Paper ID: CE 0123

Paratransit Safety Evaluation Using Poisson Regression: A Case Study Based on Driver Perception

Md Sifat Bin Siraj[1*], Most. Farjana[2], Md. Chana Ullah[3]

[1]School of Transportation and Logistics, Southwest Jiaotong University, Sichuan, China (sifatbinsiraj@gmail.com)
[2] Department of Urban and Regional Planning, RUET, Rajshahi, Bangladesh (farjanaalom384@gmail.com)
[3]Department of Civil Engineering, DUET, Dhaka, Bangladesh (sanaduetian@gmail.com)

Abstract

A demand-responsive and flexible transportation facility is frequently provided by the paratransit system. People in Bangladesh rely heavily on paratransit for their mobility due to a lack of formal public transportation or mass transit systems, particularly in medium and small cities. This research presents the results of an investigation into the safety evaluation of paratransit in Gazipur city by using the Poisson regression model. The goal of this work is to emphasize the significance of travel safety perceptions in determining perceived accessibility in day-by-day paratransit travel. A pen and paper survey were conducted of 507 drivers of several paratransit's at 9 important paratransit sites in Gazipur city. Here found accident type Property damage 76.13% & possible injury 16.17% behind the Reasons of accident non-expert driver 80.87%, driven Faster 16.96% and talking on the phone 1.97%. Vehicles involve crush with Easy bike 54.64%, Pedestrian 16.96% and Rickshaw 14.20%. For modelling count data and examining the connection between variables and event occurrences, the Poisson regression model is important. The conclusions of this article may aid the government and other relevant bodies in developing policy recommendations for paratransit, particularly when a mass transit system is being considered.

Keywords: *Paratransit Safety; Poisson regression; Driver's perception; Accidents reason; Gazipur City.*

1 Introduction

Paratransit which one is considered as an intra city transport service is the most effective mode of transportations. It has a comparatively flexible route within city network. In context of Bangladesh it doesn't have any fixed route or fixed service schedule (Ahmed et al., 2023), but it has a strong networking system. It is an urban passenger transportation services operate on public streets and highway in mixed traffic which is operated by private or public operators and available to the general public. Paratransit is different for developing and developed countries. In developing country, it is one of the best solutions for transport service to passenger with lower fare price, flexible service schedule, and comparatively door to door service. Disable, children, women can achieve highest service facilities from paratransit mode. Commonly known paratransit vehicles are CNG, Rickshaw, laguna, tempo, shared uber, shared bike service, pedicabs, motorbikes, and van-type minibuses and so(Siraj et al., 2022). It is used as a "gap filler" between conventional buses and private automobiles which are driven by both individuals and small businesses (Siraj et al., 2021b). Paratransit services are increasing day by day due to availability, save travel time, cost, comfortable traveling, and security of goods, etc. Around 72% household use rickshaw as their daily travels in Dhaka City, Bangladesh(Hossain et al., 2021). Using paratransit in developing nations has several advantages over using other types of public transportation, including greater mobility and accessibility, lower operating costs for short distances, unrestricted lane movement, relatively low maintenance costs, a large share of urban employment for unskilled workers, collector connections between houses and trunk routes, flexibility, and sensitivity to shifting market conditions, among other things (Siraj et al., 2021a, Siraj et al., 2022, Anwari et al., 2021b). From a different angle, paratransit causes problems like traffic jams, accidents, environmental pollution, and more (Siraj et al., 2023, Anwari et al., 2021a, Islam et al., 2022). The paratransit drivers in developing countries are illiterate, unskilled, mostly don't have driving license, do not follow traffic rules and regulations that's cause to occur traffic congestion, most of the accident (Jianxin et al., 2021). So, based on drivers' perception quality services, safety and security of paratransit services need to be ensured by proper management.

This study investigated the quality of paratransit drivers in terms of demographic information, driving related information, and accident information. This research mainly focused on the assessment of paratransit safety and service quality by paratransit drivers using the Poisson Regression model. Paratransit safety and service quality at industrial locations like Gazipur City in underdeveloped countries are difficult to come by. A safety evaluation of paratransit has been conducted in which the major concern is the smooth movement of pedestrians and vehicles. The analysis will focus on safety and security, the impact on societies and so on. The proper management and growing reliability of the paratransit system are needed for efficient and cost-effective operation. The findings of this study will contribute to the introduction of a simple method for raising the general standard of paratransit in Gazipur city. Therefore, to increase the safety of paratransit, policymakers and paratransit operators may focus their efforts on enhancing the most crucial characteristics.

2 Methodology

In this study, a manual questionnaire survey was employed. The poll was conducted at 9 in Gazipur's most important paratransit sites. Between 1st of June 2021 to 30th of August 2021. On weekdays and weekends, 507 people were questioned in various places. Respondents were picked at random from survey sites based on their opinions on a variety of characteristics (Age, Type of vehicles, Occupation of drivers, Education of drivers, driving experience, Institutional driving training, driving duration (Hour), Driving income daily (BDT), Speed of vehicles (kmph), Accident type, Reason of accident, Vehicle involve with crush, Awareness of traffic rules, Time of accident). In Gazipur, the Poisson Regression Model (PRM) is utilized to assess the safety and service quality of paratransit. Tempo, Laguna, CNG, Rickshaw, Easy bike are the principal paratransit modalities in Gazipur city.

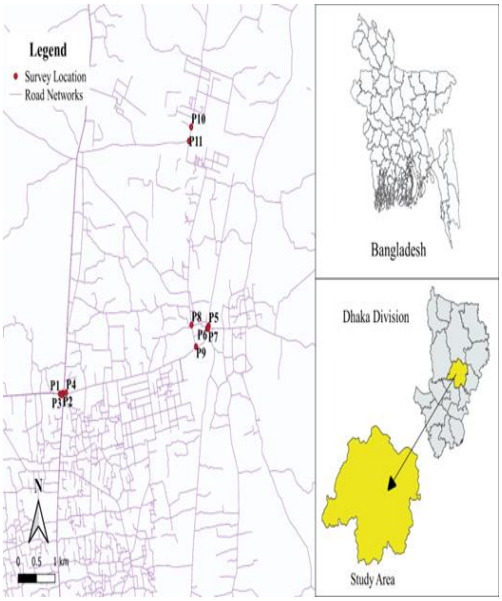

Figure 1- Paratransit research area.

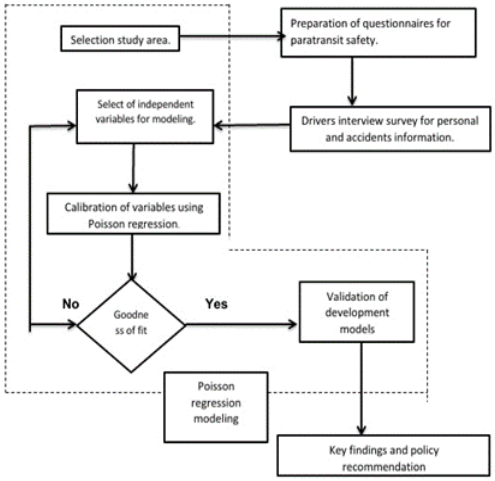

Figure 2- Research Methodology.

3 Descriptive Analysis

3.1 Driver's demographic characteristics

In the Table 1. The first column displays the attribute's name, the second column displays their category, the third column showing the quantity and percent. Height's response drivers aged 31-40 years 35.90% and 13-30 years 29.98%. Drivers are 96.84% professional drivers. Maximum paratransit vehicles are easy bike 310 (61.14%), rickshaw 143 (28.11%) and CNG 40 (7.89%). Driver's education Primary 333(65.68%), Illiterate 111(21.89%) and Secondary 61(12.03%). Most drivers driving experience 0-5 years 293(57.79%), 6-15 years 162(31.95%). Unfortunately, 98.42% of drivers have no Institutional driving training. Most drivers' daily income ranges between 500-1000 BDT 75.35% and second height income 0-500 BDT 15.58%.

Table 1. Driver's demographic characteristics.

Attribute	Category	N (%)
Type of vehicles	Tempo	2(0.39)
	Laguna	12(2.37)
	CNG	40(7.89)
	Rickshaw	143(28.21)
	Easy bike	310(61.14)
Age	13-30	152(29.98)
	31-40	182(35.90)
	41-50	106(20.91)
	>50	67(13.21)
Occupation of drivers	Caretaker	1(0.20)
	Day Labor	1(0.20)
	Farmer	2(0.39)
	Student	3(0.59)
	Business	9(1.78)
	Driving	491(96.84)
Education of drivers	Primary	333(65.68)
	Secondary	61(12.03)
	H. Secondary	1(0.20)
	Graduate	1(0.20)
	Illiterate	111(21.89)
Driving experience	0-5	293(57.79)
	6-15	162(31.95)
	16-25	37(7.30)
	26-35	15(2.96)
Institutional driving training	No	499(98.42)
	Yes	8(1.58)
Driving duration (Hour)	0-5	14(2.76)
	6-10	343(67.65)
	15-20	150(29.59)
Driver's daily income (BDT)	0-500	79(15.58)
	500-1000	382(75.35)
	1000-1500	44(8.86)
	1500-2000	2(0.39)

3.2 Descriptive statistics

From the Table 2. Found Speed of vehicles 25-40 kmph 59.17%, 15-25 kmph 28.60%. In this study area a lot of accidents were found, accident severity can be categorized as property damage only 386 (76.13%), possible injury 82(16.17%) and non-incapacitating injury 25(4.93%). Reasons of accidents are found to be non-expert driver 80.87% and driving faster 16.96%. Vehicles involved with crush impact with easy bike 54.64%, pedestrian 16.96% and rickshaw 14.20%. Here 99.01% aren't aware about traffic rules. Maximum accidents happen at day 451(88.95%) and at night 56(11.05%).

Table 2. Descriptive statistics.

Attribute	Category	N (%)
Speed of vehicles (kmph)	15-25	145(28.60)
	25-40	300(59.17)
	40-60	62(12.23)
Accident type	Fatality	6(1.18)
	Incapacitating	8(1.58)
	Non-incapacitating injury	25(4.93)
	Possible injury	82(16.17)

	Property damage only	386 (76.13)
Reason of accident	Environmental Effect	1(0.20)
	Talking on phone	10(1.97)
	Driven Faster	86(16.96)
	Non-expert driver	410(80.87)
Vehicles involve with crush	Truck	1(0.20)
	CNG	4(0.79)
	Car	7(1.38)
	Bus	11(2.17)
	Bike	49(9.66)
	Rickshaw	72(14.20)
	Pedestrian	86(16.96)
	Easy bike	277(54.64)
Awareness of traffic rules	Yes	5(0.99)
	No	502(99.01)
Time of accident	Night	56(11.05)
	Day	451(88.95)

4 Model Development (Poisson Regression Model)

Due to their suitability for the analysis of count data and their capacity to take into account a number of variables that affect safety outcomes in the paratransit setting, Poisson Regression Models (PRM) are frequently employed for paratransit safety evaluation. Here are some explanations for why Poisson regression is appropriate for assessing the safety of paratransit: data nature counts Exposure adjustment, confounder adjustment, finding predictive variables, and interpretability.

Overall, the Poisson regression model is an effective statistical technique for safety evaluation since it can handle count data, take exposure into consideration, find predictive variables, account for confounders, and produce findings that are easy to understand. Researchers and practitioners may enhance safety in a variety of areas, such as public health, transportation, workplace safety by using this model to acquire insights into the variables impacting safety outcomes.

4.1 Poisson Regression Model

In Poisson regression, the probability P of intersection i experiencing y_i accidents per year can be expressed as follows,

$$P(Y_i = y_i) = \frac{EXP\ (\lambda_i)\ \lambda_i{}^{y_i}}{y_i!} \quad (1)$$

Where λ_i which equals the anticipated number of accidents at intersection i, is the Poisson parameter for intersection i.

$$\lambda_i = EXP\ (\beta X_i) \quad (2)$$

Where a vector of explanatory variables X_i and a vector of estimable parameters β are present. The estimated number of incidents each period is indicated by this formula:

$$E[Y_i] = \lambda_i = EXP\ (\beta \chi_i)$$ (Qin et al., 2018). (3)

5 Model Results

Table 3. Poisson regression for safety evaluation of paratransit.

	Coefficient	**P-value**
Constant (Reasons of accident)	-0.251	0.831
Type of vehicles	0.175	0.094
Age	-0.032	0.502
Occupation of drivers	0.020	0.870
Education of drivers	-0.004	0.943
Driving experience	-0.063	0.050*
Institutional driving training	- 0.061	0.002*

Driving duration	-0.065	0.348
Driver's daily income	-0.001	0.910
Speed of vehicles	0.293	0.012*
Accident type	0.152	0.001*
Vehicles involve with crush	0.134	0.048*
Awareness of traffic rules	-0.228	0.595
Time of accident	0.050	0.740
Model Fit Results		
Log likelihood	-608.389	
Wald chi^2 (Prob > chi^2)	51.33 (0.0001)	
Pseudo R^2	0.39	

* P-value ≤ 0.05 is regarded as statistically significant in this case.

Poisson regression for the safety evaluation of paratransit. Reasons of accident (Fatality, Incapacitating, Non-incapacitating injury, Possible injury, Property damage only) is regarded as a dependent variable and other 12 factors (Type of vehicles, Age, Occupation of drivers, Education of drivers, driving experience, Institutional driving training, driving duration, Diver's daily income (BDT), Speed of vehicles, Accident type, Vehicle involve with crush, Awareness of traffic rules, Time of accident) are considered independent variables. From the analysis P value of Accident type (0.001), Speed of vehicles (0.012) and Vehicle involved with crush (0.048) are positively related and statistically significant with Reasons of accident. When increase Accident type, Speed of vehicles and Vehicle involve with crush then increase Reason of accidents. Institutional driving training (0.002), Driving experience (0.050) are negatively related and statistically significant with Reasons of accident. Which indicate that when increase drivers Institutional driving training and driving experience then decrease Reasons of accident.

The long likelihood of Poisson regression model is (-608.389). The Wald chi^2 Value is Significant (0.0001) and the value is (51.33). Pseudo R^2 value for accident type in paratransit is found (0.39).

4 Conclusion

In the city's transport system, shared mobility is provided via paratransit (Siraj et al., 2023). A sustainable transportation system can be provided by making paratransit transport safe and easily accessible. This research presents the results of a clear idea about the safety evaluation of paratransit in Gazipur city by using the Poisson regression model. It is critical to highlight the features specific to people's perceptions of how simple it is to live the life they want with the help of a sustainable paratransit system, as an example. driving skills of drivers (year). The findings emphasize the significance of travel safety perceptions in determining perceived accessibility in day-by-day paratransit travel. Here some (accident type, speed of vehicles vehicle involves with crush, driving experience and institutional driving training) attributes are relatively significant with Reasons of accident. There is a need to take a long-term approach to the creation of future paratransit, including constant quality improvements according to contextual needs. There are a significant number of literatures based on paratransit modes and for improving them, further examination based on comprehensive research is required. It will take more time and money to address issues like privacy and security for shared mobility and the development of various methodological approaches and timelines for paratransit operations study. In the end, the more research that can address these gaps, the better tactics and policy measures may be utilized to integrate and improve service for all users.

References

Ahmed, M. T., Sıraj, M. S. B. and Campısı, T. 2023. Paratransit Safety as a Key Resource for Sustainable Mobility in Developing Countries. Communications - Scientific letters of the University of Zilina, 25**,** 11.

Anwarı, N., Ahmed, M. T. and Islam, M. R. 2021a. Investigating the Characteristics and Opinions of Public Transit Users in an Industrial City of a Developing Country. TRB 101th Annual Meeting.

Anwarı, N., Ahmed, M. T., Islam, M. R., Hadıuzzaman, M. and Amın, S. 2021b. Exploring the travel behavior changes caused by the COVID-19 crisis: A case study for a developing country. Transportation Research Interdisciplinary Perspectives, 9**,** 100334-100334.

Hossaın, M. K., Sıraj, M. S. B., Hasan, M., Chowdhury, M. M. H., Uddın, M. H., Islam, M. S., Ratna, K. A. and Asma, M. S. 2021. Mode Choice Behavior of Chittagong City Dwellers in Bangladesh. Journal of Transportation Systems, 6**,** 10.

Islam, M. R., Ahmed, M. T., Anwarı, N., Hadıuzzaman, M. and Amın, S. 2022. The Aspiration for Happy Train Journey: Commuters' Perception of the Quality of Intercity Rail Services. CivilEng, 3**,** 909-945.

Jıanxın, Y., Rabbı, F., Sıraj, M. S. B. and Zhenzhen, L. 2021. Road Traffic Accident Situation in Dhaka City, Bangladesh. Journal of Transportation Systems, 6**,** 23-34.

Qın, L., Lu, Y. and Zhang, S. 2018. Analysis of left-turn crash using Poisson Regression model at unsignalized intersections. 163**,** 520-526.

Sıraj, M. S. B., Hasan, M. and Ahmed, M. T. 2021a. Understanding the Mode Choice Behavior for Short Distance and Regular Travel in a Developing Country. BRSA, 3rd Annual Conference on Regional Science (ACRS 3), 2021,. Dhaka, Bangladesah.

Sıraj, M. S. B., Hasan, M., Farjana, M., Ratna, K. A., Asma, M. S., Islam, M. J., Rabbı, F. and Rakıb, R. 2023. Realize Service Quality of Paratransit in a Developing Country: A Multinomial Logit Approach. 7th International Conference on Engineering Research, Innovation and Education School of Applied Sciences & Technology, SUST, Sylhet. Sylhet, Bangladesh Shahjalal University of Science and Technology (SUST).

Sıraj, M. S. B., Rabbı, F., Islam, M. J. and Asma, M. S. 2021b. Road Accident Analysis : A Case Study Dhaka Metropolitan Area. Journal of Transportation Systems, 3**,** 48-54.

Sıraj, M. S. B., Taleb, M. A., Hasan, M., Hossaın, M. K. and Ullah, M. C. 2022. Pedestrians Perceptions About Footpath Quality In Khulna City. 3rd International Conference on Research & Innovation in Civil Engineering (ICRICE 2022).