

Service Quality and Performance of Easy Bikes: A Comparative Study with Local Transport Systems in Manikganj Municipality

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ABSTRACT

This study examines the service quality and performance of Easy Bikes in relation to conventional local transportation systems in Manikganj Municipality, with a specific focus on battery-operated auto-rickshaws. The methodology comprises an extensive examination of existing literature, the establishment of clear objectives, and a meticulous survey procedure. Data was collected from a total of 210 users and 165 easy bike operators using purposive sampling approaches. Additionally, secondary data obtained from appropriate agencies were utilised. The Performance Index Scale was employed to assess and quantify the service performance of easy bikes, with data analyzed using visual representations and performance measures. The result indicated that battery-powered auto-rickshaws are mainly preferred by younger individuals and students, with 41% stating that the biggest factor influencing their choice is the cheaper travel expenses. Most journeys are short, typically spanning 2 to 3 kilometers, and the service is commonly utilized on a regular basis (34%), typically 4 to 6 days a week users are 29%. Battery-operated auto-rickshaws demonstrate superior performance in terms of fare rate and trip time, however, they encounter difficulties in ensuring safety, travel comfort, and service distribution. Paddle rickshaws provide superior trip comfort and safety in comparison, whilst battery-operated rickshaws do extremely well in journey time and crowd management. For short trips, Manikganj Municipality's easy bike/auto rickshaw is convenient and affordable. To improve user satisfaction, safety and service distribution must be improved for auto rickshaw. Regulators and transportation providers can better understand service deficiencies and enhance the urban transportation system by contrasting one local transportation alternative with another.

Keywords: Easy bike, service quality, performance, municipality, rickshaw, local transport

INTRODUCTION

Urban transportation plays a crucial role in the infrastructure of cities, exerting a considerable impact on the movement of people, economic activity, and the overall well-being of citizens (Lee and Sener, 2016).[14] The need for efficient, cost-effective, and environmentally friendly

transportation solutions is of utmost importance in fast urbanizing regions in Bangladesh (Hoque et al., 2009).[10] Easy bikes, which are a type of electric rickshaw, have become rather popular among the other modes of transportation that have evolved to suit this demand (Pramanik et al., 2004).[19] These cars are

renowned for their minimal ecological footprint (Pramanik et al., 2024),[17] cost-effectiveness, and convenient accessibility (Das, 2024).[5] Nevertheless, despite their increasing presence, there is a scarcity of comprehensive research assessing their service quality and performance compared to traditional local transportation methods.

Easy bikes are a cutting-edge solution in urban transportation, providing numerous benefits compared to traditional modes of travel including auto-rickshaws, cycle rickshaws, and public buses (Ullah et al., 2024).[30] These devices are powered by electricity, which helps to decrease carbon emissions and reduce reliance on fossil fuels (Anjum, 2018; Sharif,[27] Rahman and Morshed, 2014).[3] In addition, their very inexpensive operational expenses and fare system make them an appealing choice for a diverse group of city commuters (Hossain et al., 2019).[8] Nevertheless, the efficacy of convenient bicycles and other non motorized transport as a viable means of transportation is contingent upon not only their ecological and financial advantages, but also their performance in terms of velocity, security, comfort, and overall service excellence.

The variety of para-transit alternatives offered by Bangladesh's urban transportation system has increased with the development of battery-operated auto-rickshaws (Rana et al., 2013).[26] Since its introduction in Bangladesh in 2008, this mode of transportation has been more popular with city dwellers. This is because it is less expensive to travel by than other locally available forms of transportation and offers sufficient safety and comfort for users while they are on the road (Basri et al, 2014).[4] As a result of its popularity, the mode quickly spreads throughout Bangladesh's cities. These days, the mode of transportation is an essential aspect of the urban person's mobility network, especially in small and compact towns

(Pramanik and Rahman, 2020).[18] According to specialists (Mithu, Hauque, and Hasan, 2017),[15] battery-operated rickshaws could serve as a low-emission alternative mode of transportation for low-income individuals who are most affected by a lack of transportation options. However, its introduction should be done in a well-organised and planned manner. The operators of the mode typically originate from the economically disadvantaged areas of a city, as it necessitates a smaller initial investment to privately own a battery-operated auto-rickshaw (Dhakal, 2005).[6] The price of an electric auto-rickshaw varies between BDT 100,000 and 120,000. According to Ali (2011),[2] it is possible to recover the initial investment within a period of seven months.

In the rapidly evolving urban landscape of Bangladesh, the demand for efficient, affordable, and sustainable transportation options has led to the widespread adoption of easy bikes, particularly in smaller municipalities like Manikganj. As a battery-operated mode of transport, easy bikes offer an alternative to traditional local transport systems, yet their service quality and performance relative to other modes remain underexplored. Previous studies have highlighted various aspects of transportation in Bangladeshi municipalities, such as user perceptions of non-motorized transport services (Fahim et al., 2022),[7] the identification of accident hotspots on major highways (Jamil et al., 2021),[12] and the influence of urban density on travel behavior (Akter et al., 2021). [1] Moreover, research into mode choice behavior and public preferences, particularly in urban areas like Uttara Satellite Town, underscores the importance of understanding user expectations and experiences (Rahman & Kabir, 2021).[20] Building on these findings, this paper aims to conduct a comparative analysis of the service quality

and performance of easy bikes in Manikganj Municipality, providing insights into their effectiveness and positioning within the local transport ecosystem.

Currently, around 88% of urban passengers are utilising this method of transportation to fulfil their travel needs. The mode primarily appeals to urban passengers who typically use rickshaws, as well as to a lesser extent, nosimons, auto-tempos, and minibuses. It offers several advantages over these modes, including lower travel costs compared to rickshaws, greater comfort than minibuses, nosimons, and auto-tempos, and a satisfactory level of travel speed and service quality (Rana et al., 2013).

An autorickshaw powered by batteries moves more quickly than a cycle rickshaw. Furthermore, a single mode may accommodate three to six people, replacing three rickshaws simultaneously, suggesting that it may be able to alleviate traffic congestion caused by rickshaws (Ali, 2011). Rickshaws typically accommodate two people, however one battery-powered auto-rickshaw may accommodate two or three times as many passengers while charging a lower cost than manually operated rickshaws (Ali, 2011).

The rapid process of urbanization in Manikganj Municipality (Sayed and Haruyama, 2016)[28] has made it necessary to assess different transportation systems in order to ensure they can adequately cater to the increasing needs of the people. An in-depth analysis is needed to assess the performance and service quality of simple bikes, which have gained popularity for their convenience and cost-effectiveness. This analysis will help us understand their impact on urban mobility and their potential to either replace or

supplement existing modes of transportation.

This study aims to assess the current situation and the impact of battery-operated auto rickshaws (easy bikes) in small towns in Bangladesh. User perception is used to measure several factors related to the acceptance of easy bike, such as the percentage of easy bike users and non-users, trip cost, travel speed, travel time, and frequency of use. Additionally, it attempts to quantify the service performance index of simple bike through customer ratings on several aspects. This study also aims to compare the service performance of easy bike with other local internal transit modes.

REVIEW OF LITERATURE

The area of urban transport systems encompasses a range of factors including efficiency, sustainability, and user pleasure. The introduction of electric rickshaws, also known as easy bikes, in recent years has brought a new aspect to this industry, especially in developing nations where conventional transportation methods are prevalent. This literature study examines the current body of research on lightweight bicycles, including their performance characteristics, and how they compare to other modes of local transportation.

The study conducted by Saha et al (2009)[16] revealed that a traffic stream frequently comprises a substantial quantity of sizable and slow autos. The road infrastructure, local traffic regulations, and transport features in Bangladesh vary greatly from those in industrialised nations. According to Mohajan and Hossain (2016), Mr. Khan, the owner of Ma Enterprise, was the vanguard in introducing electric cars in Bangladesh in 2004. Initially, Mr. Khan acquired four auto-rickshaws propelled by rechargeable batteries, as well as other equipment, from

China. In 2005, he launched this mobile rickshaw for commercial use in his native town of Comilla.

The Daily Star (2011) reported that a battery-powered auto-rickshaw has the capacity to provide transportation for a maximum of eight people during a single trip, whereas a conventional rickshaw can only seat four people. While a rickshaw typically accommodates two people, a single battery-powered auto-rickshaw has the capacity to transport two or three times more passengers at a reduced cost compared to manually operated rickshaws.

Previous research has delved into various aspects of urban transport management, such as the implementation of road management systems in neighborhoods (Khan & Rahman, 2019)[13] and the relationship between built environment factors and young adult walking behaviors (Hossain et al., 2019).[9] Studies have also focused on analyzing the capacity of pedestrian facilities in densely populated areas like Motijheel (Rahman & Noman, 2018)[21,22] and the planning of corridors to enhance multimodal services in urban routes (Rahman & Ritu, 2018).[23-25] Building on this body of work, this study aims to provide a comparative analysis of the service quality and performance of easy bikes relative to other local transport systems in Manikganj Municipality, contributing to the broader discourse on sustainable urban transport solutions.

Rana et al. (2013) said that battery-powered auto-rickshaws significantly contribute to the reduction of emissions from urban transportation by replacing gasoline-powered vehicles. Furthermore, they asserted that the income-cost ratio clearly illustrates that acquiring and operating the method of transportation is highly favorable from an economic standpoint. The considerable economic viability of this business model offers a

logical justification for its rapid growth in metropolitan areas of Bangladesh. According to Rana et al. (2013), more than 50 percent of formerly jobless persons choose to pursue this profession mainly because of the higher income potential, more job independence, and lower investment expenses associated with it. Research findings indicate that roughly 85 percent of battery-powered auto-rickshaws in rural areas of Bangladesh are mostly used for short journeys, with an average distance covered of 3.29 km. The mode has the capability to do an average of 16 trips each day of that length. The poll indicates that around 88 percent of residents in a city having battery-powered auto-rickshaws opt to use this mode of transportation for their everyday travel requirements. According to Rana et al. (2013), the susceptibility of the mode to minor traffic events can be attributed to the inadequate training of drivers, the lightweight nature of the mode, and its uncontrolled use on extremely packed metropolitan roads. The major reason for not adopting battery-operated auto-rickshaws as a mode of transportation, according to almost 91% of respondents, is safety limitations.

Rahman and Islam (2013)[23] shown that the presence of auto-rickshaws decreases the unemployment rate by around 2%. This study quantified the energy consumption of the battery-powered auto rickshaw, which was around 10 kilowatts every charging cycle. Its typical range per charge is 150 kilometres. This study also discovered that the use of battery-powered auto-rickshaws has led to an increase in income, social standing, and comfort, while simultaneously reducing unemployment issues. The individual attempted to demonstrate that battery-operated auto-rickshaws provide a more cost-effective means of travel compared to traditional rickshaws, as well as offering higher comfort than other urban para-

transit options such as auto tempos, nosimons, and public transportation like minibuses. As a result, these auto-rickshaws are able to lure a considerable number of urban passengers away from these other modes of transportation.

In their study paper, Iqbal, Akhter, and Ahmad (2013)[11] performed a comparative examination of a battery-powered simple bicycle and a compressed natural gas (CNG)-powered auto rickshaw. The study examined several economic aspects, such as operational cost, production cost, maintenance cost, user-friendliness, and environmental efficacy. With respect to the examination of expenditures Research indicates that the production and maintenance expenses for CNG-powered auto rickshaws are somewhat greater than those for battery-powered electric bicycles. His demonstration revealed that the battery utilized in the Battery driven Easy Bike lacks environmental friendliness, as it is disposed of in an exposed location. An essential component of the battery is lead-acid, a dangerous chemical. Consequently, contamination of both land and air occurs.

In his study, Singh (2014)[29] analyses the socio-economic implications and technological characteristics in order to support the formalisation of e-rickshaws in the state. In addition, the research aims to establish policy suggestions that would improve the safety and efficiency of these vehicles. Furthermore, the author analyzes the Tripura Battery-operated Rickshaw laws, 2014 to pinpoint particular aspects of the legislation that may be included into the formulation of regulations in Delhi. The present study has endeavored to examine the unique advantages and drawbacks associated with the chosen mode of transportation. Furthermore, he illustrates that 37% of the e-rickshaw drivers were either jobless or involved in cycle-rickshaw pulling before to joining

the sector. These measures enable the government to achieve its particular goals of generating employment and executing the original plan of shifting from cycle rickshaws to battery rickshaws.

This literature review emphasizes the importance of electric bicycles as a sustainable alternative for urban transportation, while also emphasizing the necessity for thorough evaluations of their performance and comparative research. The current body of research offers useful insights into the advantages and disadvantages of electric bicycles, but additional studies are required to comprehensively comprehend their function and influence in various urban environments. The objective of this study is to address these deficiencies by conducting a comprehensive comparative examination of simple bikes and other local transportation systems in Manikganj Municipality. The analysis is primarily focus on performance indicators, service excellence, and user satisfaction.

METHODOLOGY

The study utilizes a thorough methodology to accomplish its goals. The study commences with a comprehensive conceptualization phase, wherein relevant literature is reviewed to gain an understanding of the operational characteristics, role, and service performance of battery-operated simple bikes. The formulation of objectives is to assess the performance of the service and make comparisons with other types of local transport. The chosen study region is the Manikganj municipality, specifically three routes that were selected based on their high level of popularity and significance. The roads are-‘Shohid Rafique Sarak’, ‘Thana road’ and ‘Shibbari road’. A matrix of objective variables is constructed in order to condense intricate occurrences into measurable quantities. Data collection encompasses primary sources, which

consist of questionnaire surveys conducted on 210 users and 165 easy bike operators, utilising purposive sampling approaches. Additionally, secondary data from relevant authorities are also utilised. Information is processed and analyzed using both qualitative and quantitative approaches, and a Performance Index Scale is used to quantify the performance of the service. The results are displayed using several visual representations, and suggestions are developed based on the examination, leading to the creation of the research article.

A questionnaire study was conducted among road users to get information on the service performance of battery-operated simple bikes. The primary goal of conducting this survey is to determine the satisfaction level of both users and non-users on the service performance of simple

bike, as well as the challenges they encountered. This knowledge will be valuable for policymakers in their future planning.

Performance Index (PI) of Battery-Operated Auto-rickshaws on Its Attributes

During a user opinion survey, respondents are requested to provide their assessment of several attributes of battery-operated auto-rickshaws using a 5-point scale (ranging from 0 to 5), where 0 represents the lowest performance and 5 denotes the highest performance. The scale is produced according to the diagram presented in Figure 1. A higher scale value indicates superior performance. For example, a scale score ranging from 4 to 5 signifies a level of performance that is very close to being exceptional.

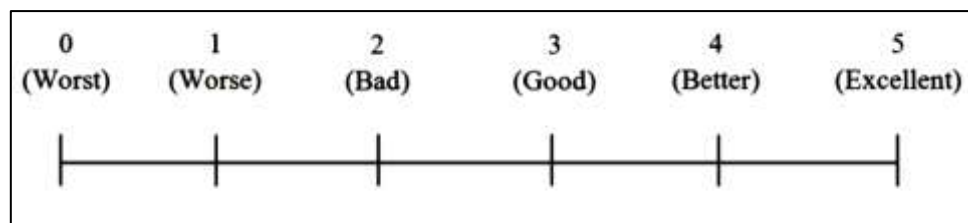


Fig. 1: Performance Index scales.

The respondent's comments are collected regarding the characteristics of battery-operated auto-rickshaws, including fare rate, trip time, travel comfort, safety, travel speed, crowd, operator's behaviour, service distribution, availability, service quality, waiting time, cleanliness, and service regularity. The performance index of the mode is computed based on the user's perspective.

RESULT AND DISCUSSION

Socio Demographic Information about users of battery-operated auto-rickshaw

The socio-demographic profile of users of battery-operated auto-rickshaws reveals a diverse group, predominantly male (62%), with females accounting for 38% of the users (table 1). The majority of users fall

within the younger age groups, with 38% aged 15-29 years and 33% aged 30-44 years, while those aged 45-60 years make up 18%, and the elderly (60+ years) represent only 2%. Regarding educational qualifications, most users have completed SSC (29%) and Honors (27%), with smaller percentages having attained HSC (23%), primary education (8%), or technical qualifications (9%), and a minority being illiterate (4%). In terms of occupation, a significant proportion are students (27%), followed by those engaged in business (22%) and private service (19%). Other occupations include housewives (18%), laborers (6%), unemployed individuals (5%), and a small percentage in government service (2%) or other unspecified jobs (1%).

Table 1: Information about users of battery-operated auto-rickshaw.

Information		Percentage of the users
Sex	Male	62
	Female	38
Age group (years)	0-14	9
	15-29	38
	30-44	33
	45-60	18
	60+	2
Educational qualification	Primary	8
	SSC	29
	HSC	23
	Honors	27
	Technical	9
	Illiterate	4
Occupation	Govt. service	2
	Private service	19
	Business	22
	Student	27
	Labor	6
	Unemployed	5
	Housewife	18
	Others	1

Reasons for using Battery-operated Auto Rickshaw

The primary reason for using battery-operated auto-rickshaws among users is the lower travel cost, which is favored by 41% of the respondents. Availability of the mode is the second most significant factor, with 37% of users citing it as a key reason for their choice (table 2). A smaller percentage of 11%, use this mode of

transport because their workplace is nearby, while 6% prioritize comfort. Only 4% of users rely on battery-operated auto-rickshaws due to the lack of alternative modes, and a minimal 1% use them for other unspecified reasons. Interestingly, safety is not a driving factor, as none of the respondents mentioned it as a reason for their choice.

Table 2: Reasons for using battery-operated auto rickshaw.

Reasons for using the mode						
Safety	Comfort	Lower travel cost	Availability	Workplace near by	No alternative modes	Others
0%	6%	41%	37%	11%	4%	1%

The main reason battery-operated auto-rickshaws are adopted is lower travel costs (41%). Availability accounts for 37% of mode selection. This mode's availability affects its popularity among travelers. The

above arguments suggest that battery-powered auto-rickshaws are essential for low-income urban dwellers in Bangladesh's municipal areas who want economical transportation. The survey

found that about 85% of battery-operated auto-rickshaw users utilize it to commute from home to job, school/college, and other locations. 8% of users use it to get from home to the bus stop or CNG station.

Trip Purpose

The trip purposes for users of battery-operated auto-rickshaws show distinct patterns between males and females. Among male users, business is the most common trip purpose, accounting for 23% of trips, followed by college at 19% and service-related travel at 15%. School trips

make up 12% of male users' purposes, while dropping children is relatively uncommon at 5% as shown in Figure 2. For female users, the primary purpose is dropping children, with 37% of trips dedicated to this task. College-related travel is also significant for females, comprising 14% of their trips, followed by service at 9% and school at 6%. A notable percentage of both male and female users, 26% and 32% respectively, use the auto-rickshaw for other purposes (shopping, marketing, tuition etc).

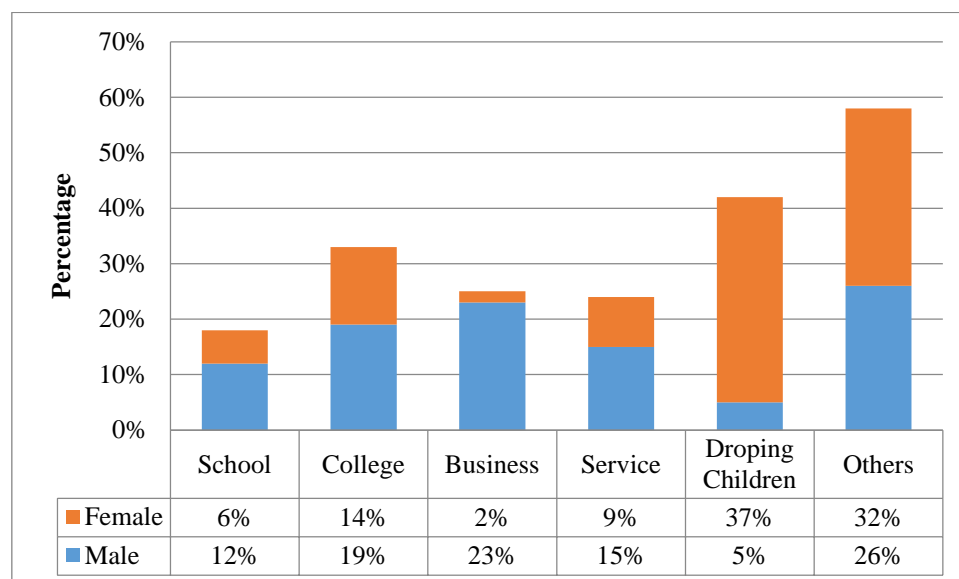


Fig. 2: Trip purpose of the battery-operated auto-rickshaw according to sex.

Travel Distance

The battery-operated auto-rickshaws are generally used for short trip by the users in the study. In the study the most used travel distance made by the users is 2-3 km (46%). And the lowest travel distance made by the users is less than ½ km (1%). So, from the study it is seen that the

battery-operated auto-rickshaw are used specially for short trip by the passengers in municipality towns. It has become popular as a mode for short distance trip (2-3 km and 3-4 km). The percentage of the total users against travel distance is presented in Table 3.

Table 3: Users travel distance.

Travel distance	Percentage of the total users of the battery-operated auto-rickshaw
Less than 1/2 km	1
1/2-1 km	5
1-2 km	9
2-3 km	46

3-4 km	24
4-5 km	15

Characteristics of Battery-Operated Auto-Rickshaw/Easy Bike in the Municipality

Frequency of weekly use of battery-operated auto-rickshaw

The frequency of weekly use of battery-operated auto-rickshaws varies among users, with the highest percentage of users (34%) opting for daily use, indicating a strong reliance on this mode of transport

(figure 3). A significant portion of users, 29%, use the auto-rickshaw 4 to 6 times per week, while 21% use it 2 to 4 times weekly. Those who use it less frequently, 1 to 3 times per week, make up 11% of the users, and a smaller group, 5%, utilize the auto-rickshaw 1 to 2 times a week. This distribution reflects the varying levels of dependence on battery-operated auto-rickshaws among the surveyed population.

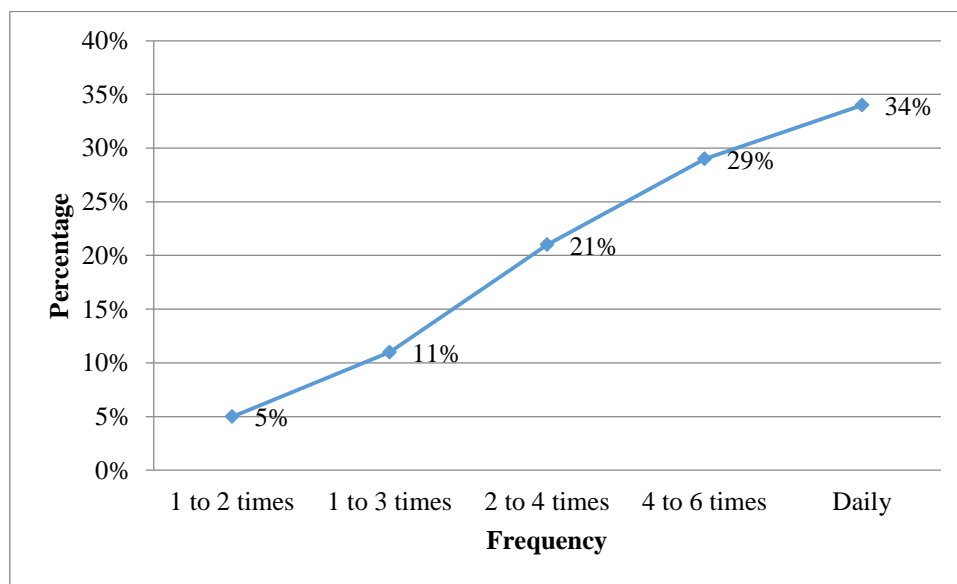


Fig. 3: Frequency of daily use of battery-operated auto-rickshaw

Figure 3 demonstrates that the majority of users of battery-operated auto-rickshaws in the municipality towns of Bangladesh utilise the method of transportation daily in the week. Furthermore, approximately 23% of individuals utilise the mode on a daily basis for their academic pursuits.

Frequency of daily use of battery-operated auto-rickshaw

Most of the users of battery-operated auto-rickshaw use the mode twice in a day (61%). 14% users use the mode once a day and 17% of the users use the mode 3-4 times in a day. The frequency of daily use of battery-operated auto-rickshaws are graphically presented in Figure 4.

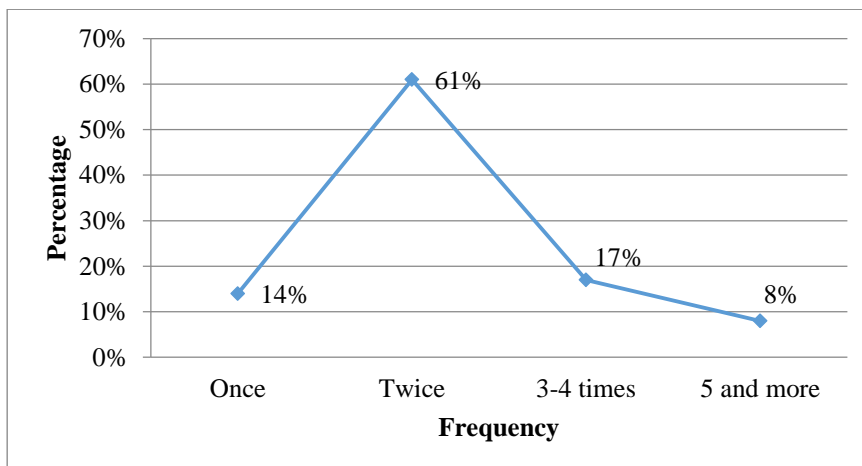


Fig. 4: Frequency of daily use of battery-operated auto-rickshaw.

Figure 4 illustrates that most of the users of battery-operated auto-rickshaw avail the mode twice a day (61%). Findings from the study indicate that battery-operated auto-rickshaws observed frequent use in Bangladeshi urban centers. Following its creation, the mode gained popularity. It currently serves as the municipality towns' primary means of local transportation.

Changes in Mode Choice

The battery-powered auto-rickshaw appeals to urban travellers due to the reasons mentioned before. Approximately 58% male and 83% female users of

battery-operated auto-rickshaws had previously used traditional rickshaws before the introduction of battery-operated ones in their town. Consequently, 19% male and 12% female of the users change from walking, 16% male from cycling, and 7% male and 5% female from other modes of transportation (such as motorcycles, etc.). The majority of users of battery-operated auto-rickshaws transition from using traditional rickshaws. Furthermore, this mode of transportation also appeals to pedestrians and cyclists. The study displays the mode choice of consumers based on their gender in figure 5.

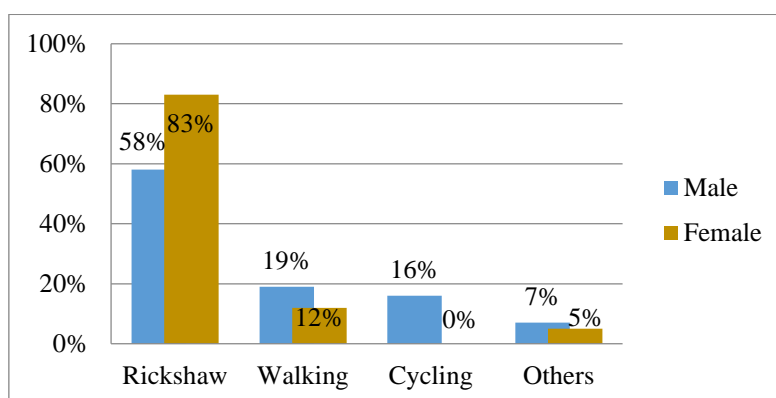


Fig. 5: Previous mode choice of users according to sex.

Figure 5 shows that the study finds that factors such as reduced travel costs (41%), increased availability (37%), and a better option of transportation for neighboring workplaces (11%), among others, are important in attracting passengers to

switch from their current mode of transportation.

Travel Cost Per Trip

Battery-operated auto rickshaw became popular from its introduced period because

of lower travel cost. It has been become popular with low and middle income people as a local transport mode. In the study 76% users said that their travel cost

per trip is 10 taka. Again 14% user's travel cost per trip is 15 taka and 6% of the users travel cost per trip is 20 taka presented in Figure 6

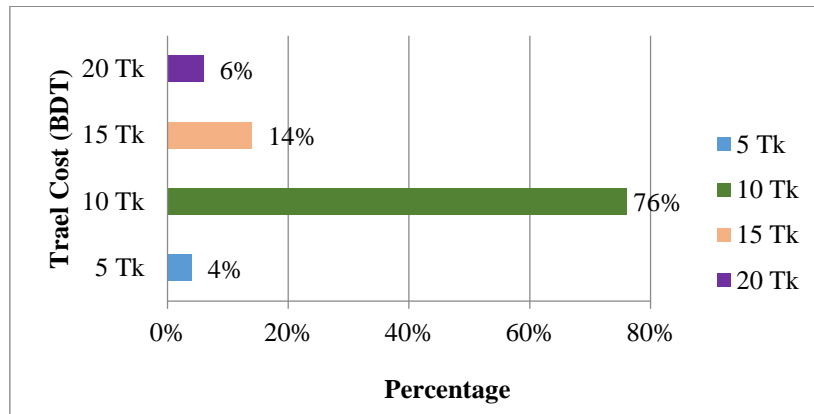


Fig. 6: Travel cost per trip of the users of the mode.

Per Hour Flow of Battery-Operated Auto Rickshaw in the Study Area

From the traffic flow data, it has been found that the maximum flow of battery-operated auto rickshaw is in the Shahid Rafique road per hour. The flow of

battery-operated auto-rickshaw of this road is 867 auto rickshaw per hour, where 557 auto rickshaw in Shivbari road and 218 auto rickshaw in Gongadhorpotti road per hour which is lowest one.

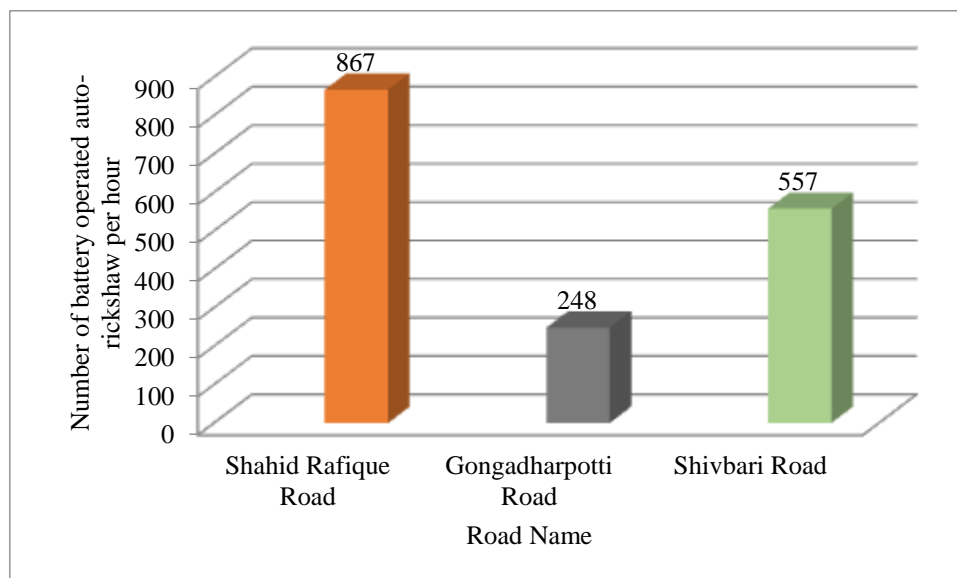


Fig. 7: Per hour flow of battery-operated auto-rickshaw in the study area.

From the Figure 7 it has been found that there is unbalance distribution of battery-operated auto-rickshaw in the selected three roads of the study area. There is maximum volume in the ShahidRoafiq

road and minimum in the Gongadhorpotti road.

Battery-operated Auto-Rickshaw as an Occupation

Battery-operated auto rickshaw is now a populous occupation for the low- and middle-income urban dwellers of municipality area in Bangladesh. The

increasing benefit of this occupation and increasing the use of the mode made many drivers choosing the profession.

Table 4: Demographic information of the drivers.

Information	Percentage of the users	
Age group (years)	0-14	3
	15-29	47
	30-44	33
	45-60	16
	60+	1
Educational qualification	Primary	26
	JSC	34
	SSC	22
	Technical	7
	Illiterate	11

Reasons for choosing the occupation

Battery-operated auto rickshaw have high income opportunity. Most of the drivers of the study (52%) choose the occupation because of high income opportunity. Additionally 31% drivers said that the

reason is less hard work and 17% said that because of unemployment they choose the occupation. The percentage of the reasons for choosing the occupation is graphically presented in figure 8.

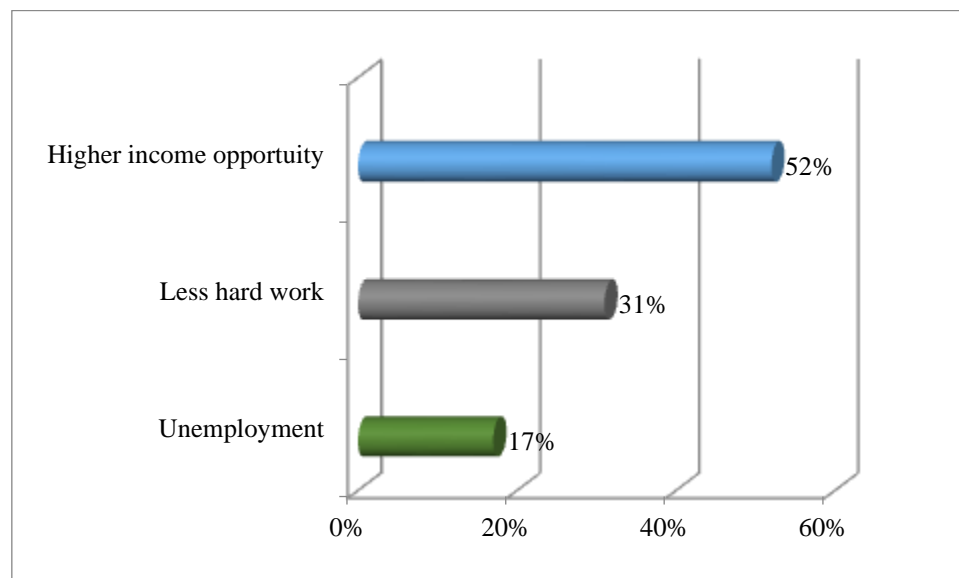


Fig. 8: Reasons for choosing the occupation.

Duration of occupation

In the study the drivers of the battery-operated auto-rickshaw are asked their duration of occupation. Most of the drivers (37%) said that they are continuing this profession 1-3 years. 29% drivers said that

they are continuing this profession from 4-6 years, 12% drivers said that they are continuing this profession from below one year and 22% of the drivers said it 7-10 years as presented in figure 9

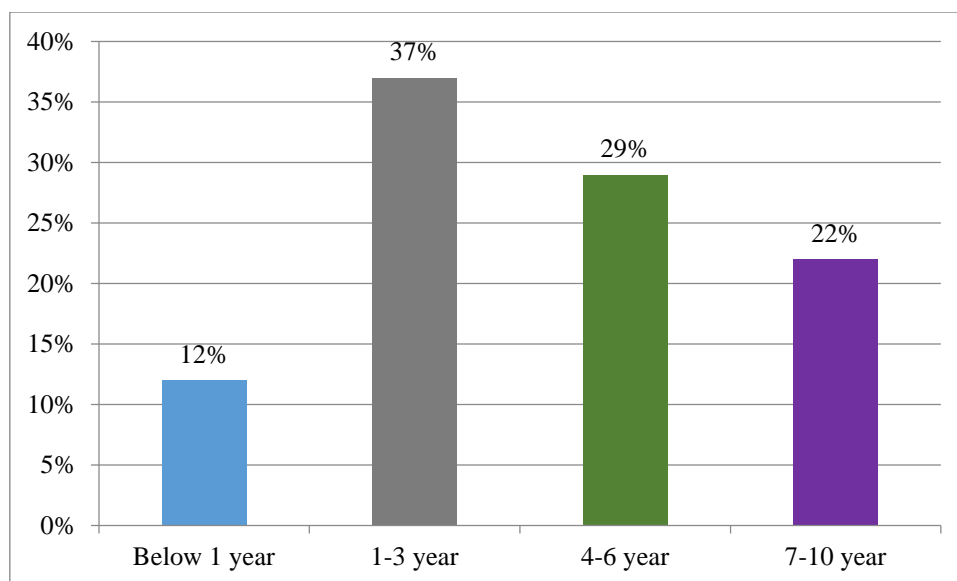


Fig. 9: Percentage of driving years of battery-operated auto-rickshaw.

Previous occupation of the drivers and reasons for changing previous occupation

The previous occupation of the drivers of battery-operated auto-rickshaw is asked during the study. Maximum 31% drivers

said that they were Rickshaw driver/puller before choosing the occupation. 17% drivers were unemployed previously, 10% drivers were van driver of, 12% drivers did private job as shown in figure 10

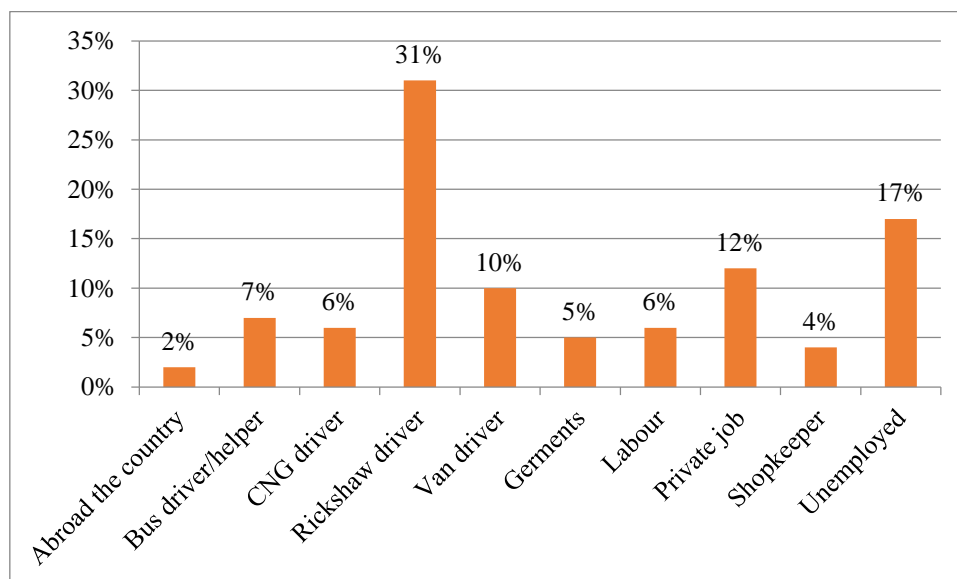


Fig. 10: Previous occupation of the drivers.

The drivers of battery-operated auto-rickshaw changed their previous occupation because of many reasons revealed from the study. Maximum drivers (52%) changed previous occupation because of high income opportunity in

driving battery-operated auto rickshaw. 31% changed the previous occupation for less hard work in this occupation. Working time of the drivers of easy bike is 11.45 hour per day. In this study, 76% percentage drivers work 11-13 hour a day.

18% of the driver work 8-10 hour and very less driver (6%) work 14-16 hour a day.

Income and operating cost, purchasing cost and daily rent

From this study it reveals that average income from the battery-operated auto rickshaw in the municipality town is 1050 Taka per day and the average daily operating cost of battery-operated auto rickshaw is 200 Taka per day. Study shows that average purchasing cost of battery-operated auto-rickshaw is 1,40,000 Taka. From the study it reveals that 65% drivers have own battery-operated auto-rickshaw and 35% drivers drive easy bike in rent. Study shows that average rent of battery-operated auto-rickshaw is 500 Taka per day.

Evaluation of the Service Performance of Battery-Operated Auto-Rickshaw/ Easy Bike

During a user opinion survey, respondents are requested to provide their assessment of several attributes of battery-operated auto-rickshaws using a 5-point scale (ranging from 0 to 5), where 0 represents the lowest performance and 5 represents the most. A higher scale value indicates superior performance. For example, a scale rating between 4 and 5 signifies a performance that is almost exceptional. The respondent's opinions are collected regarding the characteristics of battery-operated auto-rickshaws, including fare rate, travel time, travel comfort, safety, travel speed, crowd, operator's behaviour, service distribution, availability, service quality, waiting time, cleanliness, and regularity of service. The performance index of the mode is determined based on the perspective of the mode's users. The study presents the findings from user comments on the qualities of battery-operated auto-rickshaws in Table 5.

Table 5: Service performance of battery-operated auto-rickshaw/easy bike based on users of the mode.

Attributes	Scales					
	0	1	2	3	4	5
Fare rate	0	0	2	5	46	112
Travel time	0	15	17	26	62	45
Travel comfort	9	32	46	53	25	0
Safety	0	26	94	39	6	0
Travel speed	14	16	29	23	38	45
Crowd	58	31	29	26	7	14
Operator's behavior	2	11	24	113	9	6
Service distribution	17	43	72	26	7	0
Availability	0	6	16	43	47	53
Service quality	2	9	24	63	59	8
Waiting time	1	12	38	42	43	29
Cleanliness	0	0	23	34	45	63
Regularity of service	0	11	16	33	47	58

All 165 respondents (100% of the total) from the sample use battery-operated auto-rickshaws to meet their travel demand, according to the study. Based on the users'

opinions, the computation of the performance index for a battery-operated auto-rickshaw for a specific attribute, such as the fare rate, is shown below.

Performance Index of Battery-operated Auto-rickshaw on Its Fare rate

$$Ia = \sum_{i=0}^n (WiFi) / N$$

$$= (0*0 + 1*0 + 2*2 + 3*5 + 4*46 + 5*112) / 165$$

$$= 4.62$$

Accordingly, performance index of other attributes of the mode based on opinion of users are calculated and presented in Table 6

Table 6: Performance index of battery-operated auto-rickshaw on its attributes.

Attributes	Performance index
Fare rate	4.62
Travel time	3.64
Travel comfort	2.32
Safety	2.15
Travel speed	3.15
Crowd	1.61
Operator's behavior	2.81
Service distribution	1.78
Availability	3.76
Service quality	3.16
Waiting time	3.22
Cleanliness	3.90
Regularity of service	3.76

From the table 6 it is seen that user satisfaction with battery-operated easy bike/auto rickshaw varies across qualities. With a performance value of 4.62, the fare rate is the highest-rated characteristic, showing that customers find this mode of travel affordable. Users respect cleanliness, scoring 3.90, indicating that automobiles are well-maintained. The availability and regularity of service performance rating was 3.76, indicating good reliability and access to these cars. Waiting time, 3.22, and service quality, 3.16, corroborate the good view of service efficiency. There are regions of poor performance. Moderate satisfaction with trip efficiency is 3.64 for travel time and

3.15 for travel speed. The lower scores of 2.32 and 2.15 for travel comfort and safety indicate user concerns. Customer interactions should be better based on operator conduct (2.81). Crowding within cars had the lowest performance index of 1.61 and service distribution of 1.78, indicating overcrowding and uneven service coverage. These lower ratings highlight particular issues that must be addressed to improve battery-operated auto-rickshaw user experience.

Performance index of paddle rickshaw

The user's opinion on the rating on attributes of service performance are presented in table 7.

Table 7: Service performance of paddle rickshaw on user's point of view.

Attributes	Scales					
	0	1	2	3	4	5
Fare rate	16	57	68	14	8	2
Travel time	1	4	13	119	23	5
Travel	0	1	5	12	43	104

comfort						
Safety	0	0	1	31	114	19
Travel speed	0	3	19	102	21	20
Crowd	1	2	16	58	43	45
Operator's behavior	1	18	46	53	31	16
Service distribution	6	9	41	54	32	23
Availability	0	2	36	78	38	11
Service quality	0	7	31	56	65	6
Waiting time	0	9	76	42	28	10
Cleanliness	0	0	16	58	46	45
Regularity of service	0	3	39	49	66	8

According to opinions of these users, calculation of performance index for battery paddle rickshaw is demonstrated thereafter in table 8.

Table 8: Performance index of paddle rickshaw.

Attributes	Performance index
Fare rate	1.68
Travel time	3.05
Travel comfort	4.48
Safety	3.92
Travel speed	3.22
Crowd	3.67
Operator's behavior	2.87
Service distribution	3.01
Availability	3.12
Service quality	3.19
Waiting time	2.72
Cleanliness	3.73
Regularity of service	3.22

From the table 8 it is seen that paddle rickshaw performance indexes show high user satisfaction across service aspects. Travel comfort, with a performance value of 4.48, is the highest-rated characteristic of paddle rickshaws. Also well-rated, safety scores 3.92, showing people feel safe in these automobiles. A performance value of 3.73 indicates rickshaw cleanliness and maintenance satisfaction. Rickshaw crowd management is scored 3.67, suggesting modest satisfaction. Other factors including travel speed (3.22),

frequency of service (3.22), service quality (3.19), availability (3.12), and service distribution (3.01) scored mid-range, indicating that while these features are usually adequate, they may be improved. The fee rate had the lowest performance index of 1.68, showing user discontent with paddle rickshaw prices. Service delays may be due to low waiting time of 2.72. The operator's behaviour score of 2.87 reflects mixed rickshaw driver performances. While paddle rickshaws are comfortable and safe, fee rates and waiting

periods might be improved to improve passenger satisfaction.

Performance index of battery rickshaw

The users opinion on the rating on attributes of service performance are presented in table 9

Table 9: Performance index of battery-operated rickshaw on users point of view.

Attributes	Scales					
	0	1	2	3	4	5
Fare rate	8	43	64	25	18	7
Travel time	0	5	8	37	54	61
Travel comfort	10	28	47	13	26	41
Safety	24	68	35	27	6	5
Travel speed	14	16	20	36	38	41
Crowd	1	3	8	42	35	76
Operator's behavior	1	12	47	45	39	21
Service distribution	2	5	34	46	41	37
Availability	2	8	35	51	32	37
Service quality	8	26	38	42	29	22
Waiting time	0	2	56	36	41	30
Cleanliness	0	1	23	54	59	28
Regularity of service	2	15	62	53	31	2

According to opinions of these users, calculation of performance index for battery paddle rickshaw is demonstrated thereafter in table 10

Table 10: Performance index of battery-operated rickshaw.

Attributes battery	Performance index
Fare rate	2.14
Travel time	3.96
Travel comfort	2.85
Safety	1.62
Travel speed	3.16
Crowd	4.03
Operator's behavior	3.04
Service distribution	3.39
Availability	3.30
Service quality	2.75
Waiting time	3.25
Cleanliness	3.55
Regularity of service	2.62

From the table 10 it is seen that battery rickshaws' performance index reveals varying levels of customer satisfaction with regard to various service features. With a rating of 4.03, crowd management has the greatest performance score, meaning that most consumers are happy with the amount of crowding in these cars.

A good score of 3.96 was also given to travel duration, indicating satisfaction with the effectiveness of the trip. With a performance rating of 3.55, cleanliness is another feature that consumers have given high marks to, indicating that they value the cleanliness and maintenance of battery-powered rickshaws. These cars are fairly

accessible and evenly dispersed throughout service regions, as indicated by their ratings of 3.39 and 3.30 for availability and service dispersion, respectively. The mid-range scores for characteristics including trip speed (3.16), operator demeanor (3.04), and waiting time (3.25) indicate a moderate degree of satisfaction.

Comparison

In this study there are exists three modes of transport for internal transport system in the municipality area. The service performance on their attributes on the basis of users point of view is discussed above. The performance index of three modes: battery-operated auto-rickshaw; paddle rickshaw and battery-operated rickshaw are presented in figure 10

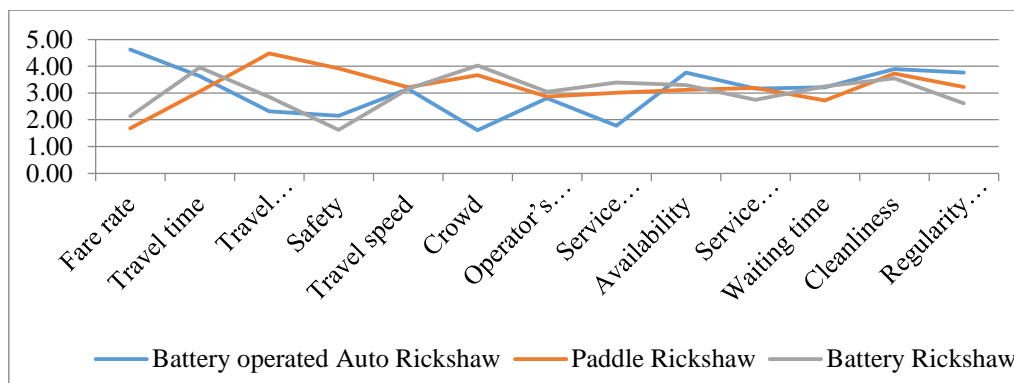


Fig. 11: Performance index of three modes.

The figure 11 presents a comparative analysis of service quality and performance attributes among three local transport modes in Manikganj Municipality: battery-operated auto-rickshaw (blue line), paddle rickshaw (orange line), and battery-operated rickshaw (grey line). The y-axis represents the performance rating on a scale from 0 to 5, with higher values indicating better performance.

The comparison among battery-operated auto-rickshaws, paddle rickshaws, and battery rickshaws reveals significant differences in user satisfaction across various service attributes.

Fare Rate: Battery-operated auto-rickshaws are perceived as the most cost-effective, with a high-performance index of 4.62, compared to battery rickshaws at 2.14 and paddle rickshaws at 1.68, which indicates lower satisfaction with the cost of paddle rickshaws.

Travel Time: Battery rickshaws have the highest satisfaction regarding travel time, with a performance index of 3.96, followed by battery-operated auto-rickshaws at 3.64 and paddle rickshaws at 3.05. This suggests that battery rickshaws are seen as the most time-efficient.

Travel Comfort: Paddle rickshaws excel in travel comfort, scoring 4.48, which is significantly higher than both battery-operated auto-rickshaws (2.32) and battery rickshaws (2.85). This indicates that paddle rickshaws are considered the most comfortable mode of transport.

Safety: In terms of safety, paddle rickshaws are rated the highest with a score of 3.92, while battery-operated auto-rickshaws score 2.15, and battery rickshaws are rated the lowest at 1.62, highlighting safety concerns among users of battery rickshaws.

Travel Speed: The three modes have similar ratings for travel speed, with

battery rickshaws slightly leading at 3.16, followed by paddle rickshaws at 3.22, and battery-operated auto-rickshaws at 3.15, suggesting moderate satisfaction across the board.

Crowd Management: Battery rickshaws stand out in crowd management with a performance index of 4.03, significantly higher than paddle rickshaws (3.67) and battery-operated auto-rickshaws (1.61), indicating better management of passenger space in battery rickshaws.

Behavior: Users rate the behavior of operators of battery rickshaws slightly higher (3.04) than those of paddle rickshaws (2.87) and battery-operated auto-rickshaws (2.81), showing a marginal preference for the conduct of battery rickshaw drivers.

Service Distribution: Battery rickshaws are perceived to have the best service distribution (3.39), followed by paddle rickshaws (3.01) and battery-operated auto-rickshaws (1.78), indicating better coverage and accessibility for battery rickshaws.

Availability: Battery-operated auto-rickshaws score the highest in availability with a performance index of 3.76, slightly ahead of battery rickshaws (3.30) and paddle rickshaws (3.12), showing that they are more readily accessible.

Service Quality: Paddle rickshaws are marginally ahead in service quality (3.19) compared to battery-operated auto-rickshaws (3.16) and battery rickshaws (2.75), reflecting a slight advantage in the perceived overall service of paddle rickshaws.

Waiting Time: Battery rickshaws have the highest satisfaction with waiting times (3.25), followed closely by battery-operated auto-rickshaws (3.22) and paddle

rickshaws (2.72), indicating more efficient service delivery for battery rickshaws.

Cleanliness: Battery-operated auto-rickshaws lead in cleanliness with a score of 3.90, followed by paddle rickshaws (3.73) and battery rickshaws (3.55), showing a higher standard of vehicle maintenance in auto-rickshaws.

Regularity of Service: Battery-operated auto-rickshaws also rank highest in the regularity of service (3.76), with paddle rickshaws (3.22) and battery rickshaws (2.62) trailing behind, reflecting more consistent service from auto-rickshaws.

This analysis highlights that each mode has its strengths: battery-operated auto-rickshaws are favored for fare rates, availability, and cleanliness; paddle rickshaws excel in travel comfort and safety; while battery rickshaws stand out in crowd management, travel time, and service distribution. However, each mode also has areas for improvement, particularly in safety and service regularity for battery rickshaws, and fare rates for paddle rickshaws.

CONCLUSION

Battery-operated auto-rickshaws have become integral to the transportation infrastructure of municipal towns in Bangladesh. It has been a favoured means of transportation for individuals with lower and middle incomes due to its cheaper travel expenses and faster travel speeds. The mode plays a crucial part in the urban transport system of municipal towns in Bangladesh. Approximately all individuals in municipality towns in Bangladesh utilise battery-operated auto-rickshaws. Approximately 80% of travellers utilise this method as their main means of transportation. Approximately 29% of passengers utilise mode 4 to 6 times per week, while approximately 34% of customers utilise the mode daily.

Operating a battery-powered auto-rickshaw as a profession is a common preference among low-income individuals in urban areas. This kind of labour offers a smaller initial investment, a higher earning potential, and requires less physical exertion compared to other alternative occupations. Consequently, the urban regions of Bangladesh have undergone significant expansion in recent years.

The battery-powered auto-rickshaw offers a competitive fee rate, efficient travel duration, improved travel speed, and reliable service distribution. However, this method of transportation suffers from a deficiency in passenger safety and inadequate service distribution. The mode is more detrimental in terms of crowd management. The seating arrangement does not offer comfortable seats for ladies. Nevertheless, the method of transportation exhibits reduced travel expenses and enhanced travel velocity compared to both pedal rickshaws and motor rickshaws. However, the paddle rickshaw offers greater safety and comfort to passengers compared to battery-operated auto-rickshaws.

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