

Users' Assessment of Auto Rickshaw: A Paratransit Mode for Mid-Sized City in India

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Abstract

Auto rickshaw, a paratransit is an important mode of urban transportation in mid-sized cities of developing countries. Patna, the capital city of Bihar in India like many other cities have observed auto rickshaw operating on fixed route but on a flexible schedule. Despite the fact that auto rickshaws in various forms have been in operation at many places throughout the developing world, not much has been done to assess user's satisfaction for this mode of transport. A questionnaire-based survey was carried out to rate the satisfaction level of the various parameters on a Likert Scale. The data collected during the survey were compiled, and Grey Relational Analysis (GRA) was carried out to rate the parameters. The study may help policy makers to improve the existing Auto-Rickshaw service to provide better facility to the users and attract them to paratransit and cater down the use of the private vehicles.

Keyword: Paratransit, Auto-Rickshaw, Likert-Scale, Grey Relational Analysis (GRA), Satisfaction Survey

1.0 Introduction

Rapid urbanization and growth of population in cities of developing countries has caused severe stress on the existing infrastructure of cities. The absence of the required priorities to cater to this situation has resulted in inadequate transportation-related infrastructure both in quantitative as well as qualitative terms (Maitra and Sadhukhan, 2013). Apart from few exceptions, there is a lack of proper rail or road based public transit system in most of the cities. In this situation, paratransit vehicles have come in to fulfill the demand. Paratransit is also known as intermediate public transport (IPT) as it is an intermediate mode between privately owned automobiles and the conventional transit system which have fixed routes and schedules. The paratransit vehicles are operated on dual system mostly on shared basis and sometimes on hired basis. The three-wheelers also called auto rickshaws in India are important modes of paratransit. Patna, the capital city of the eastern province of Bihar, is a mid-sized city of India having a population over 1.6 million (MHA, 2011). The city has witnessed the significant growth of three-wheelers (auto rickshaw) as an important mode of travel. Paratransit transit system consists of less capacity vehicles operated on flexible scheduling and fixed routing. However, sometimes flexible routing is also adopted.

The seating capacity of users varies between 5 and 10. The machines of auto- rickshaws are low horse powered 2 or 4 stroke engines. They are permitted to carry two or three adults in addition to auto drivers. These vehicles have a frame covered by canvas fabric on a back climbed engine. The mechanical operations of auto-rickshaws have a motorcycle type control. Auto rickshaws are individually operated with some possessed by the operator and other rented on a daily basis or monthly basis. A typical auto rickshaw can be seen in Figure 1.

Auto-rickshaws have become an integral part of the urban transport system for an urban middle-class population of Patna. They are preferred on four wheeler vehicles because they can easily move on narrow roads and have better maneuverability and small radius of turning. These characteristic make the autos more suitable for the overcrowded and congested roads of the mid-sized city like Patna. Moreover, the auto-rickshaw requires a lesser area for parking. The road space utilization by auto rickshaw is about 7.5 square meters as compared to cars for which it is about 12 square meters. (Source: Ministry of Industry, Government of India). Auto-rickshaw operates in large numbers in Patna. About thirty-seven thousand auto-

rickshaws ply on roads of Patna (MoRTH, 2012). They provide a higher frequency of point to point transportation from one place to another, and the fare structure is reasonable.



Fig. 1 Three-wheeler Auto-rickshaw (3-seater and 4-seater)

Urban transportation in Patna depends significantly on IPT modes. Rail and Bus transport plays an only marginal role in the urban transport network in Patna. Rail transportation mainly caters to intercity movement of passengers. The unreliable of bus service and its inefficient operation coupled with narrow and congested road network has resulted in the high patronage of IPT. Auto-rickshaw plays a vital of the role of IPT which has fulfilled more than 40% of public transport demand (Shrivastava 2011). Although this patronage of auto-rickshaw as a significant mode of urban travel, almost negligible study has been carried out to assess the customer satisfaction of its users. Therefore the present study tries to examine the user's perception of auto rickshaw as a mode of urban transportation. The study was conducted in the city of Patna. The mode share for an auto rickshaw is 8 percent for non-slum population and 10 percent of for slum population (Shrivastava 2011).

Shimazaki and Rahman (1996), as well as Hilling (1996), have carried out an intensive study on vehicular and drivers characteristics of auto-rickshaw in Sri Lanka. Their study has found that these operate on similar patterns in many developing countries and have acquired different names in different places such as Tuk-Tuks in Thailand, Auto-Rickshaw in India, Three Wheeler in Sri Lanka and Keke Napeps in Nigeria. Analysis of mode shares for select cities shows that auto-rickshaws serve between 10 and 20 percent of daily person trips made on motorised road transport methods. For these cities, auto-rickshaws establish a small

percentage (2-11%) of the total number of motor vehicles, but they explain a higher percentage of mode shares since they help multiple users over the course of a day and night (Sustainable Urban Transport in India, EMBARQ). Mohan (2008) and Natrajan et al. (2014) studied the characteristics of auto rickshaw operation in India. Nwaogbe (2012) studied the characteristic of paratransit operation in Nigeria.

Customer satisfaction survey is one of the best methods executed to assess the quality of any service. From the customer satisfaction survey, any deficiency in existing service or functioning can be ascertained and sorted out (Rohani et al.; 2013). Customer satisfaction surveys are proved to be an essential tool for taking into consideration of customers' point of views and developing strategies for improvement (Noor et al., 2014; Shaaban and Khalil, 2013).

The paper is an attempt to explore the present quality or level of services available in the auto rickshaw operating in Patna. The findings will help to understand the limitations of the existing auto rickshaw service and help responsible authorities and policy makers to improve the quality of service and attract more users to the auto rickshaw service. Through these findings, the authorities will be able to identify all elements of intermediate public transport that should be addressed. Even though a glance of the IPT service shall find it to be inadequate, of poor quality and yet economical, the user satisfaction regarding the IPT service is very much required to assess the quality of the existing system, to suggest for its improvement and also for the introduction of new modes of public transportation in the city.

2. Methodology

Customer satisfaction survey has been carried out by various researchers in which the estimation of importance is made using various statistical techniques. A well-known and suitable multiple attribute decision-making method TOPSIS has been used by Dodangeh et al., 2009 and Sadhukhan et al. (2014). Other methods includes analytical hierarchy process (AHP) which had been used by (Saaty, 2008; Wong and Li, 2008), consumer satisfaction index (CSI) (Eboli and Mazzulla, 2009), impact scoring (TRB, 1999), RIDIT analysis (Bross, 1958; Sadhukhan et al., 2014; Wu, 2007) and gray relation analysis (GRA) (Kuo et al., 2008; Wu, 2007). The present study was carried out using a paper based survey instrument and responses were collected regarding rating on the six-point Likert-type satisfaction scale. The data was analyzed using GRA analysis.

2.1 Grey Relation Analysis (GRA)

While dealing with Likert-type scale data in multiple attribute decision-making method like in customer satisfaction survey, it becomes difficult in getting a credible and accurate result when the data is small in size or discrete in nature. Grey Relation Analysis (GRA) of grey system theory, proposed by Deng Julong (Deng, 1989) has been utilized efficiently in solving this kind of problems. GRA method has emerged as a good approach to analyze the rating data, and it is distribution free.

Although the methodological aspects of GRA are well documented in the literature, a brief has been narrated below in the context of the present study. The procedure to analyse the Likert-type scale data using GRA consists of the following steps (Sadhukhan et al., 2014; Wu 2007):

Step 1: Generate Reference Data Series x_0

$x_0 = (d_{01}, d_{02}, \dots, d_{0m})$ where $m =$ number of respondents. The x_0 reference data series consists of m values representing the most favored responses.

Step 2: Generate Comparison Data Series x_i

$x_i = (d_{i1}, d_{i2}, \dots, d_{im})$ where $i = 1, \dots, k$ where $k =$ number of scale items.

Therefore, there will be k comparison data series and each comparison data series contains m values.

Step 3: Compute the difference data series Δ_i

$\Delta_i = (|d_{01} - d_{i1}|, |d_{02} - d_{i2}|, \dots, |d_{0m} - d_{im}|)$

Step 4: Find the Global Maximum Value Δ_{\max} and Global Minimum Value Δ_{\min} in the Difference Data Series

$$\Delta_{\max} = \max (\max \Delta_i) \quad \Delta_{\min} = \min (\min \Delta_i)$$

$\forall i \qquad \qquad \qquad \forall i$

Step 5: Transform each data point in each Difference Data Series to a Grey Relation Coefficient

$$\theta_i(j) = (\Delta_{\min} + \omega \Delta_{\max}) / (\Delta_i(j) + \omega \Delta_{\max})$$

where $\Delta_i(j)$ is the j value in the Δ_i difference data series and ω is a coefficient having a value between 0 to 1, while 0.5 is default value set to the model.

Step 6: Compute grey relation for each difference data series as

$$\Gamma_i = (\sum_{n=1}^m \theta_i(n)) / m$$

where Γ_i represents the grey relation grade for the i th scale item and assumes that data points in the series are of the same weights.

Step 7: Sort Γ values into either descending or ascending order to facilitate the managerial interpretation of the results.

2.2 Survey Instrument and Data Collection

Based on a review of the literature, discussion with experts and reconnaissance a total of seventeen attributes defining the service quality of an Auto-Rickshaw was selected for the present study. The brief descriptions of the selected attributes are reported in Table 1.

Table1. List of Auto-Rickshaw services attributes

Code	Attributes	Description
A1	Comfort of Riding	It means the comfort level of seating while riding an Auto-Rickshaw.
A2	Driver's Attitude	It refers to the behavior of the Auto-Rickshaw drivers towards the passenger.
A3	Cleanliness of Auto Rickshaw	It refers to the cleanliness of the vehicle.
A4	Travel Time (min/km)	It refers to the average travel time taken by the Auto-Rickshaw per kilometer.
A5	Fare of Auto Rickshaw	It refers to the average fare of the Auto-Rickshaw per kilometer.
A6	Security	It refers to the degree of security while riding.
A7	Reliability	It refers to the timely response of the vehicle as per demand.
A8	Occupancy of Vehicle	It refers to the number of the passenger riding the vehicle.
A9	Frequency of Fleet	It refers to the time gap between the successive availability of the Auto-Rickshaws.
A10	Convenience of Diversely abled People	It refers to the provision kept for differently abled people using the vehicle.
A11	Condition of the Vehicle	It refers to the physical condition of the vehicle.
A12	Safety of Women especially at night	It refers to the safety of female passenger especially at night riding Auto-Rickshaw.
A13	On-board Safety	It refers to the degree of safety inside the vehicle.
A14	Travel Information related to Fare and Route	It refers to the travel related information related to the route and fare chart of Auto-rickshaw service.
A15	Exposure to Weather	It refers to the exposure to the external weather for the passenger.
A16	Ease of Carrying Luggage	It refers to the security of travelers and their belongings while traveling during nights.
A17	Noise Exposure	It refers to the exposure to the external and internal noise produced by the Auto-rickshaw.

During the data collection, simple random sampling technique was adopted (Fricker, 2008). A total of 537 (68.92% response rate) Auto-Rickshaw passengers were interviewed and requested to rate the 17 attributes in 1 to 6 scales where 1 represent extreme dissatisfaction,

and 6 represents extreme satisfaction associated with the given attributes of Auto-Rickshaw service in the Patna city. The summary of responses of 537 respondents is shown in Fig. 2.

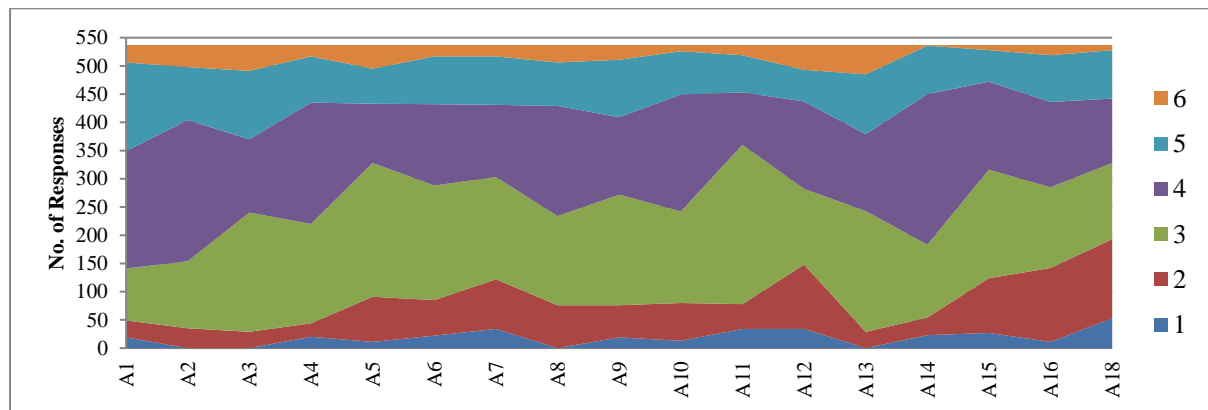


Fig. 1 Three-wheeler Auto-rickshaw (3-seater and 4-seater)

3.0 Results and Discussion

The rating responses were suitably coded in a digital database and analyzed with GRA methods. The GRA score and derived ranking of attributes based on satisfaction are presented in Table 2.

Table 2 Ranking of Auto-Rickshaw Quality Attributes using GRA method

Code	Attributes	max Δ_i	min Δ_i	Gray Relation Score (Γ_i)	Rank
A1	Comfort of Riding	6	1	0.5929	1
A2	Driver’s Attitude	6	2	0.5325	8
A3	Cleanliness of Auto Rickshaw	6	2	0.5321	9
A4	Travel Time (min/km)	6	1	0.5473	2
A5	Fare of Auto Rickshaw	6	1	0.5340	5
A6	Security	6	1	0.5299	11
A7	Reliability	6	1	0.5214	13
A8	Occupancy of Vehicle	6	2	0.4997	16
A9	Frequency of Fleet	6	1	0.5443	3
A10	Convenience of Diversely abled People	6	1	0.5302	10
A11	Condition of the Vehicle	6	1	0.5088	14
A12	Safety of Women especially at night	6	1	0.5330	6
A13	On-board Safety	6	2	0.5325	7
A14	Travel Information related to Fare and Route	6	1	0.5381	4
A15	Exposure to Weather	6	1	0.5014	15
A16	Ease of Carrying Luggage	6	1	0.5218	12
A17	Noise Exposure	6	1	0.4965	17

For reference data series (x_0), the most favoured responses were taken as ‘6’ Likert-scale value. From the columns (max Δ_i) and (min Δ_i) of above table, Global Maximum Value (Δ_{max}) = 6 and Global Minimum Value (Δ_{min}) = 0 were obtained respectively.

It may be mentioned higher the rank of an attribute represents the higher satisfaction of the user associated with the attribute under study. It may be seen from the Table 2 that users in the study area are generally satisfied with the riding comfort, travel time, and frequency of the Auto-Rickshaw. Passengers are also satisfied with present fare and women safety (as female passengers are not allowed to seat in the front seat and also given due respect and priority to ride the Auto-Rickshaw). However, passengers are not satisfied with the reliability of the mode especially at night and the ease of carrying luggage. The noise produced by the engine and higher occupancy generally in peak hours is found as dissatisfactory to the sampled respondents. The provision for elderly and differently abled people are also not found that satisfactory except in a few cases where the low floor Auto-Rickshaws are plying on several routes in the study area. It can be seen that the dissatisfaction associated with the auto rickshaw like problems of noise, occupancy of the vehicle and exposure to weather specially during the adverse weather condition is a serious discouraging factor for auto users. The condition of the vehicle, its reliability of operation and difficulty in carrying of luggage are other factors with which the users are not much satisfied with. Therefore, the frequencies of these auto rickshaws are to be increased. This shall not only cater to the demands especially during the peak hour but also reduce overcrowding. Though the users are in general satisfied with the fare structure, sitting arrangement, driver's attitude and cleanliness of the autos, the higher satisfaction rating given to the travel information about fare and route might not always be true especially for new users as no display of the above was observed in the vehicles surveyed. The average rating was accorded to the safety of women users during the night and travel time was taken. The frequency of operation and convenience of autos for an elderly and differently abled person were also given average ratings. Lack of proper auto stops equipped with information system has been observed and reported. This in the absence of proper enforcement has given the auto drivers the liberty to park their vehicle according to their will to get the maximum passengers in minimum time, leading to severe traffic snarls at many locations.

4.0 Conclusion

The present study brings out several interesting observations of users' satisfaction towards various service attributes of Auto-rickshaws operating in Patna. The findings would help concerned authority and policy maker to improve the present mode of operation of Auto-rickshaw in the city. So that the passengers of the autos have access to the real-time information of the autos along with their origin points, it is recommended that the auto

terminals to have ITS based passenger information system, which may work on any technology. This will make the passenger aware about the autos, their routes and their fare, making the auto system more attractive for the users increasing its patronage. The seating arrangement of the autos should be such that the passengers are kept protected from adverse weather condition and noise of traffic. There should be designated space for keeping the luggage, and the entry and exit should be made barrier free making it equally convenient for elderly, disabled and children. The existing autos should be retrofitted for the purpose, and the supplier of new buses should be communicated to revise the specification of supply of the autos to make it barrier-free. In order to further enhance the patronage of bus users, air conditioned auto service need to be introduced. A greater comfort associated with this mode of intermediate public transport shall attract choice riders of middle and upper middle class also. There is a need to improve driver's behavior as suggested by few users. There is a need for constant monitoring of the behavior of the public. The introduction of complaint book and its monitoring by competent authority is bound to improve the driver and conductor's behavior.

Although the findings of the study is case specific, the approach demonstrated in the manuscript may be employed in other contexts to deal with customer satisfaction towards any transportation problem in other cities with necessary changes in the input parameters.

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