Journal of Bangladesh Institute of Planners ISSN 2075-9363
Vol. 13, 2020 (Printed in June 2021), pp. 89-110, © Bangladesh Institute of Planners

Understanding the Paratransit and Intermediate Public Transport (IPT) Services in Rangpur City of Bangladesh: The Case on E-rickshaws

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Abstract

Mobility of many people in Bangladesh, particularly in the medium-sized cities, are dependent on paratransit or intermediate public transport (IPT) modes. The E-rickshaws (battery-operated electric three-wheelers), which usually provides a very flexible and demand-responsive services, as a form of paratransit/IPT is a common mode in many cities. The main purpose of this paper is to discuss the operational characteristics of E-rickshaws as a paratransit/IPT mode in Bangladesh and the trip characteristics of E-rickshaw users. A case study was done in Rangpur City. A total 397 E-rickshaw operators or drivers were interviewed to identify the factors influencing the operations and services. A total 400 passengers of E-rickshaws were interviewed for collecting information about their trip characteristics. Four types of paratransit modes are operating in Rangpur city are: cycle-rickshaws, battery-rickshaws, E-rickshaws (also called as 'auto') and CNG. Survey data reveal that around 74% of the passengers choose E-rickshaw for their trips. Existing E-rickshaw users are satisfied with the services compared to other travel modes. The performance index calculation for the fare rate of E-rickshaws was found to be 4.4, where 0 is for the worst and 5 is for the excellent. Now, as the majority of city dwellers are using E-rickshaws for their travel, complete banning or restricting of E-rickshaws will have devastating effects on urban transport system and passengers travel as well as drastic negative impacts on the earnings or livelihood of drivers/operators. The results of this paper would be helpful for the government, particularly for city authority, and the relevant agencies to formulate policy guidelines for E-rickshaws as well as other paratransit or IPTs.

Keywords: Paratransit, Intermediate Public Transport (IPT), E-rickshaw, urban mobility, mode choice.

1. Introduction

Rapid urbanization in developing countries has led to an unprecedented increase in demand for mobility services, which in turn has put tremendous pressure on urban transport infrastructure and services (Cervero and Golub, 2007). Even in cities where public transport is available, formal public transport services are often inadequate and unreliable, giving rise to the population's dependence on personal mobility options and informal public transport services for meeting their mobility needs (Shimazaki and Rahman, 1996). The performance of transportation system largely influences the

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economy and social progress of an area. It provides mobility to people, goods and services to their destination. It has linkages with other sectors of development and for a sustainable development of any area, its traffic and transportation system should be adequately addressed (Ahmed, 2008).

Paratransit, also known as intermediate public transport (IPT), is defined as the intermediate mode between privately owned automobiles and conventional transit with fixed routes and schedules (Ahmed and Datta, 2006). The definition of IPT used in this paper is considered similar to Cervero (2000; 2007), which defines IPT as the means of transport that is available for communal public use but is in some way unsanctioned. However, the paratransit/IPT modes in the urban transport sectors of developing countries often play a significant role by providing transport services to a large number of people (Cervero and Golub, 2007; Godard, 2013; Joewonoand Kubota, 2007; Tangphaisankun et al. 2009).

The E-rickshaws (battery-operated electric three-wheelers) in Bangladesh is the updated form of rickshaw which is locally known as easy-bike or auto. Usually there are four to six seats for passenger in an E-rickshaw. E-rickshaw is a para-transit/IPT mode in urban transportation system of Bangladesh (Rana et al. 2012). The mode, being introduced in 2008 in Bangladesh attains much popularity among urban passengers since it involves lower travel cost than other locally available transport modes as well as provides reasonable safety and comfort to the users during travel (Baker, 2005). This popularity, in turn results rapid growth of the mode of Bangladesh. E-rickshaws have become one of the preferred modes of transport between short distances and are operating in major urban and suburban areas and townships (Rana et al. 2013). The major problem of E-rickshaws is that they are not legalized as a public mode of transport. There remained technical problems like the manufacturing and designing of the vehicles maintaining safety standards, as these are assembled in local workshops (Dutta & Jash, 2014). Now, the mode has become inseparable part of urban peoples' mobility network, especially in small-compact towns (Ali, 2019). Therefore, it requires careful attention to incorporate this mode in local urban transport system. This research would be helpful for the policymakers to formulate policy guidelines regarding E-rickshaws and how to incorporate and integrate this mode with local transport system of the city.

2. Objectives and Methodology

The main purpose of this research is to understand the operational characteristics and services of E-rickshaws in Rangpur city as well as to explore the trip characteristics of E-rickshaw users. To attain the objectives, a mixed method approach was followed for this research. Qualitative approach was followed to explore the present services of E-rickshaws such as the route, coverage and fare, whilst quantitative approach was followed to identify its role towards sustainability and the user's opinions and perceptions. The required data were collected mostly from primary sources. Existing route, coverage and fare was identified through field survey and their potential role towards sustainability was measured through questionnaire survey, which was conducted on two types of target group, comprises of passengers and easy bike drivers. An inventory survey of existing traffic and transport infrastructure was conducted to identify the existing traffic condition and the major problems. Furthermore, unstructured

field observation was done to document descriptive and reflexive notes as well as photographic evidence to enrich the study. A total 397 operators and 400 passengers of E-rickshaws (at 5% confidence interval and 95% confidence level) were interviewed using a pre-determined questionnaire. Both the passengers and drivers were selected randomly from 10 different major points of the city.

3. Review on Paratransit and IPT Modes

The paratransit in developed countries is often defined as the full range of demand responsive services, including complementary, general public dial-a-ride, and human service transportation (Thirumurthy & Yamamura, 1986). In developing countries, these privately operated, small-scale services are varyingly referred to as "low cost transport", "intermediate technologies", and "third world transport" (Cervero, 2000). Nevertheless, paratransit can be defined as "a service that is not quite full public transit, utilizing smaller vehicles, and it can be legal or illegal as defined by local rules and regulations" (Graeff, 2008; Grava, 2003). Similarly, Orski (1975) describes the term 'paratransit' as flexible transport services such as shared taxi, community transit, or jitneys.

The IPTs service is prominent for its role as the gap filler. It exists to cover the area that is left unfilled by the public transport services. The absence of regulation and the lack of law enforcement makes the IPT grows and rapidly able to step in and take over where public transport operators have left off (Cervero, 2000). However, the characteristic of the IPT mode is variously based on the function in the different countries. Usually, the IPT modes are the preferred modes of transportation for the low-income people. In general, the IPT modes can be categorized into three groups based on the capacity of the vehicle. *First*, the individual type that can load fewer than four passengers. *Second*, the shared type that can load between five to ten passengers. *Third*, the collective type that has a capacity of more than eleven passengers (Shizamaki and Rahman, 2000).

3.1 Characteristics of Paratransit

Paratransit system can be classified broadly into two groups: non-motorized and motorized (Pramanik and Rahman, 2019). However, according to Ahmed (2008), the paratransit modes are classified into following four major groups:

(i) Type of usage: The paratransit services may be availed by different groups of users such as (a) fixed personalized mode of transportation (e.g. car rental and carpools); (b) semi-public paratransit (e.g. vanpools and subscription buses); (c) public (regular) paratransit (e.g. autorickshaw, cycle-rickshaw, tata magic).

(ii) Ownership of the vehicle or system: Paratransit vehicles may be owned and service provided by an organization not related to transportation (e.g. factory or school transport service), or by an individual who operates the vehicle (e.g. auto-rickshaw or cycle-rickshaw operator) or by an individual who does not operate but lease it to the operator (e.g. owner) or by an agency (e.g. taxi company or tourist agency).

(iii) Service type by routing: Generally, paratransit modes provide door-to-door services such as taxi, e-rickshaw and cycle-rickshaw provides (Rahman, 2013). Sometimes they adjust the service partially to the user's destination e.g. feeder service to the airport or bus terminal (Rahman, 2012). A third group of mode has fixed routes but not fixed schedule (e.g. shared travel mode auto-rickshaw service).

(iv) Method of getting service: Users may have paratransit service available at fixed parking lots (auto rickshaw, cycle-rickshaw) or their trips may be pre-arranged (subscription paratransits) or they obtain it by hailing the vehicle on street sides, or calling it by telephone from the travel agencies.

3.2 Characteristics of IPT

The IPT takes many shapes and plays many roles, as commuter modes for marginalized areas, as feeder-modes for formal public transport, as door-to-door connectivity, etc. Due to absence of formal public transport systems, especially in small and medium-sized cities where public transport has not yet developed or is insufficient, IPT plays a crucial role of providing transport services (Rahman et al 2012). In such cases, IPT often plays an important role as the feeder services (access and egress legs) and also provides affordable mobility in areas where the public transport system does not reach (Rahman, 2013; Rahman et al 2013; Luthra, 2006).

The characteristic of IPT can be summarized as below:

- *Entrepreneurialism*: In many cases in the Asian developing countries, the IPT services are managed and coordinated by the formal private company, cooperatives, and private transport associations (Rahman, 2012; Cervero, 2000).
- *Service Condition*: The IPT operators have the flexibility to operate whenever and wherever it is profitable for them (Shizamaki and Rahman, 2000). Commonly, the operating hours and schedules of IPT is not fixed; the working time depends on the driver's need to get passenger or depends on rush hour (Rahman and Timms, 2020; Tuan and Mateo-Babiano, 2007). As a result, often to earn more money, specific locations such as CBD, market, or terminal are crowded by IPT waiting for their passengers (Rahman, 2013; Joewono and Kubota, 2007).
- *Fare*: The fare systems of IPT can be divided into three categories, e.g. fixed, metered, and negotiation (Rahman and Timms, 2020; Shizamaki and Rahman, 2000). In general, the fare of individual IPT type is agreed by negotiation between the passenger and the driver, and therefore it is highly dependent on the driver's character, location, and time (Rahman, 2013; Tuan and Mateo-Babiano, 2007).

3.3 Comparison of Paratransit and IPT

To summarize the above discussion, the Table 1 serves to illustrate the comparative aspects of major characteristics of the two types – paratransit and IPTs. Table 1 shows that both IPT and paratransit have similar service characteristics in terms of routing (e.g. both can have fixed or flexible routes or route deviation). However, both of them differ significantly with respect to other service characteristics such as scheduling, means of access, ride exclusivity, market served, and fare flexibility.

Table 1: Major characteristics of Paratransit and IPT

Major Characteristics			Paratransit	IPT
A. Service Characteristics	Routing	Flexible route	Yes*	Yes
		Route deviation	Yes	Yes
		Fixed route	Yes	Yes
	Scheduling	Unscheduled	Yes	Yes
		Semi scheduled	Yes	Sometimes
		Scheduled	Yes	No
	Means of Access	Fixed stops and schedules	Yes	No
		Mail	Yes	Yes
		Phone	Yes	No
		Prior arrangement	Yes	No
	Ride exclusivity	Exclusive	No	Yes
		Limited ride-sharing	Yes	Yes
		Public	Yes	Yes
	Market Served	General market	Yes	Yes
		Target market	Yes	No
	Fares	Negotiated	No	Yes
		Fixed	Yes	Yes
B. Technology	Vehicle type	Traditional	No	Yes
		Intermediate	No	Yes
		Modern	Yes	No
	Population	Non motorized	No	Yes
		Motorized	Yes	Yes
C. Organization	Scale	Small	Yes	Yes
		Medium	Yes	Yes
		Large	Yes	No
	Ownership	Private	Yes	Yes
		State/Municipal	No	No
	Management	Informal	Yes	Yes
		Formal	Yes	No
		Semi formal	No	Yes
**Yes means that it is possible to have that characteristics but not necessarily so.*				

Source: SUGIJANTO, 1982 and developed by author, 2020

Generally, the major issues faced by both paratransit and IPT can be categorized into following:

- Operational issues, including regulation, coordination, and integration of the various systems' operations within the paratransit and IPT systems themselves as well as between each one and the existing conventional transit;
- Issues related to provision of services, such as funding, organization and management, and labor issues;
- Institutional issues: the coordination of the pertinent transit organization and public institutions;
- Policy issues which are related to the government's national objectives and strategy;
- Planning and design issues, such as the planning process, modeling, and evaluation of both alternative systems.

3.4 Regulatory Framework of Paratransit/IPT in Bangladesh

Bangladesh Road and Transport Authority (BRTA) has functional responsibility to provide driving license, checking the fitness of vehicles, license of vehicles, route permit, license renew and registration for motorized vehicles and concerned on the highways only. Due to some procedural and mechanical shortcomings, the BRTA is unable to register the E-rickshaws as motor vehicles and provide license, route permits and fitness certificates. Moreover, the paratransit/IPT has never been welcomed by the government of Bangladesh (Rahman 2013; Rana et al. 2013). The first initiative of importing E-rickshaws was taken by the business sectors of Bangladesh. As of 2014, an estimated 4,00,000 or more E-rickshaws are plying all over Bangladesh (Dhaka Tribune, 2014).

There is a controversy regarding whether these easy-bikes are motor vehicles or not. According to section 34(1) of the 'Motor Vehicles Ordinance 1983', an application has to be submitted under Form-H (as stated in the Schedule of the Ordinance) for registration of a motor vehicle. Again, according to sub-section (2) of section 34, a certificate is provided in Form-I of the Schedule under the Ordinance, which requires information regarding number of cylinders, chassis number, engine number, fuel used in engine, cubic capacity (CC) etc. This information cannot be provided for E-rickshaws as it has no engine number, cubic capacity, engine fuel in easy-bikes, per statutory requirements. Consequently, easy-bikes cannot be registered under this Ordinance. As a stop-gap arrangement, these three-wheelers are now plying on roads with parking numbers given by city corporations, municipalities and union councils. Licensing and management aspects of non-motorized vehicles such as cycle-rickshaws and non-fuel vehicles such as battery-driven E-rickshaws and rickshaws are the responsibility of Rangpur City Corporation (RpCC) and Rangpur Metropolitan Police (RpMP).

According to Ali (2019) published in The Daily Star newspaper, electricity-run vehicles like easy-bikes and electric cars increasing gradually in the country, the government has decided to bring those under regulation. Bangladesh Road Transport Authority (BRTA) has prepared draft guidelines in this regard and sent the draft to the road transport and bridges ministry for approval, officials said. As per the draft guidelines, each electric vehicle has to obtain registration, fitness certificate and route permit like those required for an engine-run vehicle. The government will fix the lifetime and fares of electric hire

vehicles. As per the draft, an electric vehicle means it is run by electric power stored in a rechargeable battery. The ministry will hold an inter-ministerial meeting before its approval. Although a very few electric cars have been operating in the country now, around 10 lakh battery-run easy-bikes are plying on the streets of Bangladesh.

3.5 Market size of E-rickshaws in Bangladesh

According to Transparency Market Research (2018), E-Rickshaw is an electric powered, three-wheeled vehicle primarily utilized for commercial purposes in order to transport passengers and goods. It utilizes a battery, traction motor, and electric power train in order to propel the vehicle. Rickshaws are a prominent mode of commercial passenger transportation, especially across India, China, ASEAN, and several countries in Africa. Lower cost of transport, lower cost of rickshaws, and their maneuverability across congested urban roads are some advantages of rickshaws, which are driving their demand across the globe. Moreover, stringent emission norms, rising fuel prices, incentives over e-rickshaws, and increased range of e-rickshaws are shifting consumer preference toward e-rickshaws. Furthermore, the expected ban over fuel powered vehicles is likely to propel the demand for e-rickshaws.

The global E-rickshaw market is primarily restrained by the underdeveloped charging infrastructure across several countries (Transparency Market Research, 2018). Moreover, lack of regulations is also restraining the global e-rickshaw market. The global E-rickshaw market can be segmented based on rickshaw type, battery capacity, power rating, components, application, and region. In terms of the types of rickshaw, the global E-rickshaw market can be classified into two segments. Considering the low weight requirement for higher efficiency, the rate of adoption of open type E-rickshaws is rising among consumers (Bose et al., 2014. Asia Pacific accounted for a major share of the market, in terms of revenue, in 2018, which is primarily attributed to the rising demand from consumers, government incentives and supportive policies, ban over fuel-powered rickshaws, and increasing fuel prices (Mallik et al., 2018). Moreover, battery operated rickshaws are a prominent mode of transportation across urban areas of several countries in Asia, such as China and India. Moreover, presence of globally leading e-rickshaw manufacturers is another prominent driver of the E-rickshaw market in Asia Pacific.

However, the E-rickshaws are most popular in Asia. The low-cost Chinese version being the first to show up on streets. They are mostly used in China, India, Bangladesh and Nepal, also in low numbers other parts of Asia they have been showing up. China, Japan, India, and European countries (Switzerland, France, Germany) have researched and developed electric tricycles for commercial transport and are attempting to capture the growing market in Asia (Simon & Rojesh, 2014). Bangladesh imports electric rickshaws directly from China or via other countries, the well established cities prefer them as cheaper and better means of transport (The Daily Star, 2019). The government in an inter-ministerial meeting on May 5, 2011 banned import and assembly of the vehicles and decided to send off-road those already plying, primarily on the ground that it consumes electricity mostly through illegal connections.

Table 2 shows the divisional market size of E-rickshaws in the context of Bangladesh. According to Rangpur Master Plan (2014), total area of Rangpur city is 205.76 square kilometers with 7,96,556 population. The market size of E-rickshaw in the Rangpur City Corporation is 21,800. This indicates that the proportion of E-rickshaws with population is 1:37.

Table 2: Market size of E-rickshaw in Bangladesh

Division	Number of E-rickshaw	Population	E-rickshaw: Population
Dhaka	67,753	4,74,24,418	1:700
Chittagong	63,580	2,84,23,019	1:447
Khulna	60,820	1,56,87,759	1:258
Rajshahi	54,342	1,84,84,858	1:340
Sylhet	56,885	99,10,219	1:174
Barisal	47,740	83,25,666	1:174
Rangpur	43,642	1,57,87,758	1:362

Source: (1) The New Age, 7 November 2013

(2) Statistical Pocket Book Bangladesh, 2015

4. Results from the Case Study

4.1 Description of the case study area: Rangpur city

Rangpur is the second largest city of the northern region of the country, located 335 kilometers north-west of the capital city Dhaka. Rangpur is one of the newly established City Corporations of Bangladesh. This city is situated on the bank of the river Ghagat- a moribund tributary of the river Teesta**.** Figure 1 and Figure 2 show the location of Rangpur City in the national context and the Rangpur City Corporation area respectively.

Figure 1: Location of Rangpur city in context of Bangladesh

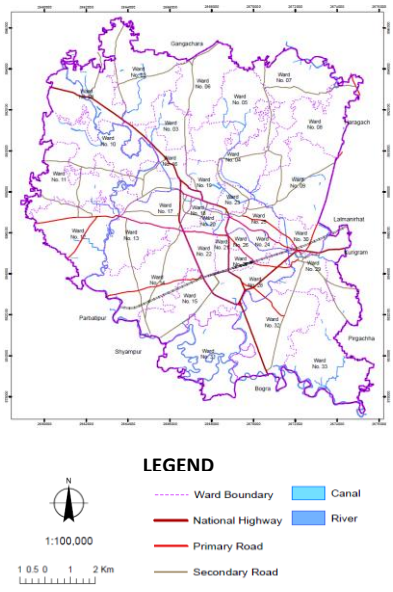


Figure 2: Road Network of Rangpur City Corporation Area

Table 3 shows the details of projected population with density on the basis of Core and Non-core area of RpCC. The projected population of Rangpur city is 7,13,541 in 2018, to be 8,80,808 in 2023 and 11,37,599 in 2028 and 15,78,605 in 2033.

Table 3: Projected Population of Rangpur City in different years

Year	Core Area		Non-core Area		Total Area	
	Population	Density (per acre)	Population	Density (per acre)	Population	Density (per acre)
2013	206183	32.12	379439	8.57	585622	11.56
2018	237287	36.96	476254	10.76	713541	14.08
2023	274414	42.75	606394	13.70	880808	17.38
2028	314281	48.96	823318	18.60	1137599	22.45
2033	361692	56.34	1216912	27.50	1578605	31.15

Source: BBS, 2011 and RpCC Master Plan, 2014

Considering the roadway hierarchy (functional classification), there are primary roads including national highways, secondary roads, tertiary and access roads in the city area. Distribution of existing roads as per roadway hierarchy is shown in Table 4 below.

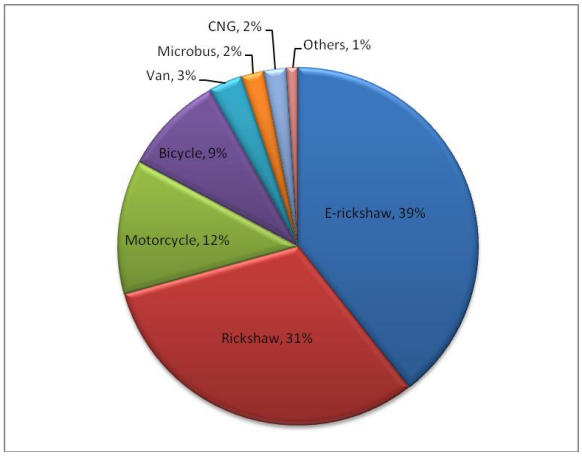
Table 4: Existing roads in Rangpur City as per roadway hierarchy

Functional Category	Length (km)	Length (mile)	%
National Highway	32.85	20.41	2.30
Primary Road	34.69	21.55	2.43
Secondary Road	99.98	62.12	7.00
Tertiary and Access	1259.93	782.88	88.26
Total	1427.44	886.97	100.00

Source: RpCC Master Plan, 2014

4.2 Paratransit/IPT Modes in Rangpur city

Major three types of paratransit modes such as cycle-rickshaw, Electric-rickshaw, E-rickshaws are plying in Rangpur city. Among them, the E-rickshaws has the highest percentage share of occupants. In order to investigate the nature of traffic movement and assess the traffic composition, traffic count survey in seven major intersections were conducted. From the survey the study identified that the traffic composition are: E-rickshaw (39%), rickshaw (31%), motorcycle (12%), and bicycle (9%), as seen in Figure 3.



Source: RpCC Master Plan, 2014

Figure 3: Percentage of Paratransit Modes in Rangpur City

A wide range of vehicles was found as public transport modes. All the vehicle types except pedal-powered cycle rickshaws are motorized and have different seating capacity. The vehicles can be classified into three distinct categories according to seating capacity: low-capacity vehicles, medium-capacity vehicles, and high-capacity paratransit modes.

Table 5: Physical and operational characteristics of paratransit modes in Rangpur City

Mode	No of wheels	No of seats	Mode of operation	Coverage
Rickshaw	3	2	Human driven	All the roadways
E-rickshaw/Easy Bike	3	6	Battery driven	All the roadways
CNG (reserved)	3	5	Motorized	All the roadways
CNG (shared)	3	5	Motorized	Selected routes
Laguna	4	12	Motorized	Selected routes

Source: Field Survey, 2019

4.3 Operational Characteristics of E-rickshaw

4.3.1 E-rickshaw services in Rangpur City

E-rickshaws in Rangpur can be classified in three groups based on their operation or movement pattern. E-rickshaws whose origin and destination are within the main city are placed under the 'Core to Core' category, while those having at least either of the origin or the destination within the main city are classified in 'Core to periphery' category. Those having both the origin and destination outside the main city and operating predominantly on the city periphery routes are classified in the 'Periphery to Periphery' category. Among the movement category, 57% routes are from core to periphery, while 28.5% routes are based on periphery to periphery movement and the rest 14.5% routes are core to core routes.

The average trip length for E-rickshaw operations is between 3 to 5 km. From the field survey, it was found that the nature of trips in the main city is very different from the city periphery. For example, in the main city the majority (around 68%) of the respondents mentioned that E-rickshaws are their primary mode of travel and do not use for any intermodal connection. On the other hand, E-rickshaws in the periphery areas, are solely used for last mile connectivity. However, due to absence of road hierarchy or lack of alternative public transport service in Rangpur, E-rickshaws are plying on the arterial roads, national and state highways. Almost 69% of the respondents consider that E-rickshaws as a paratransit mode in Rangpur have improved the connectivity and 31% of the respondents mentioned E-rickshaws are very easily available, therefore, they prefer this over other modes for travel.

There is no fixed fare policy affirmed by the authorities to determine the fare structure of easy bike. Fare is usually determined by the easy bike driver. However, the fare is more or less same based on the distance. RpCC (2012) acclaimed that per km fare is around Tk 5, which is the lowest fare for any distance travelled by easy bike. However, the fare for E-rickshaws varies among stoppages to stoppages based on distance (Table 6).

Table 6: Travel cost in different routes of Rangpur City

Major routes	Route length* (Km)	Fare (Tk)	Average Fare (Tk/Km)
Medical Morr to City Bazar	3.2	10	3.13
Satmatha to Medical Morr	7.1	25	3.53
City Bazar to Railway Station	3.2	10	3.13
City Bazar to Satmatha	4.3	15	3.48
Modern Morr to City Bazar	5.1	15	2.94
Terminal to City Bazar	3.3	10	3.30

Source: Google Map 2019*; Field Survey, 2019

4.3.2 Income and Employment

Table 7 shows the results of different parameters both for rental and self-owned E-rickshaw drivers. This table indicates the net profit Tk 453 for rental easy bike drivers and net profit Tk 750 for self-owned E-rickshaw drivers which is referring that earning economic condition of self-owned E-rickshaw drivers are far better than rental e-rickshaw drivers. Initial investment differs for the new and second-hand e-rickshaw which is also shown in Table 7 below.

Table 7: Rental and Self-owned E-rickshaw

E-rickshaw Type	Parameter	Mean Value (Tk)
Rental	Daily Income	914
	Daily Rent	461
	Net Daily Profit	453
Self-owned	Initial Investment for new Easy bike	1,60,000
	Initial investment for second hand Easy bike	71,500
	Daily Income	925
	Daily maintenance cost	175
	Net Daily Profit	750

Source: E-rickshaw Operators' Survey, 2019

If the vehicle is owned by the operator then the investment is usually its assembling cost, charging cost, maintenance cost, and parts replacement cost. The assembling cost is expressed as monthly depreciation. It (depreciation) is a useful accounting technique of allocating the cost of a tangible asset over its economic service life and is used to account for declines in value. In this study, it can be viewed as a cost of the e-rickshaw owner. Table 8 shows the monthly depreciation of e-rickshaw. This result is obtained using the straight-line depreciation method. Due to short economic service life and replacement of battery pack after each year, e-rickshaw generates a high amount of monthly depreciation near the owner.

Table 8: Depreciation of E-rickshaw

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

* $\sum$ *(Battery replacement + Salvage value) x Year*

** *Depreciable amount / (3 x 12)*

Usually an E-rickshaw has 4 to 6 batteries, but most of them in Rangpur have 5 batteries. If it takes 10 hours to fully charge the 5 batteries and each consume 2 units for full charging then 5 batteries consume 10 (5×2=10) units. The unit cost of electricity for commercial electric supply line is about Tk 9. So, the cost of charging of an e-rickshaw with 5 batteries is approximately Tk 90 (10×9= 90) daily. Thus, the annual average operation cost for this an E-rickshaw is Tk 32,400.

Maintenance costs are the cost of periodical repairing and servicing, including the costs of consumable items like brake shoes, battery, tyres etc. Average cost for periodical maintenance and servicing was found Tk 1500 – Tk 2000 per month excluding the cost of

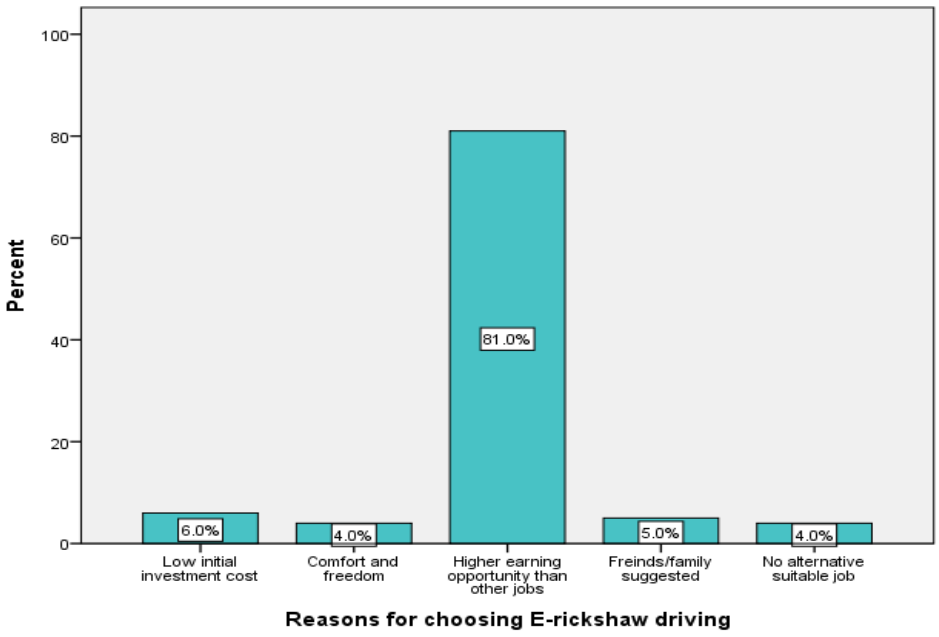
batteries and tyres. In the primary survey, it was found that 64% of the respondents in Rangpur have a maintenance cost around Tk 1500 – Tk 2000 per month. While 24% have a cost more than Tk 2,000 per month, the rest 12% have maintenance cost of below Tk 1500. Table 9 provides the calculation of income-expenditure ratio for the operators who have their own E-rickshaws.

Table 9: Income-expenditure ratio for E-rickshaw (owned) operator

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

4.3.3 Reasons behind choosing E-rickshaw driving

On the basis of primary survey, 81% of the total respondents stated that they wanted to earn more money that was the main reason for select this occupation. Figure 4 shows that only 6% of the respondents stated low initial investment cost whilst others mentioned unavailability of other suitable job as the reason for choosing E-rickshaw driving as occupation.



Source: E-rickshaw Operators' Survey, 2019

Figure 4: Reasons for choosing E-rickshaw driving in Rangpur city

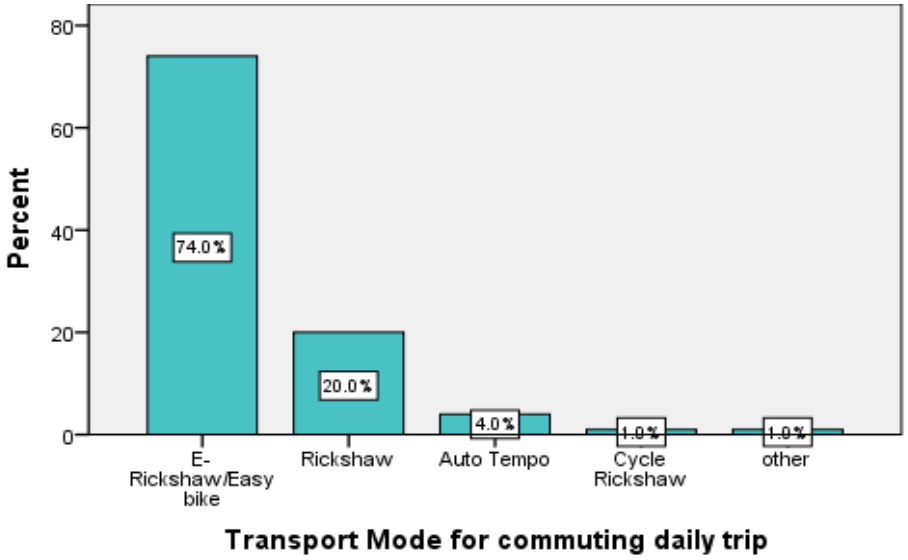
4.3.4 Social aspects of E-rickshaw driving

From the survey it is found that about 70% of the E-rickshaw drivers reported their financial condition or earnings are now better compared with their previous occupation. Remaining 30% mentioned that with E-rickshaw driving their financial condition have not changed at all. Nevertheless, approximately 20% drivers, who were previously engaged in hawking or other similar occupations, strongly agree that driving E-rickshaw has increased their social status and prestige. Many of the previously unemployed youth are now getting a good source of income. Therefore, many cycle-rickshaw drivers are also switching to driving e-rickshaws as it provides them a better social status, more revenue and less strenuous work.

4.4 Travel Characteristics of E-rickshaw Passengers'

4.4.1 Travel mode choice

Survey data reveal that around 74% of the respondents choose E-rickshaws to meet up their regular travel needs or demand (Figure 5). The present study revealed that people prefer to use E-rickshaw as intermediate paratransit mode as compared to other paratransit modes such as electric rickshaw auto tempo demand responsive modes.



Source: E-rickshaw Passengers' Survey, 2019

Figure 5: Transport Modes used by the respondents for commuting daily trip

In Table 10, respondents provided their opinions regarding some the travel attributes/factors (availability, comfortable, privacy, reliable and safety) for different modes of travel in case study city Rangpur. In each factor E-rickshaw was the dominant mode except safety aspect. Out of 400 respondents, almost 92% mentioned that travelling on E-rickshaw is comfortable than other modes available in the city. According to them (77% of total respondents), public bus is safer than others while moving around the city.

Table 10: Respondents' opinion (%) about mode choice factors

Mode	Availability	Comfortable	More private	Reliable	Safe to travel
Rickshaw	90	67	71	68	45
E-rickshaw	85	92	56	74	61
Minibus	9	57	24	22	66
Bus	2	60	2	18	77

Source: E-rickshaw Passengers' Survey, 2019

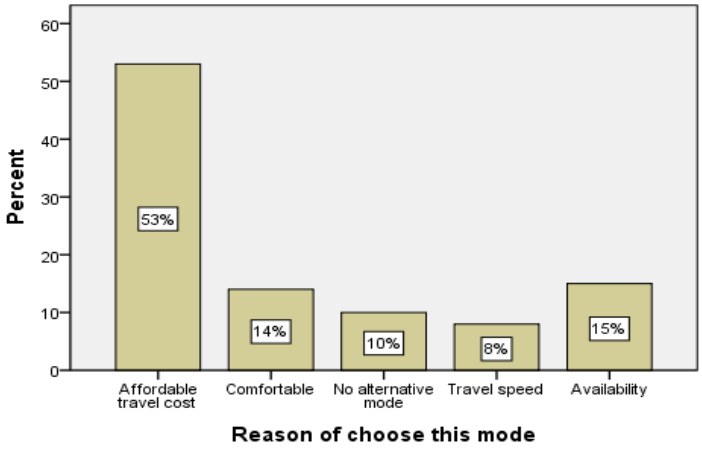
Table 11 depicts the mean rating of different modes for various trips by the respondents. When respondents were asked to rate (in a scale of 5, 1 for minimum and 5 for maximum) the importance or usability of different modes for three different types of trips (in terms of distance) the mean rating of E-rickshaws were highest (4.55) for medium length trips (2-5 km). For long distance trips (above 5 km), E-rickshaws were rated quite low, which was natural; public bus received highest rating followed by CNG.

Table 11: Mean rating of different modes for different trips

Mode choice	Mean rating of trips		
	Short trip (< 2 km)	Medium length trip (2-5 km)	Long distance trip (above 5 km)
Cycle Rickshaw/Electric Rickshaw	4.17	3.24	0.86
E-rickshaw/Auto	3.85	4.55	2.56
CNG	1.11	2.75	3.98
Public bus	0.25	2.13	4.11

Source: Field Survey, 2019

E-rickshaw is playing important role to meet the travel demand of low-income people and students seeking for low cost travel mode in local urban areas of Bangladesh. This mode is proving comfort during travel with better travel speed to low income people where higher income people are not using the mode for the quest of lack of comfort and lower travel speed. This is because definition of comfort and travel speed varies with people's income level. This mode is providing service to majority of people of a city with acceptable comfort and travel speed. Figure 6 shows that around 53 percent of users of battery-operated auto-rickshaw avail the mode as it has lower travel cost than other locally available transport modes and thus affordable. Only 14% said that they choose for comfortable traveling.

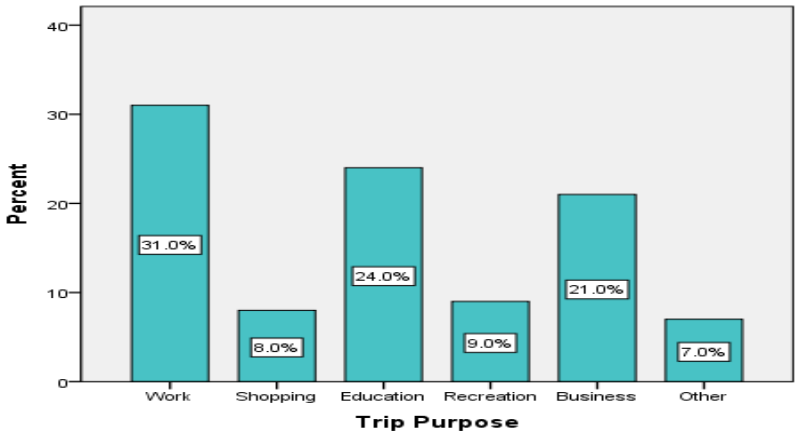


Source: E-rickshaw Passengers' Survey, 2019

Figure 6: Reasons of choosing E-rickshaw for daily commuting trip

4.4.2 Purpose of trips

The difference in mode choice, priorities and their psychological dynamics are the outcome of the difference in their socio-economic characteristics and the available facilities. A field survey was carried out about an individual trip-maker's socio-economic background, opinions about different travel attributes for different modes, trips information details for a single day, and also the passenger's attitude towards E-rickshaw as a travel mode. Study reveals that most of the passengers are generated their trips for the purpose of working (31%), business (21%), education (24%), shopping (8%) and so on (in Figure 7). E-rickshaw serves overall 30% to 40 % of total commuting populations of daily users for fixed destination.



Source: E-rickshaw Passengers' Survey, 2019

Figure 7: Purpose of trips by E-rickshaw

4.4.3 Dependency and availability of E-rickshaw in the city

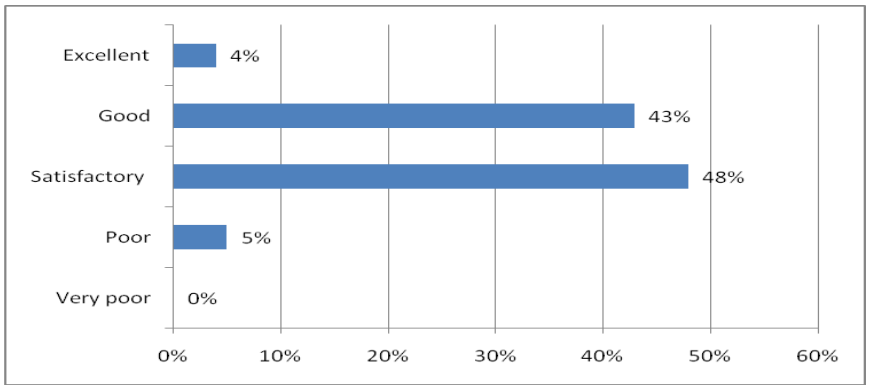
From the Table 12 it is clear that the citizens are highly depended on Easy bike as their daily comminuting trips in the city. Almost half (51%) of the respondents informed that they are using this mode daily for their working purposes where only 4% of them rarely use this mode for their various purposes.

Table 12: E-rickshaw use frequency per week in Rangpur city

E-rickshaw use frequency per week	Percent
1-2 days	17.0
3-4 days	17.0
5-7 days	51.0
Sometimes	11.0
No use or rarely	4.0
Total	100.0

Source: E-rickshaw Passengers' Survey, 2019

Availability of E-rickshaw vehicle varies with the demand. It is more available in off-peak time than office time because the demand is decreased. Most of the respondents (48%) mentioned the service quality is satisfactory in terms of availability and only 5% users' opinion as poor (in Figure 8).



Source: E-rickshaw Passengers' Survey, 2019

Figure 8: Users' perception on availability of E-rickshaw in the city

4.4.4 Evaluation of opinions on E-rickshaw services

E-rickshaw users' opinions were taken on the attributes- "fare rate", "travel time", "travel comfort", safety, travel speed, crowd, operators' behaviour, and quality of service associated with e-rickshaws. The opinions of E-rickshaw users' on different attributes are presented in Table 13. From the Table 14 below, it is observed that fare rate of E-rickshaw is nearly excellent. Based on their opinions, performance index for fare rate of E-rickshaw was calculated and it is 4.06. That means, fare rate is close to very satisfied. Moreover,

nearly satisfactory performance on quality of service (Index 3.64) issue. However, the mode is unable to ensure safety (Index 1.86). Light weight of the mode, lack of skill training of operators is main reasons for lack of safety associated with e-rickshaws as found from the study.

Table 13: Performance of attributes based on opinion of E-rickshaw users

Attributes	Scale					Total respondents
	1 (very dissatisfied)	2 (dissatisfied)	3 (neutral)	4 (satisfied)	5 (very satisfied)	
Fare rate	0	0	20	336	44	400
Travel time	16	80	10	288	6	400
Travel comfort	50	112	18	220	0	400
Safety	156	190	8	46	0	400
Travel speed	0	30	130	230	10	400
Crowd	152	178	20	46	0	400
Operators' behavior	38	140	68	156	0	400
Quality of service	0	38	104	224	34	400

Source: E-rickshaw Passengers' Survey, 2019

Table 14: Performance Index of attributes based on opinion of E-rickshaw passengers

Attributes	Performance Index	Rank
Fare rate	4.06	1
Travel time	3.47	4
Travel comfort	3.02	5
Safety	1.86	8
Travel speed	3.55	3
Crowd	1.88	7
Operators' behavior	2.87	6
Quality of service	3.64	2

Note: Performance Index = $\sum$(Value X Scale)/Total respondents

5. Discussion

This study also delineates the challenges that stand in the way of proper implementation of these e-rickshaws in the public transport sector. The major challenge of the e-rickshaws would be to meet the present day traffic conditions. The popular sentiment, much purported by the media is that auto rickshaws are a major cause of traffic congestion; because of their small turning radius, people claim auto rickshaws can easily

"cut lanes" and cause impediments in traffic flow. There are no specified pickup points for the shared auto rickshaw service. Since no proper regularization has been maintained for the E-rickshaw operating zones, these vehicles have been operating on all types of roads, from by-lanes to thoroughfares. These vehicles have no fixed routes, but the starting points are fixed by the operators and union bodies. The major issues and challenges faced by E-rickshaws, derived from the field survey and observation, can be grouped on following.

- **Inter–Vehicle conflict:** This type conflict has been observed in case of E-rickshaw operation with that of the other types of three-wheeled vehicles. In many parts of the city where E-rickshaws have come up, the stronger unions of the other vehicles have not been allowing the E-rickshaws to ply of most of the routes. Even petitions were filed against the E-rickshaws by auto-rickshaw unions stating the fact that those were not permitted to carry passengers. The stronger cycle-rickshaw and van-rickshaw unions in many places do not let the E-rickshaws to carry passengers. So, the E-rickshaws often choose to operate during the time of the day when other vehicles population is smaller. These challenges remain due to the sharing of passenger load and thus the income from transportation.
- **Undefined halt points:** They are low speed vehicles with undefined stoppages and stops according to the passenger needs. They usually operate on narrow streets or lanes. This increases the chances of congestion as the vehicles behind them have to stop with them, if there is a group of rickshaws stopping together on narrow roads.
- **Technical/mechanical issues:** From field survey, 63% of the drivers face technical issues in operation and about 77% face mechanical breakdowns during operation after about 3-4 months from the date of purchase of the vehicle. This issue is faced even by the certified e-rickshaws.
- **Issue due to rains:** During the rainy season, there is greater chance of their breakdowns. The water may penetrate into the oiled parts in the handle and affect its operation. The speedometer and other parts also become dysfunctional if water penetrates into them. The E-rickshaw operators cover the handle to avoid this problem.
- **Lack of designated charging points:** There is no subsidized provision or authorized charging stations for charging the vehicles. In the cases where the drivers charge them at their houses, stay away from their routes of operation and have to travel to their routes in the morning and also return to their residences in the evening, they either travel on the restricted routes or don't get any passengers on their way. This increases the 'dead distance' (the distance between the operational route and residence of the driver on which the rickshaw is vacant and does not create any income for the driver). This reduces the distance which he/she could have covered if the rickshaw had a parking and charging space near the route.
- **Lack of designated parking spaces:** Parking spaces are not available for the rickshaws. Drivers, who can't take their rickshaws to their houses, have to park them in shops or in rented places. According to E-rickshaw Operators' survey, 81% of the drivers do not have proper parking spaces and they have to park their vehicles at their own risk. The remaining 11% don't have to face any problems because they park their vehicles in their own houses.

- **Lack of stopping and resting areas:** According to E-rickshaw Operators' survey, 98% drivers consider this as one of the problems during operation. There is a lack of resting facilities or designated areas where these can wait for their passengers. It is illegal to stop in those areas and they have to flee from that area in case any traffic official comes.

6. Conclusion

This study was conducted to understand the mobility about paratransit/IPT system particularly E-rickshaws in the context of Rangpur city, Bangladesh. Majority of urban passengers use the mode to meet their travel demand now for some specific benefits that the mode offers over other vehicles. Simultaneously, a large portion of urban poor people's livelihood is now associated with the mode. Therefore, banning/restriction of the mode might affect their living as well as bring negative impact in urban transportation system especially regarding passenger's modal choice. E-rickshaws are providing the last mile connectivity as well as serving as a public transport in some routes. These modes are not completely illegal rather they are unregulated. This is also a barrier for the Government to set up a fare regulation for paratransit in the city. To effectively implement paratransit/IPT as a feeder system for mass transit, it is important to understand how paratransit influence the commuters and mass transit connectivity. This research is proposed to emphasize the utilization of the existing transport modes through the strategy of integrated urban transport.

7. References

Ahmed M., Datta R. 2006. Utility of paratransit modes in cities of Assam, India. *Transportation Research Record: Journal of the Transportation Research Board,* (1971), pp. 107-115.

Ahmed. M. 2008. Socio – economic status of paratransit operator in the city of Assam. *ITPI Journal*, 2008, pp. 21-27.

Ali, T. 2019. Electric rickshaws run out of steam. *The Daily Star*. Retrieved from https://www.thedailystar.net/news-detail-187825

Baker, J. 2005. 'Urban Poverty and Transport: The Case of Mumbai', World Bank Policy Research Working Paper 3693. Washington, DC: The World Bank.

Bangladesh Road Transport Authority (BRTA). 1990. *The Motor Vehicles Ordinance 1983,* Ministry of Law and Land Reforms, Government of The People's Republic of Bangladesh

BBS 2011. *Bangladesh population and Housing Census 2011*, National Report, Volume-3: Urban area report (1st edition). Dhaka: Bangladesh Bureau of Statistics.

Bose, Pratim, and Ranjan. 2014. *Cheap rides, low costs: it's Tuk-Tuk time in Tripura*.

Cervero, R. 2000. Informal Transport In the Developing World, pp.117–144. Available from: https://books.google.nl/books/about/Informal_Transport_in_the_Developing_Wor.html?id=_4z7AI6XuH8C&redir_esc=y.

Cervero, R. and Golub, A. 2007. Informal transport: A global perspective. *Transport Policy*,14(6), pp. 445-457.

Dhaka Tribune. 2014. *Solar-powered charging stations for easy-bikes, battery-run rickshaws on the cards*. Accessed October 19, 2014.

Dutta, A. and Jash, T. 2014. Studies on energy consumption pattern in mechanized van rickshaws in West Bengal and the problems associated with these vehicles. *Energy Procedia*, 54, pp. 111-115.

Godard, X., 2013. Comparisons of urban transport sustainability: Lessons from West and North Africa. *Research in Transportation Economics,* 40(1), pp. 96-103.

Graeff, J. 2008. The Organization and Future of the Matatu Industry in Nairobi, Kenya. New York, NY.

Grava, S. 2003. Urban Transportation Systems. Choices for Communities. Mc Graw Hill Professional.

Joewono, T. B. and Kubota, H. 2007. User perceptions of private paratransit operation in Indonesia. *Journal of Public Transportation,* 10(4), p. 5.

Luthra, A. 2006. *Para Transit System in Medium Sized Cities Problem or Panacea*,

Mallik, A., Arefin, M. A., and Pal, S. K. 2018. Solar Based Micro Hybridized Auto-Rickshaw & its Feasibility Analysis for Bangladesh. *Proceedings of the International Conference on Mechanical Engineering and Renewable Energy (ICMERE2017)*, 2017.

Orski, C. K. (1975). Paratransit: the coming of age of a transportation concept. *Transportation,* 4(4), pp. 329-334.

Pramanik, M. A. and Rahman, M. S. U. 2019. Operational characteristics of paratransit in medium-sized city: a case study on E-rickshaws in Rangpur City, Bangladesh. *Journal of Bangladesh Institute of Planers (JBIP)*, 12, pp. 45-62.

Rahman, M. S. U. 2012. Public transport in a small island of a developing country, *Brazilian Journal of Urban Management (URBE)*, 4(1), pp. 61-72.

Rahman, M. S. U. and Timms, P. 2020. Pre-determined fare structure for rickshaws when integrating with BRT systems, *Case Studies on Transport Policy,* 8(1), pp. 236-244.

Rahman, M. S. U., Timms, P. and Montgomery, F. 2012. Integrating BRT systems with rickshaws in developing cities to promote energy efficient travel, *Procedia - Social and Behavioral Sciences,* 54, pp. 261-274.

Rahman, M. S. U., Timms, P. and Montgomery, F. 2013. Suggestions for integration of cycle-rickshaws with public transport in Dhaka city. *Proceedings of 13th World Congress on Transport Research (WCTR)*, Rio de Janerio, Brazil, 15-18 July 2013. Available at: *http://www.wctrs-society.com/wp-content/uploads/abstracts/rio/selected/2861.pdf*

Rana, M. S., Hossain, F., Roy, S. S. and Mitra, M. S. K. 2013. Exploring operational Characteristics of Battery operated Auto Rickshaws in Urban Transportation System. *American Journal of Engineering Research (AJER),* 2(4). Retrieved from *http://www.ajer.org/papers/v2(4)/A0240111.pdf*

Rana, M. S., Hossain, F., Roy, S. S. and 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), pp. 1-5. Retrieved from http://www-nrd.nhtsa.dot.gov/pdf/esv/esv20/07-0301-O.pdf (Retrieved on 15 July 2020).

Rangpur City Corporation Master Plan (RpCC). 2014. Ministry of Local Government, Rural Development and Cooperatives (MLGRD&C), Government of Bangladesh.

Shimazaki T. and Rahman M. 1996. Physical characteristics of paratransit in developing countries of Asia. *Journal of advanced transportation,* 30(2), pp. 5-24.

Shizamaki, T. and Rahman, M. 2000. Operational Characteristics of Paratransit in Developing Countries of Asia.

Simon and Rojesh. 2014. Battery rickshaws in New Delhi and the regulation conundrum. *Economic and Political Weekly*. XLIX (35). Retrieved 15 September 2014.

Tangphaisankun, A., Nakamura, F. and Okamura, T. 2009. Influences of paratransit as a feeder of mass transit system in developing countries based on commuter satisfaction. *Journal of the Eastern Asia Society for Transportation Studies*, 8.

Thirumurthy, A. M., and Yamamura, E. 1986. Intermediate Public Transport a Scenario and their Contribution to Urban Traffic Congestion in Indian Cities. 8(2).

Transparency Market Research. 2018. *E-rickshaw Market-Global Industry Analysis, Size, Share, Growth, Trends, and Forecast 2018-2026*. Retrieved from *https://www.transparencymarketresearch.com/e-rickshaw-market.html*

Tuan, V.A. and Mateo-babiano, I.B. 2007. Motorcycle Taxi Service in Vietnam – Its Socioeconomic Impacts and Policy Considerations. 9.