

Research Article

Prospects and Challenges of E-Rickshaws in Urban Transportation Systems of Bangladesh: A Case Study of Rangpur City Corporation

Md. Ashrafuzzaman Pramanik¹, M. Shafiq-Ur Rahman², Ashraf Uddin Fahim¹,
Mohammad Mizanur Rahman^{2,*} 

¹Department of Urban and Regional Planning, Pabna University of Science and Technology, Pabna, Bangladesh

²Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka, Bangladesh

Abstract

The availability of public transportation is frequently insufficient and the quality of the services is quite low in many cities of developing country. This is mostly because of the growing discrepancy between the supply and demand for transportation infrastructure and the provision of services. As a result, E-rickshaws (battery-operated electric three-wheelers locally termed as Auto/Easy bike) have emerged as a form of para-transit/informal public transport in many developing country cities and providing flexible and demand-responsive services to users. E-rickshaws are becoming one of the main travel modes and playing a crucial role in urban mobility because bus-based or formal public transportation is lacking in many medium- and small-sized cities in Bangladesh. This study made an effort to answer how E-rickshaws might function in the future when public bus service will be launched in a mixed traffic situation of Bangladesh. Rangpur in Bangladesh was selected as the representative of developing country cities for conducting the case study. This study is generally based on primary survey because the E-rickshaw is a new concept in urban transport. Primary data were collected at different road intersections and some temporary E-rickshaw stands in Rangpur City (as no permanent E-rickshaw stand in the city). Basically, the data was collected by Questionnaires Survey with E-rickshaw Drivers and Users; Focus Group Discussion (FGD) with E-rickshaw union members and Key Informants Interview (KII) with local authorities who are concerned with E-rickshaws. The driver-owned, operational E-rickshaw has an income-investment ratio of 1.45 and generates an average daily income of BDT 850. According to the survey, 81% of the drivers of E-rickshaws agreed that their current financial situation or income is better than it was when they worked in another or previous occupation. Compared with other travel modes, commuters are very satisfied with the quality of E-rickshaw services. Based on study findings it may be concluded that the E-rickshaw is a potential future-proof means of transportation. Public transport planning should include E-rickshaw in providing services which may not be catered by the formal public transport. The conclusions drawn from this case study is that locations may be applied to other places in the country or cities where rickshaws are a significant source of informal public transportation.

Keywords

E-rickshaw, Public Bus, Para-Transit, Informal Public Mode, Public Transport Planning

*Corresponding author: mizanurp@juniv.edu (Mohammad Mizanur Rahman)

Received: 6 March 2024; **Accepted:** 25 March 2024; **Published:** 29 April 2024



Copyright: © The Author(s), 2024. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

1. Introduction

The demand for mobility services has increased to an unprecedented level in most emerging nations due to rapid urbanization, placing enormous pressure on urban transport infrastructure and services [1]. The populace now relies on informal public transportation services and personal mobility options to meet their mobility demands, even in cities with formal public transportation [2]. This is because conventional public transportation is frequently unreliable and inadequate. The term "public transport" frequently excludes non-official transportation options as tempo, CNG auto rickshaws, E-rickshaws, shared automobiles, taxis, mini buses, etc [3]. Due to the lack of regular public transportation infrastructures or their scarcity, these unofficial means of transportation frequently function as paratransit or intermediate public transportation (IPT) [4].

The battery-operated three-wheeled e-rickshaw is an upgraded version of the auto-rickshaw, sometimes referred to as the Easy-bike/Auto in Bangladeshi language. In addition to the driver, an E-rickshaw frequently has four to six seats for passengers. Bangladesh's urban transportation system uses e-rickshaws as a para-transit or informal public method of transportation [5]. The photographic view of E-rickshaw available in Bangladesh is shown in Figure 1 below.



Source: Khan, 2018 [6]

Figure 1. E-rickshaw/ Battery rickshaw/Easy bike/Auto.

The E-rickshaws, being introduced in Bangladesh in 2008, attained much popularity among urban passengers, particularly in small and medium towns, mainly because of lower travel cost as well as reasonable comfort and safety compared with other locally available travel modes [3]. This mode's quick expansion is a direct outcome of its popularity. Nowadays, e-rickshaws are one of the most popular ways to go short distances and are available in most major cities, suburbs, and townships [7].

E-rickshaws are not legalized as public or private transport mode in Bangladesh. Whatever the case, this form of transportation is now practically a necessary component

of how urban people move around, especially in small and medium-sized cities [8]. Therefore, adding this mode to the local urban transportation system may need a very thorough evaluation. It is unclear at this point in time if this para-transit/informal public travel option will still be necessary in order to support the sustainable growth of public transportation. The primary objective of the study is to explore future existence when formal public transport like city buses will be introduced in a city in Bangladesh. This study also provides some guidelines (based on research findings) on how to manage E-rickshaw when initiating formal public transport like a public bus in the case study Rangpur city of Bangladesh.

2. Literature Review

Motorization has happened so fast in the developing countries that traffic management methods and road infrastructure have not kept up [9, 10, 22]. High-density, mixed-use cities represent the majority of urban areas in developing countries [11, 23, 24]. In developing countries, the majority of urban transportation systems are based on land and often function in mixed traffic settings. There are many different types of vehicles that use the same road space in Bandung, Indonesia, including automobiles, buses, rickshaws, motorbikes, bicycles, pedestrians, and even animals like the "delman," a human-carriage carried by horse that is a popular tourist attraction [12]. This results in significant traffic interruptions, lengthy idle periods, and fatal accidents.

The absence of an institutionalized transportation infrastructure is compensated by the informal transportation services that characterize cities in Sub-Saharan Africa [13]. A major army of boda-boda (boda) motorbike taxis has multiplied across Kampala, Uganda. The drivers of these vehicles maneuver around the city's narrow and run-down roadways while carrying and/or transporting people. In order to better understand the function of informal mobility in Kampala's sustainable urban context, this study looks at the boda industry from the perspective of its users, or passengers and cargo. In summary, this research highlights the supplementary function of the boda system and proposes three strategies to facilitate its incorporation into the public transportation system: enhancement, complementary planning, and institutional transformation. According to this report, the informal mobility system's users should take an active role in eradicating unfavorable perceptions of the transport sector and promoting sustainable urban growth and mobility.

Para-transit modes play an essential role in the urban transport sectors of developing countries since they provide transportation services to a large number of individuals [1, 14, 15, 25]. For instance, E-rickshaws are used more frequently than motorized two-wheeled vehicles for all types of trips—aside from work, leisure, and personal business. They

are, after buses, the most frequently utilized type of motor vehicle in Mumbai for social, educational, medical, and shopping trips. E-rickshaws are used by both high- and low-income populations [16, 17, 26]. The main causes of dependency on paratransit are either an acute shortage of official public transportation service or a very poor quality of public transportation service [18, 27]. Para-transit systems are characterized by unique features. They have somewhat unpredictable schedules and operate over specified paths that function as corridors [19, 20]. Passengers are typically (though not always) picked up and dropped off anywhere along the routes.

Short trips are often covered by e-rickshaws. This mode, which has just been established, provides jobs in Bangladesh as well [7]. However, other than individual purchases, no significant financial institution or organization has been seen investing much in E-rickshaws. The E-rickshaw's operational performance is also directly impacted by power consumption and drive duration before a full charge [21]. Therefore, a thorough financial analysis of e-rickshaws in Bangladesh is crucial in order to draw in big investors. Furthermore, there isn't a systematic study that estimates power consumption and run duration at various battery lifetimes.

3. Research Methodology

Primary data was collected from different road intersections and E-rickshaw stands in the case study city Rangpur of Bangladesh. Data collection methods were included traffic volume survey, structured questionnaire interviews, Focus Group Discussion (KII) and Key Informants Interview (KII). The E-rickshaw users and drivers were interviewed using a structured questionnaire. It is mentioned that for statistical validity 400 samples were selected at 5% confidence interval and 95% confidence level. One FGD was conducted with the members of E-rickshaw union/association whilst the KII with the representatives of local government authorities and organizations involved with para-transits/informal public transport mode management in case study Rangpur city of Bangladesh.

4. Results and Discussion

4.1. Results from E-rickshaw Drivers' Interview Survey

A little over 13% of E-rickshaw drivers who had previously pulled cycle rickshaws made the switch to driving E-rickshaws as their full-time job. Figure 2 illustrates the previous employment status of E-rickshaw drivers: 12% were unemployed, 10% employed as day laborers, 23% were farmers, 9% were students, and 11% were engaged in small business (Source: Field Survey, 2023).

Almost 81% of the respondents mentioned that they

switched to driving E-rickshaw as an occupation mainly because they want to earn more money, as shown in Figure 3. The other reasons are low initial investment cost (6%), unavailability of other suitable job (4%) (Source: E-rickshaw Drivers' Survey, 2023).

The Rangpur city's financial stability of e-rickshaws was assessed, as well as their potential to generate revenue. By using established questionnaires to interview drivers, information on the initial purchasing cost, daily running cost, monthly maintenance cost, and daily average income from E-rickshaws was obtained. An E-rickshaw typically has four to six batteries, while the majority of those in Rangpur have five. The five batteries need an average of ten hours to complete the full charge, with each battery using two units of electricity throughout the charging process. Five batteries consumed total ten ($5 \times 2 = 10$) units of electricity. An E-rickshaw with five batteries will cost about BDT 90 ($10 \times 9 = 90$, 9 BDT for single units of electricity) every day to full charge. Therefore, BDT 32,400 is the average yearly operating cost for this e-rickshaw.

The cost of regular maintenance, which includes the price of components like brake shoes, batteries, tires, and other accessories, is known as maintenance expenses. With the excluded price of batteries and tires, E-rickshaw drivers reported/mentioned that the average monthly cost of periodic maintenance and repair was between BDT 1500 and BDT 2000. According to the findings of the interviews, 64% of the respondents pay between BDT 1500 and BDT 2000 for maintenance each month. However, 24% of respondents reported monthly maintenance costs of more than BDT 2,000 while 12% reported monthly maintenance costs of less than BDT 1500. The average maintenance expense per year is BDT 20,115. The income-expenditure ratio for drivers who own their own E-rickshaws is calculated and shown in Table 1. From the table it was found that the income-investment ratio was 1.45.

Table 1. Income-investment ratio for the self-owned E-rickshaw drivers (in average).

	Vehicle purchasing cost	BDT 1,60,000
	Annual average operation cost	BDT 32,400
Investment	Annual average maintenance cost	BDT 20,115
	Total annual expenditure/investment	BDT 2,12,515
Income	Annual average income	BDT 3,08,000
	Income-Investment Ratio = (annual average income/total annual expenditure) = 1.45	

Source: E-rickshaw Drivers' Survey, 2023 & author's calculation

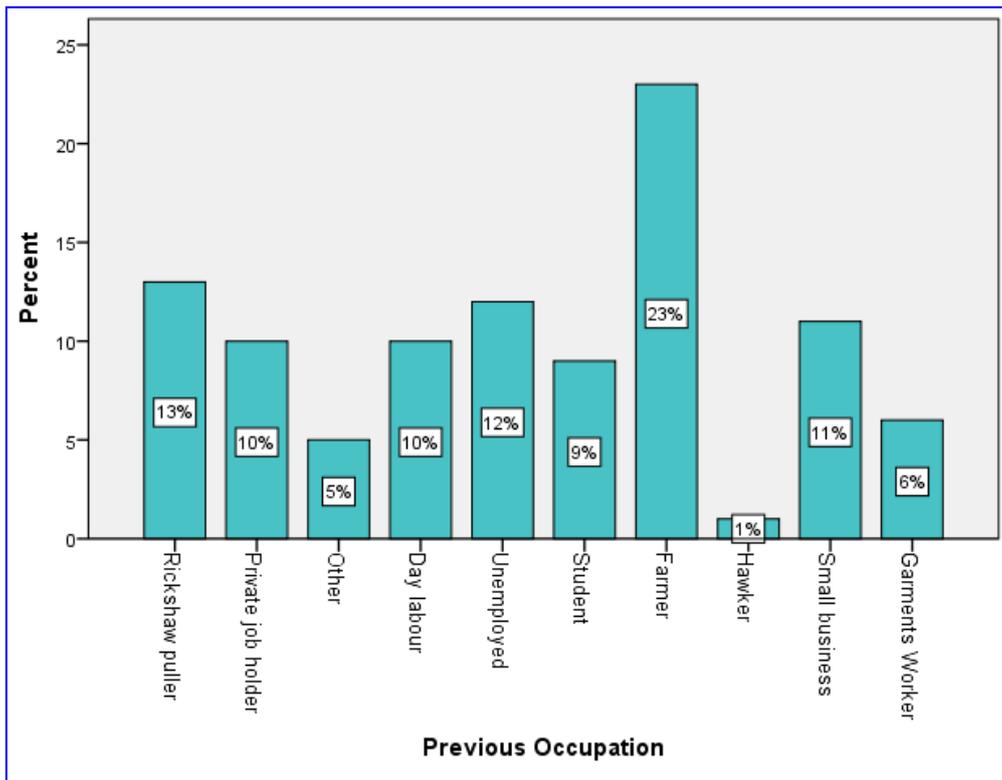


Figure 2. Previous occupation of E-rickshaw drivers.

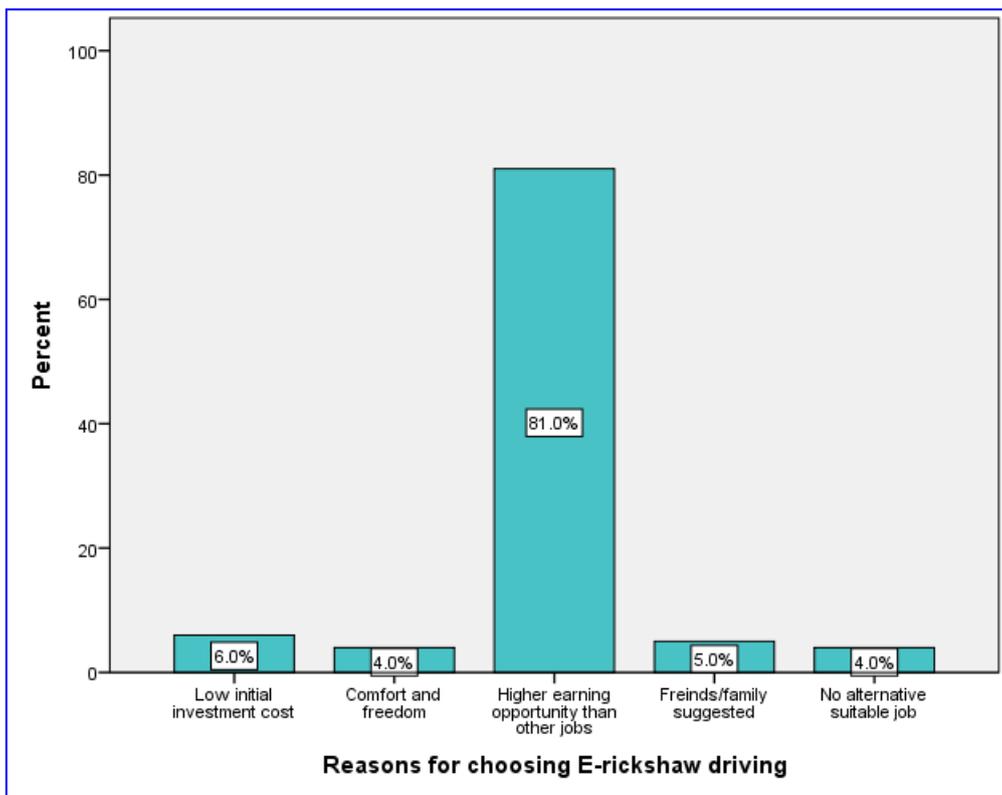


Figure 3. Reasons for choosing E-rickshaw driving in Rangpur city.

Table 2. Depreciation of E-rickshaw.

Price of new E-rickshaw (Avg.)	BDT 1,60,000
Economic service life (Avg.)	3 year
Battery replacement after each one year	BDT 60,000
Salvage value ¹ (Avg.)	BDT 25,000
Depreciable amount ²	BDT 2,55,000
Depreciation (monthly) ³	BDT 7083

¹ The simplest approach to record depreciation is usually by adopting the straight-line technique for asset depreciation. Throughout the asset's useful life, it records an equal annual depreciation expenditure until the asset is fully depreciated to its salvage value. Access to <https://www.investopedia.com/terms/s/straightlinebasis.asp>

² $\sum(\text{Battery replacement} + \text{Salvage value}) \times \text{Year}$

³ $\text{Depreciable amount} / (3 \times 12)$

The costs associated with assembly, charging, maintenance, and part replacement typically account for an E-rickshaw operated by an individual. The monthly depreciation represents the cost of assembly. In order to account for value reductions, depreciation is a helpful accounting strategy that

distributes a tangible asset's cost over the course of its economic service life. was taken into account as the E-rickshaw owner's expense in this study. Table 2 displays the E-rickshaw's monthly depreciation. The straight-line depreciation approach generated this outcome. An e-rickshaw's short economic life and the need to replace the battery pack annually result in an expensive monthly depreciation fee for the owner (Source: E-rickshaw Drivers' Survey, 2023 & Author's calculation).

4.2. Results from E-rickshaw Passengers' Survey

Four different attributes like availability, comfort, reliability, and fare rates for the various travel modes available in Rangpur city were presented to the respondents. The findings highlight that the users prioritize qualitative attributes than quantitative attributes. Perception of the passengers were analyzed with the Relative to an identified distribution integral transformation (RIDIT) technique as shown in Table 3, the score for E-rickshaw is higher than other modes in the city.

Table 3. Service quality attributes of available travel modes in Rangpur city.

Mode	RIDIT Score				Meanscore	Rank
	Availability	Comfort	Reliability	Fare rate		
Cycle rickshaw	0.42	0.55	0.65	0.34	0.490	2
Battery rickshaw	0.52	0.43	0.56	0.38	0.473	3
E-rickshaw	0.45	0.50	0.66	0.76	0.593	1
Auto-rickshaw/CNG	0.31	0.51	0.56	0.47	0.463	4

Source: E-rickshaw Passengers' Survey, 2023

The current state of the quality of the paratransit service was inquired about from the respondents. While 32% of users believe that the current situation is favorable, 45% of respondents responded that the overall quality of the paratransit service is satisfactory (Source: E-rickshaw Passengers' Survey, 2023). The user's perceptions of the current E-rickshaw quality are shown in Figure 4 below.

Rangpur City Corporation is planning to provide city bus service around inner of the city (proposed route map has been shown in Figure 7). If the bus service is expanded to cover larger areas, a substantial share of existing E-rickshaw passengers may shift to bus. Almost 79% of the respondents will shift to bus services and only 21% will continue using E-rickshaw (Source: E-rickshaw Passengers' Survey, 2023) and they emphasized need to protect E-rickshaw by integrat-

ing with public bus (Figure 5).

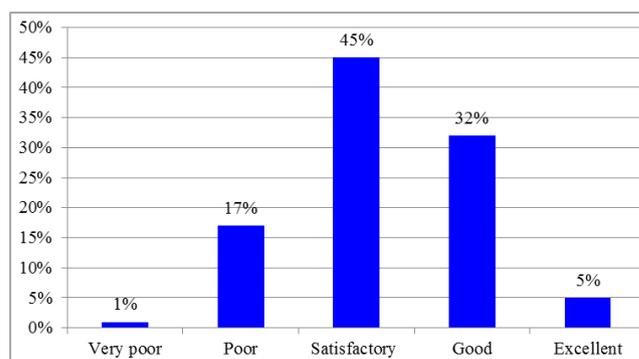


Figure 4. Users' perception on E-rickshaw service quality.

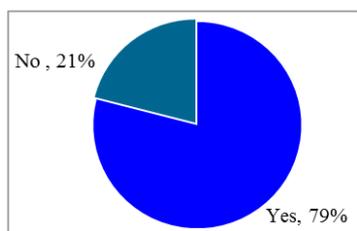


Figure 5. Attitude towards public bus use in the city.

E-rickshaw passengers' preference between the proposed city bus and the E-rickshaw considering their socio-economic characteristics is shown in Table 4. The majority of males (68%) would prefer the proposed city bus, in contrast the majority of females (65%) would prefer E-rickshaws. Users of higher age (more than 18 years) are observed to have a

higher preference for buses, where E-rickshaw is more popular among the young groups. Users engaged in government employment like salaried jobs and college students from the majority users of buses followed by the school students and daily labours. School-going students prefer E-rickshaw (59%) more than the city bus due to the availability of this mode around the city. Govt. employees and day labour groups had more intention to use city buses in the future. Income has been classified into lower to higher income groups. Income less than BDT 15,000 was termed a lower income group, middle income group was between BDT 15001 to 30,000 and the higher income group was regarded as more than BDT 30,000 in the case study city. Lower income category had a higher preference for future city buses compared to the present E-rickshaw service as a public mode of transport in the city.

Table 4. Socio-economic characteristics of E-rickshaw Passengers in mode choice between city bus (proposed) and E-rickshaw.

Variable	Classification	Mode choice (%)	
		Proposed public bus	E-rickshaw
Gender	Male	68	32
	Female	35	65
Age	Less than 18 years	56	44
	>18 – 60 years	74	26
	Above 60 years	57	43
Occupation	Govt. job	87	13
	Private job	69	31
	Business	61	39
	Self employed	53	47
	School student	41	59
	College and higher study	67	33
	Day labour	91	9
Income	Unemployed	64	36
	Low income	77	23
	Middle income	55	45
	High income	44	56

Source: E-rickshaw passengers' survey, 2023

4.3. Implications of E-rickshaw Bans/Restrictions on Major Roads in Rangpur City

Data was collected on the effects of the E-rickshaw ban or

limitation on major roads in Rangpur city as the Rangpur City Corporation authority presented proposed city bus routes around the city. When E-rickshaws were taken off from main roadways, passengers were asked during questionnaire survey to rate the severity (on a scale of 1 to 5, with 5 being the worst) of the effects if they experienced. In Table 5, the average of

their scores for each category of respondents is shown. It demonstrates that women and the young group (children in school) were seen as being negatively impacted. College students are the group most impacted, whereas business peo-

ple and independent contractors are mildly affected. Those who hold private jobs and those who work for the government would be less impacted by the prohibition or restrictions of E-rickshaws from the major roads of the city.

Table 5. Affected stakeholders due to ban/restrictions of E-rickshaw on major roads of Rangpur city.

Variable	Category	Most affected (mean > 3.9)	Moderately affected (mean 3 – 3.9)	Less affected (mean < 3)
Gender	Male		√	
	Female	√		
Age	Less than 18 years	√		
	>18 – 60 years			√
	Above 60 years		√	
Occupation	Govt. job			√
	Private job			√
	Business		√	
	Self employed		√	
	School student	√		
	College and higher study	√		
	Day labour		√	
	Unemployed		√	
Income	Low income		√	
	Middle income		√	
	High income		√	
Length of trip	Short trip	√		
	Medium trip		√	
	Long trip			√

Source: E-rickshaw passengers' survey, 2023

Socio-economic variables like gender, income and to a lesser extent age were observed to have an impact on mode choice. All the travel time components i.e. access and egress time, waiting time and in-vehicle time have a relation towards mode choice. Women's activities will be severely disturbed and they will be the most affected group if the E-rickshaws are restricted on the major roads of the city.

4.4. Results from Focus Group Discussion (FGD)

Rangpur District E-rickshaw Owner-Driver Association is the registered E-rickshaw union. The purpose of this union's formation was to protect the rights, welfare, and legal stand-

ing of drivers and owners. The route and fee must be fixed by the association. The organization has already altered or updated the E-rickshaw fare prices many times. The association's chosen executives seek to protect members' rights and offer assistance in times of need. The bus firms recently addressed the union over the possibility of E-rickshaws providing feeder services and integrating with the city's primary bus stations.

In the Focus Group Discussion (FGD) with members of the E-rickshaw association, ten out of twelve participants expressed that E-rickshaws may be essential feeder services if public buses were introduced to the city. They proposed that their group could control and oversee the functioning of E-rickshaws (such as managing queuing and traffic on the streets). They said that in order to decide whether or not to

control e-rickshaws in the city, the drivers' association, the traffic police, and the local administration may meet together (Source: Focus group discussion with E-rickshaw union, 2023). The union members proposed ideas including lane separation, define routes, and the introduction of permanent

stands in major intersections like Jahajcompany, Pyra chattar, Shapla and Lalbag intersections and also in front of Zila Parishad Community Supermarket for better E-rickshaw management in Rangpur city (as shown in Figure 6 below).

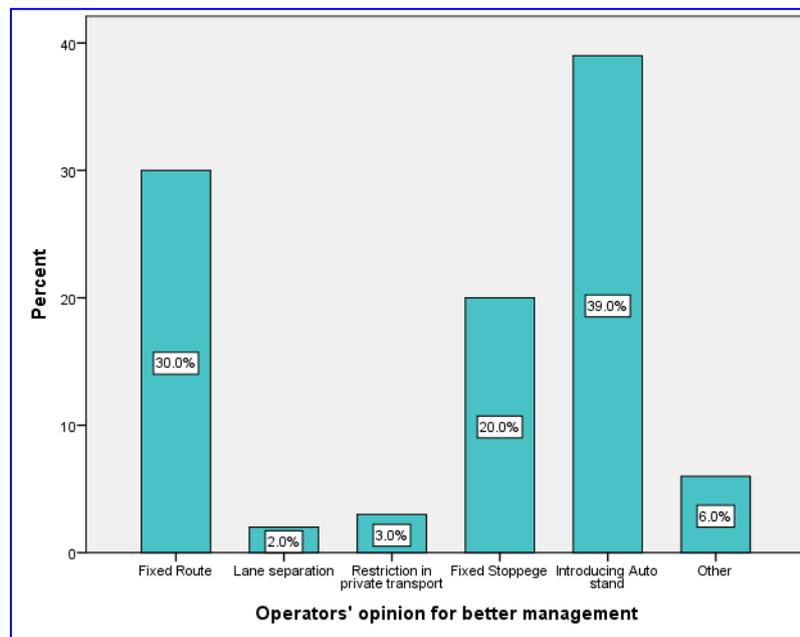


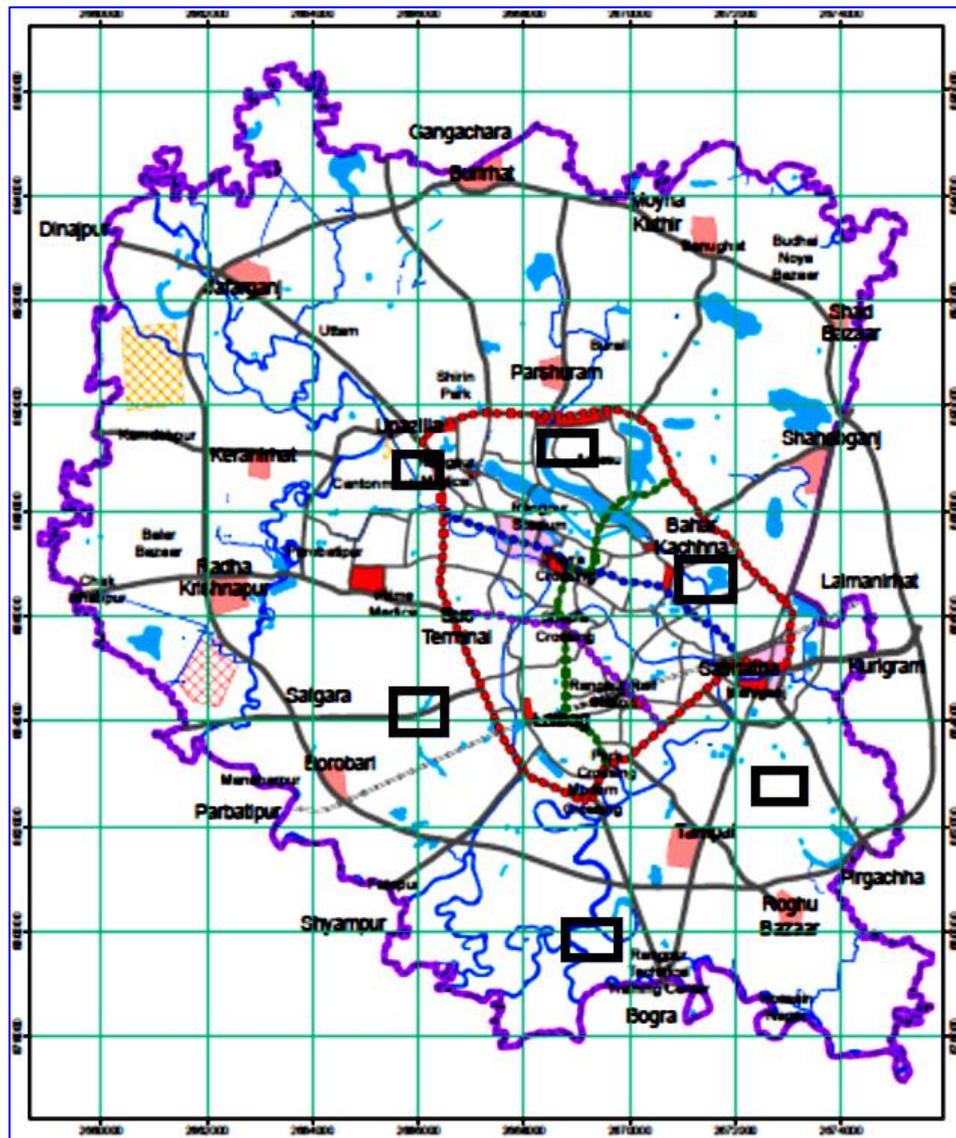
Figure 6. E-rickshaw drivers' opinions for better traffic management.

According to the respondents in FGD, public charging station developed by Rangpur City Corporation (RpCC) would be useful for them who do not have access to authorized charging stations or are unable to charge E-rickshaws. Charging stations can also function as parking areas during non-operational hours and solve the issue of parking to some extent.

4.5. Results from Key Informants Interview (KII)

Face-to-face in-depth interviews were carried out after an open-ended, semi-structured questionnaire. To learn more about the procedure for registering and permission for E-rickshaws, as well as future plans for both private and public transportation in the city, two interviews with City Corporation officials were conducted (one with the honorable Mayor and another with Executive Engineer along with Urban Planner). Additionally, a conversation about duties and responsibilities, traffic laws, and management in Rangpur city was had with the Additional Commissioner of Police, Rangpur City Corporation Police Department. A KII was also discussing guidelines and recommendations with a Bangladesh Road Transport Authority (BRTA), Rangpur officer.

According to the RpCC interviewers, e-rickshaws run on a few established routes as a public transportation option with a fixed pricing structure. They operate by the basic principle of "first in, first out." Owing to the lack of formal public transportation, certain route-based E-rickshaw trips are conducted informally in order to preserve connection between important cities nodes. They also mentioned that as the city is expected not to expand far beyond the inner core at least within plan period and several route based public bus service sufficiently covering the core area might be recommended. Route based public bus service and E-rickshaw stands proposed by RpCC officials around the core area along the inner circular road and across the city on major arterial roads connecting important traffic generating areas (as shown in Figure 7 below). According to RpCC officials, E-rickshaw could serve as an intermediate mode of public transportation if city buses follow the proposed routes in the city. According to them, this mode is the best to operate as a feeder service to other transit modes like the bus, minibus, etc. Along the main bus route, there will be stops at some selected fixed nodal points, and E-rickshaw will carry passengers from the secondary routes to those points. The role of E-rickshaw will be rather complementary in nature on the primary roads.



(Source: Rangpur City Corporation (RpCC), 2023.

Figure 7. Route based public bus service are proposed by Rangpur City Corporation.

Many of the city of Rangpur's roads are extremely narrow, making it impossible to operate normal public transportation vehicles on them. In those narrow and congested streets, not even a small bus with twenty to twenty-five seats could fit. In Rangpur, all other mass transit would only run on the main

thoroughfares or highways. Because many of the small streets would make it impossible for public transportation to operate nearby, it would not be feasible to provide its public bus. Therefore, in order for customers to reach and access to public bus service terminals, feeder services are required.

Officials from the Bangladesh Road Transport Authority (BRTA) in Rangpur stated that the City Corporation of Rangpur should designate the route's boundaries in order to control how the vehicles operate. To control the number of automobiles that exist in a specific area, designated zones should be created. To prevent traffic issues and route blockage, they claim that specific parking spaces and waiting stations may be built for these battery-operated rickshaws.

may be a more convenient and preferable choice if they are a planned intervention that can be placed at a contemporary junction or city entry since they might take less time—3-5 minutes, maximum (Figure 8).



Figure 8. Location proposed battery swapping cum charging station in Modern intersection.



Figure 9. Location of battery charging station in central bus terminal.

The Bus Terminal, Shapla Chattarr, Medical College (Figures 9, 10, and 11) and other major establishments in the city are suitable locations for the charging/parking stations. The RpCC's permitted charging stations could help in promoting effective E-rickshaw transportation. The lack of charging stations now limits the distance that E-rickshaws may go. This problem can be solved by placing charging stations along designated routes. According to the responses, battery charging is becoming more common than battery swapping (replacing the battery). Battery swapping stations



Figure 10. Location proposed battery charging station in Medical intersection.



Figure 11. Location proposed battery charging station in Shaplachattarr intersection.

5. Conclusion

This study was carried out to investigate E-rickshaw operating features within the context of Bangladesh's Rangpur city. A brief summary of the issue is given by the results. Urban passengers like e-rickshaws as their preferred form of transportation due to their deserved speed, increased comfort, and reduced cost of travel. When compared to alternative jobs available to them in nearby towns, driving is a more comfortable and independent form of transportation that requires less capital investment and generates a higher income for low-income urban residents. From an economic perspective, this mode significantly increases the city's annual revenue by increasing the drivers' daily pay. Additionally, it creates jobs for low-income residents in nearby towns

and cities. Besides from these, the majority of urban passengers currently choose the mode that meets their need for travel due to a few special benefits it has over other forms of transportation. It's critical to comprehend how various modes affect passengers and mass transit connectivity in order to implement informal public transportation as a feeder system for mass transit. It is suggested that this study focus on using the current transportation options by implementing an integrated urban transport plan.

Abbreviations

E-rickshaws: Battery-operated Electric three-wheelers
 FGD: Focus Group Discussion
 BDT: Bangladeshi Taka (Money)
 KII: Key Informants Interview
 IPT: Intermediate Public Transportation
 RIDIT: Identified Distribution Integral Transformation
 RpCC: Rangpur City Corporation
 BRTA: Bangladesh Road Transport Authority

Author Contributions

Md. Ashrafuzzaman Pramanik: Conceptualization, Resources, Data curation, Formal Analysis, Supervision, Validation, Investigation, Visualization, Methodology, Writing – original draft, Writing – review & editing.

M. Shafiq-Ur Rahman: Conceptualization, Supervision, Investigation, Methodology, Writing – review & editing.

Ashraf Uddin Fahim: Conceptualization, Data curation, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing.

Mohammad Mizanur Rahman: Conceptualization, Resources, Formal Analysis, Funding acquisition, Validation, Visualization, Methodology, Writing – review & editing.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Cervero, R., & Golub, A. (2007). Informal transport: A global perspective. *Transport policy*, 14(6), 445-457. <https://doi.org/10.1016/j.tranpol.2007.04.011>
- [2] Shimazaki, T., & Rahman, M. (1996). Physical characteristics of paratransit in developing countries of Asia. *Journal of advanced transportation*, 30(2), 5-24. <https://doi.org/10.1002/atr.5670300203>
- [3] Basri, R., Khatun, T., Reza, M. S., & Khan, M. M. H. (2014). Changing modes of transportation: A case study of rajshahi city corporation. *Bangladesh J. Pol. Econ*, 29(3), 1-23. https://www.researchgate.net/profile/Rabeya-Basri/publication/360526091_Changing_Modes_of_Transportation_A_Case_Study_of_Rajshahi_City_Corporation/links/627be81237329433d9a843cf/Changing-Modes-of-Transportation-A-Case-Study-of-Rajshahi-City-Corporation.pdf
- [4] Rahman, F., Haque, F., Ehsan, MT., Rahman, M.M., and Hadiuzzaman, M. (2017). "Determination of user's perception of para-transit service quality in Dhaka city based on user's perception." *Inter Journal of Education and Applied Science*, 7, Issue 1: 19-24. ISSN: 2249-4944.
- [5] Hossain, F., Roy, S. S., & Mitra, S. K. (2012). Battery Operated Auto-rickshaw and Its Role in Urban Income and Employment Generation. *International Journal of Advancements in Research & Technology*, 1(5), 223-227. Retrieved from https://www.academia.edu/2236858/Battery_Operated_Auto_rickshaw_and_Its_Role_in_Urban_Income_and_Employment_Generation
- [6] Khan, Z. R. (2018). Final Report on the Efficient Charging System for Electric Three Wheelers. *REEEP, GIZ: Dhaka, Bangladesh*. Available at: https://reep.sreda.gov.bd/projects/Final%20Report_Efficient%20Charging%20System%20for%20Electric%20Three%20Wheelers.pdf
- [7] Rana, S., Hossain, F., Roy, S. S., & Mitra, S. K. (2013). The role of battery operated auto-rickshaw in the transportation system of a city. *Journal of Asian Electric Vehicles*, 11(1), 1635-1644. <https://doi.org/10.4130/jaev.11.1635>
- [8] Ali, T. (2019, March 19). Battery rickshaws run out of steam. *The Daily Star*. Retrieved from <https://www.thedailystar.net/news-detail-187825>
- [9] Taiyab, N. (2007). Transportation in Mega-Cities: A Local Issue, A Global Question. Population (English Edition). Boston. 1-8.
- [10] Schipper, L. (2010). Car Crazy: The Perils of Asia's Hyper-Motorization. *Global Asia*, 4(4), 48-55.
- [11] Reddy, K. S., Aravindhan, S., & Mallick, T. K. (2017). Techno-economic investigation of solar powered electric auto-rickshaw for a sustainable transport system. *Energies*, 10(6), 754. <https://doi.org/10.3390/en10060754>
- [12] Andaleeb, S. S., Haq, M., & Ahmed, R. I. (2007). Reforming innercity bus transportation in a developing country: A passenger-driven model. *Journal of Public Transportation*, 10(1), 1-25. <https://doi.org/10.5038/2375-0901.10.1.1>
- [13] Ng, C., & Yi, S. (2016). Rethinking Sustainable Mobility: Understanding the use of boda-boda motorcycle taxis in Kampala, Uganda. *IIIEE Masters Thesis*. <https://lup.lub.lu.se/luur/download?func=downloadFile&recordId=8895390&fileId=8895391>
- [14] Joewono, T. B., & Kubota, H. (2007). User satisfaction with paratransit in competition with motorization in Indonesia: anticipation of future implications. *Transportation*, 34, 337-354. <https://doi.org/10.1007/s11116-007-9119-7>
- [15] Vuchic, V. R. (2007). *Urban transit systems and technology*. John Wiley & Sons.

- [16] Baker, J. (2005). 'Urban Poverty and Transport: The Case of Mumbai', World Bank Policy Research Working Paper 3693. Washington, DC: The World Bank.
- [17] Tiwari, G. (2003). Transport and land-use policies in Delhi. *Bulletin of the World Health Organization*, 81(6), 444-450. <https://pubmed.ncbi.nlm.nih.gov/12894330/>
- [18] Senbil, M., Fujiwara, A., Zhang, J., & Asri, D. U. (2005, July). Development of a choice model for evaluating sustainable urban form. In *Proceedings of the Eastern Asia Society for Transportation Studies* (Vol. 5, pp. 2164-2178).
- [19] Neumann, A., & Nagel, K. (2011). A Para-transit-Inspired Evolutionary Process For Public Transit Network Design. Transportation Research Board Annual Meeting pp. 1–16.
- [20] Cervero, R. (2000). Informal Transport In the Developing World., pp.117–144.
- [21] Dhakal, D. S. (2005). Role of Government, private sector and civic society in promoting battery operated electric three-wheelers in Kathmandu, Nepal. *Institute for Global Environmental Strategies (IGES), Kitakyushu Office*, 19.
- [22] Khan, A. and Rahman, M. M. (2019). "Road Management System (RMS) for a Neighborhood" in the *1st International Conference on Urban and Regional Planning*, 5-6 October, 2019, pp. 417-424. Dhaka, Bangladesh.
- [23] Akter, J., Shawon, M. T. A., & Rahman, M. M. (2021). Urban density influence on travel and mode choice behavior of Savar municipality: Household survey study. *Journal of Transportation Engineering and Traffic Management*, 2(2), 1-20. <https://zenodo.org/records/5082057>
- [24] Rahman, M. M., & Ritu, S. (2018). An Analysis of Corridor Planning to Enhance the Multimodal Service: Case Study of 'Gabtoli to Farmgate' Route. *The Jahangirnagar Review, Part II: Social Sciences*, 39, 91-103.
- [25] Rahman, M. M., & Kabir, M. H. (2021). Mode Choice Behavior Modeling and Discovering Public Preferences for Office Trip: A Case Study in Uttara Satellite Town. *Journal of Interior Designing and Regional Planning*, 6(1).
- [26] Fahim, A. U., Rahman, M. M., Abir, F. A., & Bhuiyan, M. A. F. (2022). An investigation of users' perception on non-motorized transport services in a municipality area: A cross-sectional study on Pabna municipality. *Case studies on transport policy*, 10(1), 657-663. <https://doi.org/10.1016/j.cstp.2022.01.026>
- [27] Rahman, M. M., & Kabir, M. H. (2021). Office Trip Comfort Perception Based on Passenger Travel Behavior: A Case Study in Uttara Satellite Town. *Journal of Transportation Engineering and Traffic Management*, 2(1), 1-13. <http://doi.org/10.5281/zenodo.4800707>