CYCLE-RICKSHAW AS A SUSTAINABLE MODE OF PUBLIC TRANSPORT IN DHAKA CITY

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ABSTRACT

Dhaka, the capital of Bangladesh is the economic and administrative hub of the country. Unfortunately, about 90 percentage of urban roads has become inaccessible to motorised vehicles particularly mass transit due to unplanned infrastructure development. This study tries to promote cycle-rickshaw as an effective mode of public transport for sinusoidal, criss-crossing road network. The significance of modal choice by income level and trip purpose has been stressed within general context of sustainable development. To enhance the study, sampling method is followed to collect representative sample and detailed questionaire survey is undertaken. Another outcome of this study is to establish relationship between distance and rickshaw fare and to provide relative comparison with other modes of transport. More specifically, evidence is presented that indicates cycle-rickshaw as the most efficient mode of public transport for short distance travel including scattered destinations. This study is a manifestation of cycle-rickshaw as a sustainable transport which is to be integrated in transportation planning and management for overall improvement of the system.

Keywords: *Cycle-rickshaw, dhaka, public transport, sustainable mode, trip*

1. INTRODUCTION

Any transportation system that allows basic access needs in complement to environmental concern can be denoted as sustainable transport. In spite of being densely populated, Dhaka city has characteristics which support sustainability. Rickshaw plays an important role in Dhaka Metropolitan Area (DMA) which accounts for 38.3% of modal share, highest among all transport modes (DHUTS, 2010). The value reaches 58.1% if walking (19.8%) is included (ibid). Being non-polluting and free from fuel consumption, these are the most sustainable transport modes. Besides, for people without a job skill, pulling a rickshaw is the only option other than begging or crime. Consequently, social and economic structure is not developed enough to meet increasing transport demand. Number of registered motor vehicles is about 0.9 million in Dhaka city (BRTA, 2015). If population of Dhaka city is estimated as 15 million then number of motor vehicles per 1000 people will be 60 which are certainly not adequate to meet current travel demand. Considering severity of traffic congestion, we cannot encourage modernization based on motorization. Lax in policy towards cycle-rickshaw will undoubtedly, have negative impacts on air pollution, energy use, mobility and employment of low-income people. This study attempts to confirm the significant role of cycle-rickshaw in sustainable development of Dhaka city.

2. LITERATURE REVIEW

Previously several studies have been undertaken on cycle-rickshaw as a part of non motorized vehicle. Some of them are briefly reviewed here.

Replogle (1991) conducted a detailed study on non-motorized vehicles in Asia as a part of sustainable transport planning. He identified appropriate conditions, obstacles and desirable steps to develop a Non-Motorized Transport Strategy for a city or region, in Asia. Besides he also mentioned that in countries like Bangladesh cycle-rickshaw should be encouraged as a complementary paratransit mode of motorized vehicles.

Bose and Sarker (2002) took an attempt to examine the impact of cycle rickshaw on a heterogeneous traffic flow and proposed options to augment the role of cycle rickshaws in a city of India. Moreover they concluded that in spite of being responsible for decreasing the speed of the vehicular flow, Cycle rickshaws cannot be removed totally as certain areas in the region are suited to this mode of transport only.

Begum and Sen (2005) conducted a study whether pulling a cycle-rickshaw can provide a way out of extreme rural poverty. They showed that though pulling a rickshaw provides regular income flow, health crises, financial

crises, personal insecurity create adverse long-term consequences. Finally they reached in conclusion that rickshaw pulling provides no permanent route to escaping poverty.

Taking care of the above mentioned studies, this study attempts to present an overall scenario about sustainability of cycle-rickshaw in the current context of Dhaka city.

3. METHODOLOGY

The study adopted sampling method to acquire information on daily travel characteristics in Dhaka city from a representative sample size of 80. A questionnaire survey was undertaken in September-October 2015 to find out trip purpose, O-D zones, mode of transport used. Collected primary data was analyzed based on gender, occupation and socio-economic status. To increase the sample size, both online and field survey were undertaken.

Secondary data was collected from District Statistics 2011 by Bangladesh Bureau of Statistics (BBS) and survey report on DHUTS in Bangladesh by JICA. Then the authors analyzed the data in accordance with the required objectives of the study.

4. FINDINGS

4.1 Overview

Cycle-rickshaws, most commonly known as rickshaws are the most common modes of transport in current context of Dhaka city. Rickshaws are operated mostly in residential areas and market places. Due to undermining policy, there is no accurate official statistics available related to this sector. Division wise distribution of rickshawsin Bangladesh is presented in Figure 1.

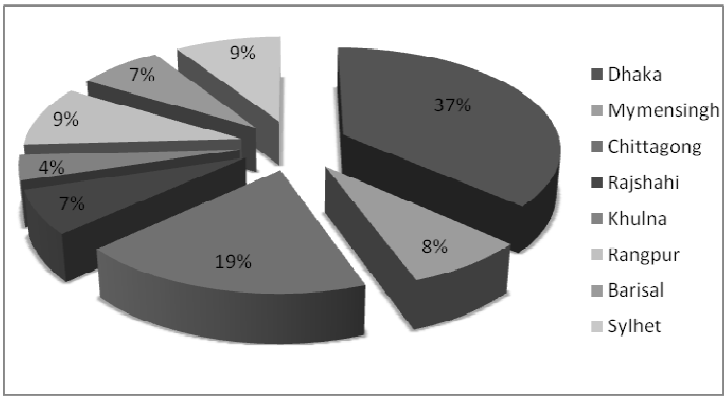

Figure 1: Division wise distribution of rickshaws in Bangladesh (source: BBS,2013)

There are 10, 52, 139 rickshaws in Bangladesh and 3,85,368 of them are plying on Dhaka which constitutes 37% of total number (BBS,2013). But observing the present scenerio, it can be stated that actual number of rickshaws is much higher. Everyday rickshaw numbers are increasing due to growing demand. Nowadays number of daily rickshaw trips amount to about 7.9 million in Dhaka city (DHUTS, 2010). Average rickshaw fare paid per trip is Tk. 20 average trip length is 1.8 km (ibid). Moreover considering the number of people involved in this industry, cycle-rickshaw can be considered as an important component of informal economics of developing countries like Bangladesh.

4.2 Modal Choice by Income Level

This study designates three levels of household income group as follow:

Group 1: Monthly household income with more than BDT 50,000. High-Income Group (HIG).
Group 2: Monthly household income between BDT 20,000 and BDT 50,000. Middle-Income Group (MIG).
Group 3: Monthly household income with less than BDT 20,000. Low-Income Group (LIG).

Table 2: Groupwise distribution of participants

Group	No. of participants
1	19
2	26
3	35
Total	80

Table 2 shows groupwise distribution of participants that constitutes total sample size of 80. The desired objective is to determine trip purpose and tendency of modal choice structure by income level. The percentage share of respondents by household income groups is as follows

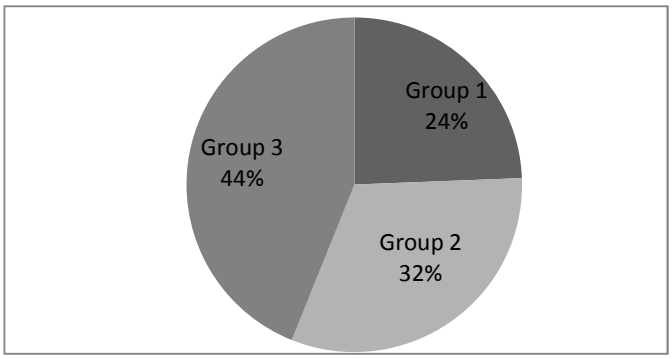

Figure 2: Percentage of different income groups

Figure 2 shows that the highest percentage (44%) of participants has monthly household income more than BDT 50,000. The number of respondents from group 2 and group 1 are 32% and 24% respectively. Of all the participants, 62% are male and 38% are female. The sample is composed of 44% students, 27% service holders, 25% bussinessmen and 4% others.

4.3 Variation in Modal Choice Based on Trip Purpose

The participants were asked to select the mode of transport they most frequently use for accessing work and shopping. For the students, university option was provided in lieu of work. In case of trips produced by multiple modes, the respondents selected the mode that is used to cover the most part of the distance.

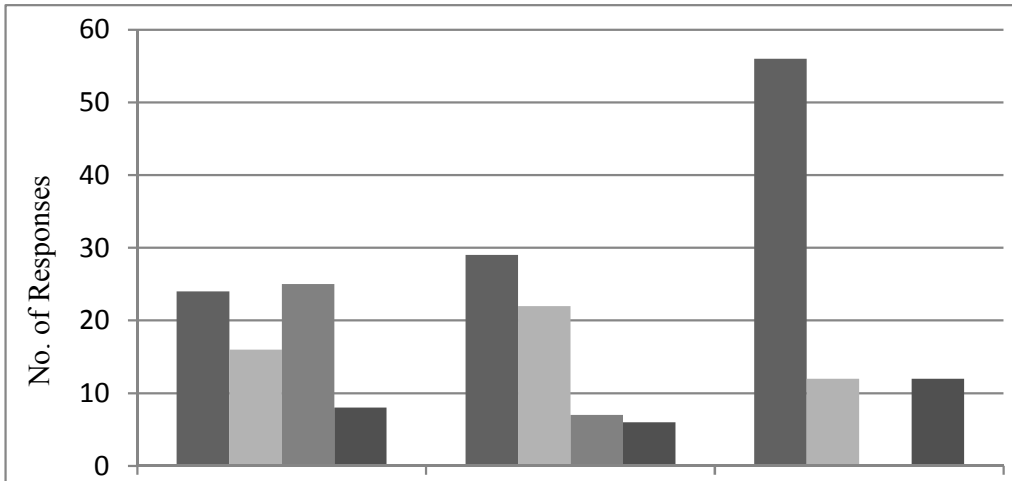

Figure 3: Mode of transport used for accessing work

From Figure 3, it is clear that majority of people (70%) from low income group travel by rickshaw to access work place. It is because people in this group generally live near the site and tends to make shorter trips. The percentage of bus users and walking are pretty close. It is hardly surprising that there is no user of car in this group. For group-2, rickshaw constitutes the highest percentage (45%) of trips. It is closely followed by bus trips (34%). There is 11% of private car ownership. Walking is the least chosen mode which is understandable considering relative travel time and travel distance. The highest percentage (34%) of private motorized trips is produced by the group with monthly household income more than Tk. 50,000. Interestingly percentage of rickshaw trips (32%) is nearly same and the value is greater than bus (22%). Since most of the time buses remain overcrowded and CNG drivers charge extra fare, women and passengers with goods try to make limited uses of these modes.

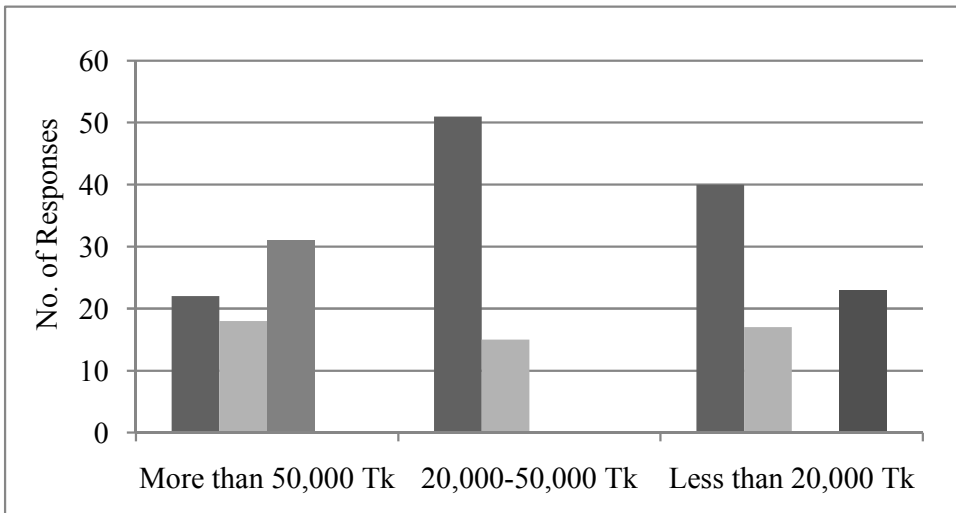

Figure 4: Mode of transport used for shopping

Figure 4 shows dominance of rickshaw in case of trips produced for the purpose of shopping as well. Since these types of trips are generated during holidays when commuter traffic is less, percentage share of bus is relatively higher. For middle income group, choice of mode is very limited. They cannot afford their privatized vehicle and walking with baggage affects their sense of status roughly. So naturally rickshaw is the predominant mode here. People from HIG uses car more frequently for shopping than accessing work. The fact is most often shopping trips consist of family members and naturally they prefer the most convenient mode.

4.4 Relationship between Rickshaw Fare and Distance

From the questionnaire survey, 25 locations were randomly chosen and some analysis was done to establish a relationship between distance and rickshaw fare. In order to achieve consistency, location of trip generation was chosen 'BUET' for all collected data. A preliminary field survey was undertaken to find out whether the participants could estimate the distance and travel time accurately. In most instances, they either overestimate or underestimate the distance and provide some approximate value. Therefore to maintain accuracy the distance of trip distribution was calculated using the "Directions" menu of Google map. In case of rickshaw fare, there is no defined rate per km and in most cases it is an abstract value. In practice, the passenger has to fix the fare with the puller before starting the trip. Generally most rickshaw pullers demand Tk.10-40 more than the usual fare. So there is a good chance to be deceived if anyone has no idea about the fare. In fact the rickshaw fare is fixed based on the verbal agreement of both the passenger and the puller. If the fare is not prefixed very often unpleasent situation arises. Sometimes pullers cotrol the distribution of trip by taking passengers suitable for their desired locations.

Table 2: Collected data for distancewise rickshaw fare

Location	Distance(km)	Average fare(Tk.)	Unit fare per Km(Tk.)
Malibagh Chowdhuripara	5.5	70	12.7
32, Dhanmondi	3.6	50	13.9
Gulistan	2.2	40	18.2
Nilkhet	1.4	25	17.9
Azimpur	1	20	20.0
Palashi	0.4	10	25.0
Star kabab,Dhanmondi	2.3	40	17.4
Banga Bazar	1.5	25	16.7
Kamalapur	5.3	70	13.2
Kathalbagan	3.5	50	14.3
Greenroad	2.9	50	17.2
Jigatola	4.9	70	14.3
Hatirpool	2.1	30	14.3
TT Para More	5.2	70	13.5
Mugdapara	6.9	100	14.5
Shukrabad	4.7	50	10.6
Polton	2.8	40	14.3
Khilgaon	6.5	90	13.8
Shahbag	2.3	30	13.0
Farmgate	6.2	80	12.9
Dhanmondi	4.2	60	14.3
Elephant Road	2.8	40	14.3
Poribag	2.6	40	15.4
Lalbagh	2.4	30	12.5
Baily road.	2.9	40	13.8

To obtain the values of Table 2, the participants were asked to provide average rate of rickshaw fare. The obtained values were calibrated by the author himself by travelling 10 locations with rickshaw selected randomly. Before making each trip, about 3-5 rickshaw pullers were asked the fare at which they were willing to go. It was found that the obtained data intended to over-estimate the costs about 15%. So the values were adjusted downwards accordingly.

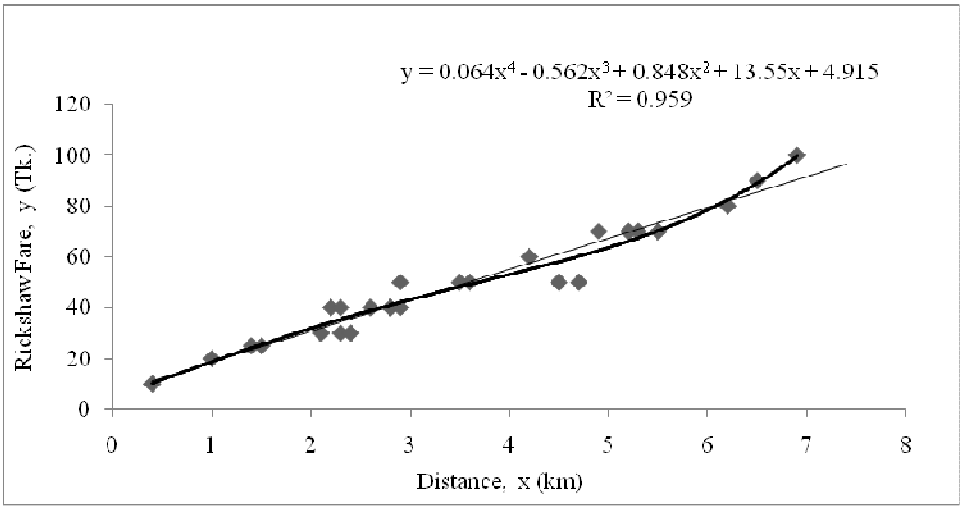

Figure 5: Variation of rickshaw fare with distance

Figure 5 shows average rickshaw fare as a function of distance. Specifically rickshaw fare is a function of number of parameters, such as- political situation, weather condition, period of travel, physical strength, religious or social festivals etc. For example, during political strikes public transports are not generally available. At that time rickshaw becomes predominant mode of transportation. So the pullers try to make the

best use of the situation by asking exorbitant fares. Similar scenario can be found during rainy days. Due to water-logging on most roads of Dhaka city motor vehicles cannot operate in most places. For movement, non-motorized vehicles especially rickshaws become the only choice of commuters. On those days rickshaw fare is much higher than as usual. In this study, the effects of other parameters on rickshaw fare have been neglected for simplicity. The adjusted data are plotted and a closed form model of 4^{th} order polynomial regression equation is obtained.

$$y = 0.064x^4 - 0.562x^3 + .848x^2 + 13.55x + 4.915 \quad (1)$$

In this model, distance is used as independent variable since it can be measured more accurately without error. It is assumed that distance and corresponding rickshaw fare follows normal distribution. The model shows corresponding variation of rickshaw fare with increasing distance. For this model the value of co-efficient of determination (R^2) is 0.959. It indicates that 95.9% of the original uncertainty has been explained by the model. If linear regression is done it explains variability of data in 94.4% cases. Therefore polynomial regression provides a better representation of data.

4.5 Costs of Rickshaw per Passenger-Kilometre

In order to compare with other modes, the unit cost of rickshaw fare is needed to be determined. But truly speaking it creates a dilemma. From this study arithmetic mean of per km rickshaw fare is calculated as Tk. 15. If too short trips (< 1 km) and too long trips (> 5 km) are discarded, this value becomes Tk. 14.60. The calculated weighted arithmetic mean is Tk. 14 per km. Therefore the most sensible approach will be to consider the cost corresponding to most common distance travelled by rickshaw. For the establishment of this relationship, rationally the average distance can be taken as 2.5 km for rickshaw trips and the corresponding average rate of fare as Tk. 15.

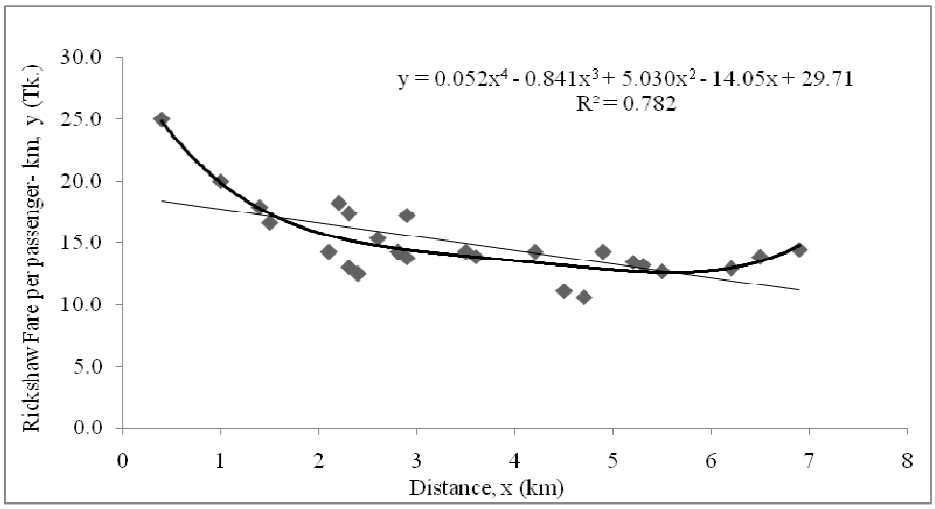

Figure 6: Rate of rickshaw fare vs. travel distance

Figure 6 indicates costs per passenger-km with increasing travel distance. From the plotted data, a 4^{th} order polynomial regression model is fitted. The corresponding equation is

$$y = 0.052x^4 - 0.341x^3 + 5.030x^2 - 14.05x + 29.71 \quad (2)$$

The value of co-efficient of determination (R^2) is 0.782 which signifies that the model is representative in roughly 80% cases. For best fit linear regression, this value is much lower $(R^2 = .424)$. Interestingly it is noticeable that for same set of values, Total cost – Distance model represents the actual situation better than the Unit cost – Distance model. The underlying reason is as the distance increases, unit cost of a particular mode of transport falls generally. This is evident in case of rickshaw fare up to a certain distance. In shorter trips, pullers need to wait some time for the next one after taking a passenger resulting. It creates disturbance to continuity of income. From the observations it is evident that unit cost of rickshaw is much higher in case of either very short or very long trips. This phenomenon can be explained as no rickshaw puller will go anywhere for less than a fixed rate no matter how short the distance is. Now-a-days this rate is about Tk. 10 which becomes much higher

if it is calculated per km basis. For very long trips rickshaw pullers try to take the advantage of humanity giving excuses of longer distance and delay because of congestion. Therefore rickshaw trips are suitable up to an optimum distance where speed does not matter so much.

4.6 Comparison of Rickshaw Fare with Other Public Transports

For CNG-run auto-rickshaws minimum fare is about Tk 40. Besides commuters need to pay Tk 12 for each kilometre and Tk 2 per minute as the waiting charge. Very often drivers coerce riders to pay additional fares and refuse to make short trips. The current rate of bus fare is Tk. 1.70/km and minimum fare is Tk. 7. It indicates that passengers have to pay at least the fare for 4.2 km (7 Tk.÷1.70 Tk./km=4.2 km). It is understandable since for shorter distance bus transit will be less efficient considering the output of slower travel speed. According to BRTA bus fare chart (September 16, 2015), apparently 5.5 km distance can be travelled within cost of Tk. 10 in Dhaka city. Currently for rickshaw trip, one needs to spend Tk. 70-80 on average to travel the same distance. It is prominent that now-a-days, rickshaw fare is 7-8 times the existing bus fare. Hence anyone may get surprised about the existence rather dominance of cycle-rickshaw in our transportation system. The explanation can be given from several points of view.

4.7 Poor Quality of Bus Service

The existing bus service is not satisfactory from several perspectives. In most instances people have to wait in long queue for arrival of bus due to severe traffic congestion. It is even more difficult to get on the bus due to overcrowding in peak hours. Sometimes it becomes nearly impossible to board a bus especially for women and children. Another striking factor is that since buses are jam-packed with standing passengers, it takes more effort and jostling to get off from backwards. Therefore passengers tend to stand nearby the gate making the situation even worse. In such circumstances it is hardly surprising that buses are used for longer distance trips. On the contrary, rickshaw provides a journey of convenience for relatively shorter distance.

4.7.1 Rickshaw Friendly Road Network

The road network system of Dhaka city is rickshaw biased. Most of the local street network is very narrow, sinusoidal and crisscrossed with 90° sharp bending. Therefore road network is dictating a complementary smaller sized vehicle for efficient travelling. Besides, rickshaws trips are dedicated to scattered locations which cannot be served by a single bus trip. Rickshaw service provides much flexibility which results in better efficiency although the unit cost is lot higher. In addition motor vehicles require greater safe stopping distance in tern higher intra-vehicular headway while rickshaw can travel close altogether even in bumper to bumper condition.

4.7.2 Availability in Critical Situations

Another important advantage of rickshaw as a mode of transport is its availability. In least cases people need to wait to get on a rickshaw. The climatic condition of our country plays a vital role in this regard. During late monsoon, heavy rainfall disrupts the normal movement of people. Due to water logging in most of the important roads and low-lying areas, motorized vehicles are hardly be seen. In such instances, rickshaw can ply on roads without much difficulty and at that time people are compelled to use rickshaw in spite of excessive fare. During transport strikes and flood, rickshaw becomes the most suitable means of transport on certain roads of Dhaka city.

4.7.3 Provisions for personalization

Privacy is one of the most vital roles of rickshaw in transportation sector. As soon as one gets on a rickshaw it becomes a personalized paratransit. Generally it is very difficult to get on a bus with a luggage or holding something in hand. The existing service for women and disabled is not at all satisfactory. In most cases there is no provision of reserved seats and if any, occupied by other passengers. So people choose rickshaw particularly who cannot afford a motorized private transport.

4.8 User's Perception on Advantages of Rickshaw

In the questionnaire survey, an attempt has been made to investigate user's perception on advantages of rickshaw over other modes of transport. Each person was asked to choose from four given options. Everyone was allowed to select more than one option and add suitable advantages oneself if necessary. After collating respondent's answers the following bar chart is drawn.

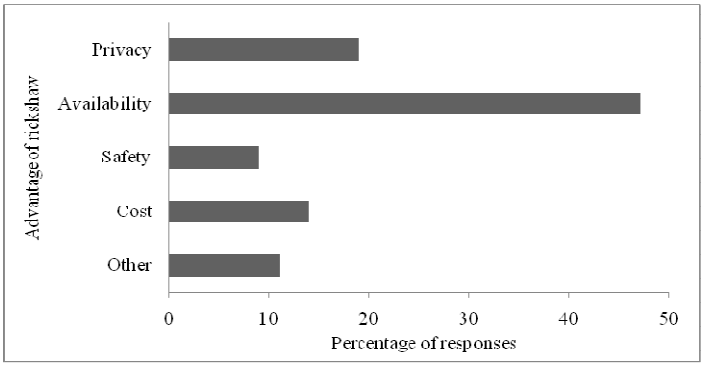

Figure 7: Comparison of rickshaw advantages

Figure 7 represents about 47% of respondents consider availability as the major advantage of rickshaw transport. Privacy is considered as an important benefit of rickshaw as it was chosen by 19% of people. This advantage is followed by 14% people taking it as cost-effective. 11% selected other which includes comfort, safety, environment friendly, faster than walking.

4.9 Difficulties with Other Sustainable Alternatives

The real sustainable alternative to rickshaw is bicycle. It is not only flexible but also cost effective. Due to some reasons bicycle has not earned much popularity. Firstly, the initial cost of a bicycle is much higher relative to neighbourhood countries. Secondly, adequate locking and security are not available creating the risk of being stolen. Thirdly and most importantly, riding a bicycle is considered as a low status activity in Bangladesh. This mode is best suited for people of middle class and upper-middle class. Ironically in most cases, they feel the prejudice against bicycle. As a result bicycle ownership is comparatively low in Bangladesh.

5. CONCLUSIONS

Considering the number of rickshaws and percentage of trips produced, it can be stated that rickshaw has become an indispensable part of the current transportation system. From the above analysis, it is easy to interpret when travel demand is scattered, a fleet of rickshaws can operate more efficiently than a single bus. Redefining the rickshaw involves developing rickshaw technology, operating conditions and traffic management. Comprehensive study should be undertaken to extend the developed models for establishing a suitable rickshaw fare structure. To reduce hassle, rate of fare can be fixed at least for some routes used heavily by general people. Speed wise dedicated rickshaw lane should be provided. It should be supported by ensuring proper maintenance for convenient travel and to avoid encroachment. Detailed research should be done for restructuring of rickshaw so that it becomes viable with decent travel time and travel speed. Finally, rickshaw becomes a problem when it is uncontrolled. But a controlled and well-regulated system will present cycle-rickshaw as a transport with zero-pollution, committed to sustainable development.

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