The data was collected during April 2015 along with inventory and Field data. For this study by land use characteristics divided into the different regions are central business District (CBD) is the commercial, Industrial and business center of main city junctions of the city such as Railway and Bus station. The developed region (an area of land upon which improvement is made) this region occupy mostly residential, educational institutes and small market area according to study. Moreover, developing region (undergoing development) which new residential apartments, big market, and malls, few are in under construction, Study map shown in figure 1. It is clear that area under trade and commerce and recreation is very low. The area under a road network is 8.88%. The sample size is an important

part of the design process. The degree of accuracy of sample size depends upon two key factors, which is needed for the sample; and the extent to which there is variation in the population regarding the key characteristics of the study (de Vaus, 2002). The number of questionnaires needed to represent the population of public transport passengers to the 95% confidence level for the operator was 620 out of 95000 and passenger 510 out of 186000 as per the occupancy ratio. The standard equation was calculated (Cochean,1977) to determine the sample size of public transport users about the total population. In this formula small n is The sample size or the number of completed interviews and capital N is The scale of the population. In both equations, the difference is less than 1. In operator survey the value we got after putting the value is 615.98 which shows the difference more than one (615.98 ¡ 620). In passenger sample size calculation got the value 508.61 which also shows difference more than one( 508.61 ¡ 510).This means the size of the population does not have an impact on the sample size. The only case where it may impact on the sample size is if the population is small, and the sample size is less than 5% of the population (Czaja and Blair, 2005). Time-speed data is collected using v-box with on board measurement on selected route of three regions, to investigate the travel time and average speed of the Autorickshaw in peak hours. The 12 trips from each region were collected and selected a final trip with a mean of all trips basis. (kumar et.al., 2009).

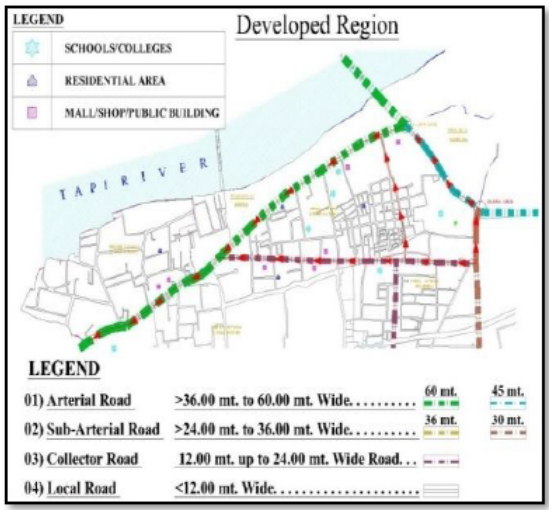


Fig 1(a) Developed

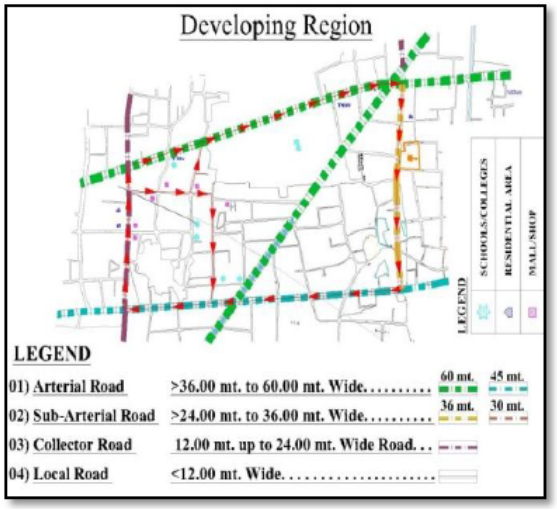


Fig 1(b) Developing

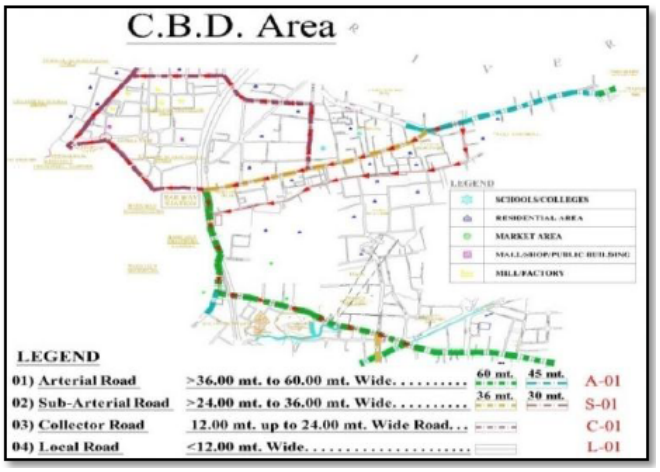


Fig 1(c) CBD region of Surat city

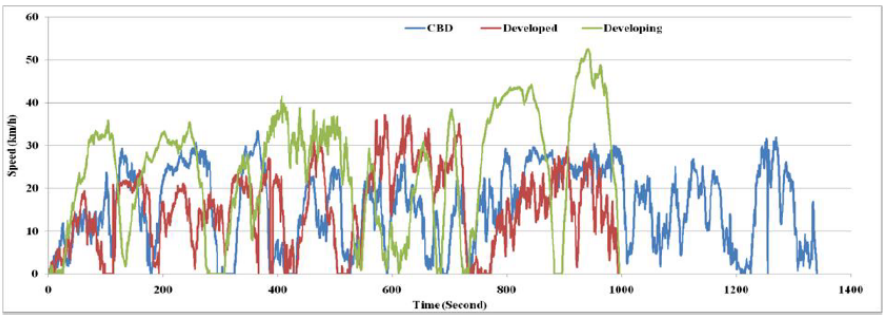


Fig 2: Travel time-speed of Autorickshaw CBD, Developed Developing region

The utility of three wheelers was analyzed using binary logit model (Electriwala et.al.2014). The response variable (dependent variables) is opinions towards three wheelers paratransit service. Independent variables including income, household size, vehicle ownership, travel cost and travel distance were categorized, and the impact of these variables on the response variable was found out. The null hypothesis shows that there was no difference between the model without independent variables and the model with independent variables was rejected. The decision to use three wheelers as paratransit service was employed as shown in Equation 1.

$$Pr\,(Auto) = \frac{exp^{[(1.729-0.164(Income)-0.196(HS)+0.120(AR)-0.172(TC)-0.132(TD))]}}{1+exp^{[(1.729-0.164(Income)-0.196(HS)+0.120(AR)-0.172(TC)-0.132(TD))]}} \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where, HS = household size, AR= Autorickshaw ownership, TC= travel cost and TD= travel distance.

A higher negative coefficient value indicates lower choice of auto rickshaw as paratransit service. In present study, it was noted except household size (HS) (p = 0.038), Autorickshaw ownership (AR) (p = 0.182), travel cost (TC) (p = 0.135) and travel distance (TD) (p = 0.131) and income (p = 0.028) contributed significantly. Hence, income factor was 18% more likely to increase the choice of Autorickshaw as a paratransit service. The travel cost and travel distance will have a negative impact on the Autorickshaw as a paratransit system.

Table 1: Operating characteristics of Autorickshaw in Surat city

| Characteristics | CBD | Developed | Developing | Surat City |
|---|---|---|---|---|
| Maximum operation Hours | 14 | 16 | 17 | 15.667 |
| Average operating hours | 11 | 13 | 13 | 12.333 |
| Average kms per day | 71 | 48 | 67 | 62.000 |
| Maximum Distance travelled (kms) | 125 | 100 | 150 | 125.000 |
| Maximum trip per day | 22 | 20 | 16 | 19.333 |
| Average trip per day | 12 | 10.67 | 9.5 | 10.723 |
| Average trip length (kms) | 5.92 | 4.44 | 6.97 | 5.777 |
| Average Passenger carried per day | 3.42 | 2.04 | 1.56 | 2.340 |
| Empty kms per day | 12 | 10 | 24 | 15.333 |
| Empty kms (%) | 16.901 | 20.8333 | 35.821 | 24.519 |

As per the survey analysis, 87.96% Autorickshaw is on a share basis in CBD region and 70.16% in the developed region and 10.71% in the developing area. The Reason behind this is the purpose of trip in CBD region 62% trips for work and in developing region it is 24% by Autorickshaw. The more than 30% passenger travel 6 km in CBD region and the developed region its reduces to 5km but in developing region its increases 7 km. The average numbers of trips are 11 in CBD, 11.5 in Developed and 9.5 in developing the region as per the operator survey. The trip length in developing area is 6.96 km, 5.96 km in CBD region and the shortest trip is 4.43 km in developed area.

# 3 Result and Discussion

The Autorickshaws were run on each study area for ten numbers of times to estimate the driving characteristic. The average speed is found out 15.6 km/h in CBD region and 16 kmph, 26 km/h in the developed and developing regions respectively. The Three-wheelers, Average time on trip length is 1390 second, 970 second, and 940 seconds in CBD, developed, developing regions respectively. Figure 2 shows driving the behavior of Autorickshaw in CBD, developed, developing region; It can be observed that in CBD Autorickshaw spent higher time in acceleration and deceleration.Though in developing region it spends much lower time in acceleration and deceleration, the peaks of developing region are quite high compared to the developed region and CBD region.

There has been some research that looks into the socio-economics of Autorickshaw drivers ( Mohan and Roy 2003, Reynolds et al. 2011) have studied Autorickshaw operational characteristics in Delhi. They found that over 24-hour period Autorickshaw in Delhi traveled between 90 to 210 km accounting for an average of around 54000 km per year. In Chennai, it travels around 100 km (Akshay Mani et.al 2012). Same in the case of Surat city average operating hours are 12 hours per day and on an Average Autorickshaw traveled 62 km/day accounting for an average around 22630 km per year.

# 4 Conclusion

In this study different surveys regarding paratransit like paratransit operator survey and paratransit passenger user survey are conducted to know the different aspects regarding paratransit like the socioeconomic characteristics of both paratransit passenger and drivers, the monthly income spectrum, the purpose of travel of passengers and other mode preferences, the stated preferences regarding willingness to shift to three wheeler service, the reasons for the willingness or unwillingness, the access distance of all type of users to get the idea of the influence area and also the access mode of the paratransit system. The different

outcomes of the study related to different parameters of paratransit system are as follows.

A) The 18% of the people want to use Autorickshaw as a paratransit service. With Increase of travel cost and travel distance gives negative impact on passenger shift.

B) The socio-economic characteristics of paratransit operators are increased considerably due to the formalization of operation zone in the central area due to increase in the passenger-kilometer and the respective revenue increase.

C) Increases the propensity to use the paratransit system as a feeder to the city bus service and the remaining autorickshaw can cater as the trunk system which further reduces the traffic on road.

D) The present study revealed that as low and medium class people prefer to use shared auto rickshaw as intermediate paratransit mode as compared to other paratransit modes such as a bicycle, demand responsive modes. Thus, the auto rickshaws are the one of the best model of intermediate paratransit system at present.

# References

[1] Cervero, R.., Informal transport in the developing world. Unhabitat 2000..

[2] Srdjan M.Lukic, PriscillaMulhall, Gilsu Choi, Mustafa Naviwala, Sairam Nimmagadda, and Ali Emadi. Usage Pattern Development for Three-wheel Auto Rickshaw Taxis in India. IEEE. 2007.

[3] Prasenjit Adak, RaviSahu, Suresh Pandian Elumalai, Development of emission factors for motorcycles and shared auto-rickshaws using . real-world driving cycle for a typical Indian city 2015.

[4] Mallouh, M. A., Denman, B., Surgenor, B., Peppley, B.. A study of fuel cell hybrid auto rickshaws using realistic urban drive cycles. JAMIE, (2010) 4(1).

[5] Mani, A., Pai, M., Aggarwal, R.. Sustainable urban transport in India: the role of the auto-rickshaw sector . Cochran, W. G.. Sampling techniques-3 2012.

[6] Czaja, R., Blair, J.. Designing survey: A guide to decisions and procedures Undergraduate research methods and statistics in the social sciences. New York, NY: Putnam 2005.

[7] Saleh, W., Kumar, R., Kirby, H., Kumar, P.. Real world driving cycle for motorcycles in Edinburgh. Transportation research part D: transport and environment, 14(5), (2009) pp. 326-333.

[8] Bazaras, D., Verseckiene, A. Palsaitis, R., Analyzing The Aspects of Organizing Paratransit Services in Vilnius. ISSN, 28(1), (2013) pp. 60-68.

[9] Tarigan, A. K., Susilo, Y. Joewono, T. B., Segmentation of paratransit users based on service quality and travel behaviour in Bandung, Indonesia. Transportation Planning and Technology, 37(2), (2014) pp. 200-218.

[10] T Shimazaki, M. R. R., Physical characteristics of paratransit in developing countries of Asia Transportation in Asia-Pacific countries Journal of Advanced Transportation, 30(1), (1996): pp. 5-24.

[11] Ferro, S., Behrens, R. Golub, A., Planned and Paratransit Service Integration Through Trunk and Feeder Arrangements: An International a Review. Pretoria, Southern African Transport Conference 2012.

[12] Fu, L., Yang, J., Casello, J., Quantifying Technical Efficiency of Paratransit Systems by Data Envelopment Analysis Method. Transportation Research Record:Journal of the Transportation Research Board, Volume 10, (2007) pp. 115-122.