

AN EXPLORATIVE STUDY ON STUDENTS USING BICYCLE IN KHULNA CITY

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ABSTRACT

Khulna is the 3rd largest city in the southwestern part of Bangladesh having a population of 1.5 million. Among them, 32 percent have their own vehicle. The number of bicycle users is constrained to 5.9 percent in the city. The demand for transport facilities contrasts due to need, purposes and aptitudes from person to person. As bicycle act as a safe and economical mode of transportation, students prefer much about their daily uses. Because of the undeveloped public transit system and people's low socio-economic conditions, there is great potential for cycling as a mode of transport in Khulna city. This research analyzes the overall scenario of the students using the bicycle and their travel behavior in the northern part of Khulna City. Moreover, this study focuses on how bicycle trip generation is affected by different socio-economic parameters. Five wards (ward no: 6,7,9,10,14) of Khulna City Corporation were selected as a study area of the research which covers almost northern part of the City. 100 students were randomly chosen for collecting primary data through a questionnaire survey. Data was collected on their travel time and distance, origin-destination, trip generation and other social & economical condition. Six focus group discussions (FGDs) and five key informant interviews (KIIs) with different bicycle groups and teachers of schools and coachings respectively were conducted. Secondary data was collected through desktop research and literature review. Students having age of 15-20 year of middle and lower-middle income family uses bicycle most for the fast and economical travel. The average travel distance is 2.71 km per trip with average travel speed of 16.30 kmph in rush whereas 10.68 kmph in normal condition. Maximum number of trips are originated from Pabla and Khalishpur which is under ward no. 6 & 10 and maximum destination is in ward no. 9 & 14. The main purpose of using a bicycle is going to school and coaching centers, which is almost 77 percent of the total trip. Beside some of the respondent use bicycle for going to market, recreation, playing and other purposes. 115 BDT is spent every month by each student for maintenance of bicycle on an average. Teenagers of age 13-15 years, having rush speed of 19.61 kmph faces more accident than other age group. Around 45 percent bicycle rider lose their control over the bicycle and causes an accident. Student prefers walking and rickshaw for short distance travelling. They usually use other mode of transport in bad weather and for mechanical problem of the cycle. While for travelling long distance, they prefer Mahindra and auto. The regression model indicates travel distance has negative influence on the number of trip generation. On the other hand family income and cost of other transport mode have a positive influence on it. Inadequate parking, safety and road facilities are the main problems for cyclist. This study has rarely discussed about the influence of the built environment on the uses of the bicycle. This research may help the concern authority and policy makers for improving and redesigning transport policy and other related problems of Khulna city.

Keyword: *Bicycle, Travel Behavior, Transportation Mode, Trip Number, Travel Speed.*

1. INTRODUCTION

Transport is one of the vital components of economic activity all over the world. In fastest growing economic country like Bangladesh, growth in motorized vehicles is increasing rapidly (Tiwari, et al., 2008). On the other hand, country's travel demand is still predominantly met by non-motorized modes like walking, rickshaws-vans and bicycles. Bicycle is considered safe and effective popular transport modes in rural and urban streets. During traffic congestion, bicycles are more efficient and faster than cars or public transport (García-Palomares, et al., 2012; Larsen & Geneidy, 2010; Munley & Daniel, 2006). Traffic congestion and speedy urban lifestyle make bicycling a mainstream mode of transport. Bicycling's benefits are multidimensional. It can reduce the total travel time in congested urban areas and take a little time for parking near the destination site. Bicycles have become a popular mode of urban transport worldwide due to ensuring sustainable urban mobility. In Netherlands, nearly 30% of all trips were made by bicycle, while Denmark had nearly 20% trips (Dey, *et al.*, 2014). Where there is no option of separate paths or lanes, traffic calming initiatives play an important role in safe bicycling. For example, the speed limit has been lowered to 30 km/h in most residential areas in Denmark, Germany and the Netherlands (Rana, *et al.*, 2016). Bicycles are commonly seen in both rural and urban areas in Bangladesh. Bicycle trips are primarily used for work and school trips. Around 6.3% trips on arterial road of Dhaka City are completed by bicycle. Medium-sized cities have a bicycle share of 4.3-7.1% of total trips and a high share of the cycle in intercity and small towns in Bangladesh (Tiwari, *et al.*, 2008).

Khulna is the third largest city of Bangladesh and has significant numbers of bicycle users. Here, bicycle is an important mode of transport at individual level. The number of bicycle users is constrained to 5.9% (Rana, *et al.*, 2017). In Khulna City, there is great potential for cycling as a mode of transportation due to the undeveloped public transit system as well as the socio-economic condition of the residents. The potentials of bicycling in Khulna City have not yet been clarified, so it is not obvious which benefits are actually found by bicycling. This research analyzes socio-economic condition of students and their bicycle trip number and the reasons behind using bicycle in the Khulna City. The objective of research is to investigate the relation between number of bicycle trip generated by students and their socio-economic parameters. The findings of the research might help the concern authority in decision making especially for the transport related issues to solve the city traffic problems.

2. DATA AND METHODS

Five wards (i.e., ward 06, ward 07, ward 09, ward 10, and ward 14) under the Khulna City Corporation (KCC) were selected and finalized as study area (see Figure 1) based on field visits and reconnaissance survey. According to Bangladesh Bureau of Statistics 2014, the study area has an area of 9.67 square kilometers with 128,130 population and density of 13,250 per square kilometer. The main focus of the study was to find out the scenario of the students using a bicycle. As it was found that the concentration of students using bicycle (maybe origin or destination) was more in those areas because of schools and coaching. So, these areas are considered as a study area.

Secondary data from relevant organizations including physical features (i.e., boundary, roads, structures, river etc.) from KCC, and satellite images from Google Earth were collected. 06 Focus Group Discussions (FGDs) with the bicycle groups and 05 Key Informant Interviews (KIIs) with school authority and coaching stuffs were also conducted for finding the exiting condition bicycling. A questionnaire survey was also conducted among the 100 randomly selected bicycle user students visiting various schools and coaching in the study area. The questions were based on bicycle trips (i.e., number of trips, origin-destination, travel time etc.) and socioeconomic conditions (i.e., family income, age, gender, education etc.). Origin-Destination and speed variation in different routes were shown in map where trip distribution, speed, accident and other transport mode choice scenarios were presented by different charts and tables. Correlation analysis was done among different parameters to show the relation between the various types of data.

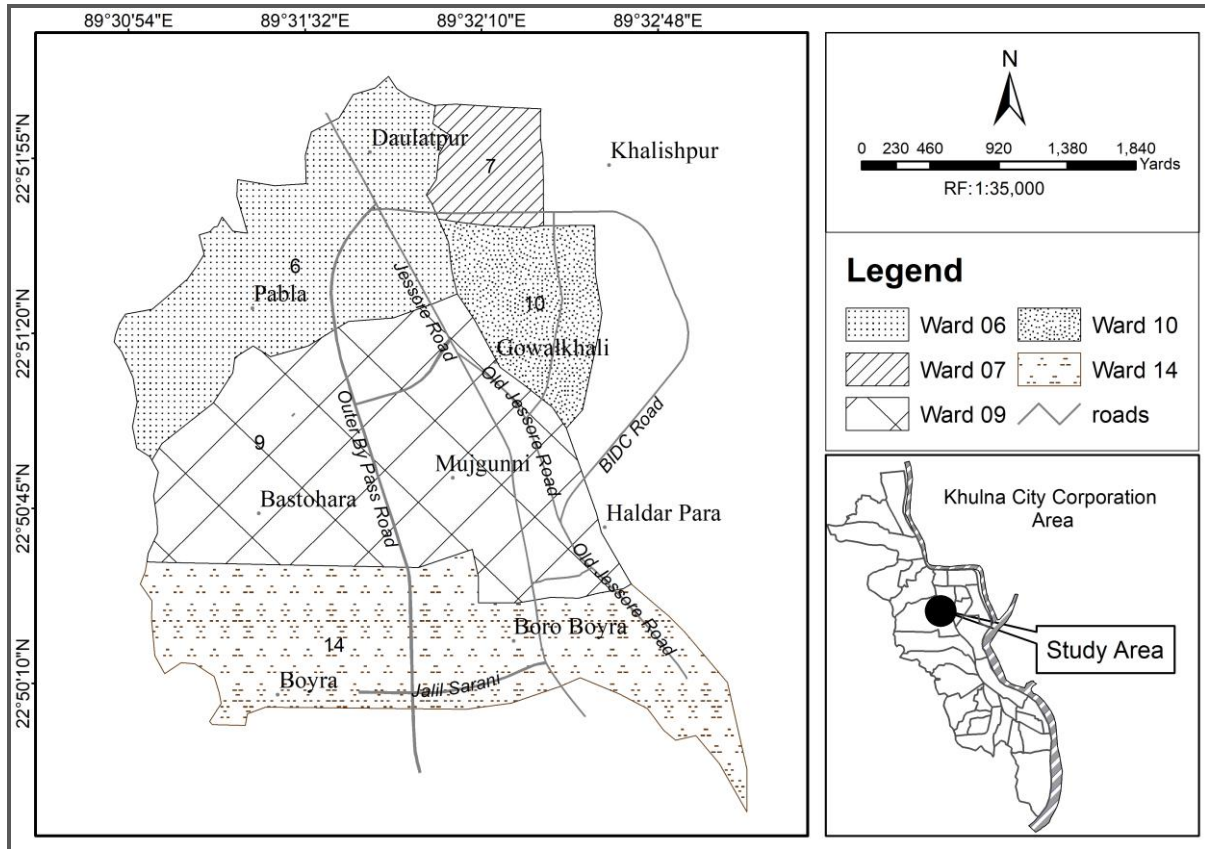


Figure 1: Location of the Study Area

A relation was established between the numbers of trip generated with other socio-economic parameters. In order to establish the relation, linear regression model was used shown in equation 1.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots \dots \dots + \beta_p X_p \quad (1)$$

Where, Y = the dependent variable (i.e., number of trips generated by bicycle), X = the independent variables (i.e., socio-economic parameters like family income, travel cost and travel distance) and β = coefficient.

3. RESULTS AND DISCUSSIONS

3.1 Scenario of Bicycling

As found by the survey, most of the bicycle user students were teenagers. The average speed of the bicycle was found 10.68 kmph and 16.30 kmph for normal and rush case respectively. Covering an average travel distance of 2.71 km a student usually gave 10 trips per week (Table 1).

Table 1: Average of different parameters of bicycle users in the study area

Average Age (Years)	15-20
Average Distance Cover (km)	2.71
Average Speed (km/hr)	10.68
Average Rush Speed (km/hr)	16.30
Average Trip Number (per week)	10
Average Maintenance Cost (tk per month)	115

3.2 Origin and Destination Analysis

Though the study area were selected as ward 6,7,9,10,14 but it was found that the origin and destination covered almost half of the KCC areas. In figure 2 (a), the number of origins were more in ward 06, 07, 08 and 10. Maximum trip origins were in Pabla and Khalishpur areas. In ward 09 and 14, the number of destinations were more. Maximum coaching centers and schools were situated in these two wards. So, the students from ward 06, 07, 08 and 10 came to ward 09 and 14 for coaching or other educational purposes.

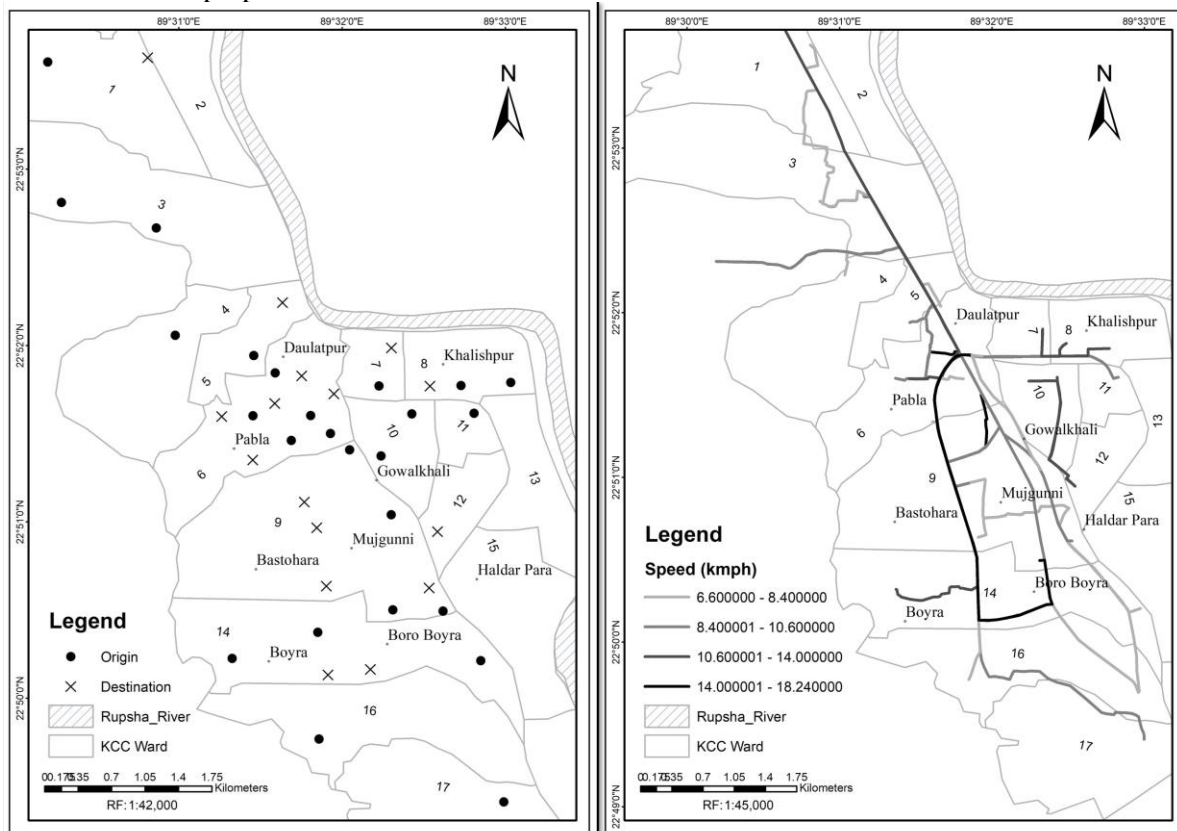


Figure 2: (a) Location of Origin-Destination and (b) speed variation in different routes

Again, in Figure 2 (b), speed variation in different route was shown. The speed of the cycle was more in the route between ward 14 to ward 06 via ward 09. Traffic volume was comparatively lower in that route. So, the cycle speed was more than 14 kmph on that route. Moreover, we saw that the speed varied with the main highway route to Khulna. The speed varied from 8.40-14 kmph in different section of the route. The reason was that the traffic volume was more on that route and high-speed

vehicle generally used that route. So, considering the safety and traffic issues, the speed in that section was moderate. But in between the different residential area, the speed was above the average speed that was in between 10.60-14.00 kmph. The speed in those routes were moderate that's because of the road type and condition.

3.3 Trip distributions

From the survey, it was found that the students generally gave 9 to 10 bicycle trips per week on an average and maximum student (36% of our surveyed respondents) gave 14 trips per week for their study and other purpose.

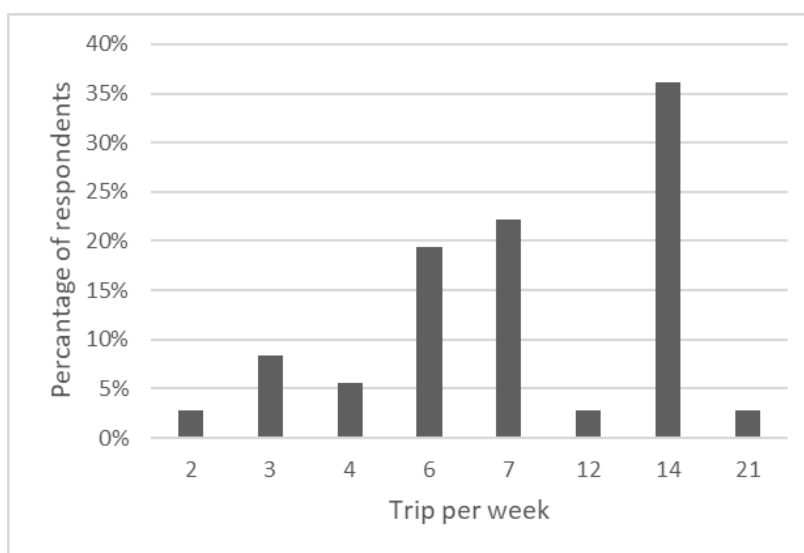


Figure 3: Number of trips per week of the respondents

The maintenance cost of bicycle was affected by the trip numbers. The correlation was 0.35 with 95 percent confidence interval. Average maintenance cost of bicycle was found BDT 115 per month.

Table 2: Trip distribution of bicycle user students according to their education institute and age

Institution	Age (Years)			Total (%)
	13-15	15-20	20-25	
College	0	36	8	44
School	20	25	0	45
University	0	0	11	11
Percentage	20	61	19	100

Around 80 percent of students using bicycles in Khulna city were school and college going and their age was between 13-18 years old (Table 2). So, their main purpose of using bicycle was going to school, college and coaching.

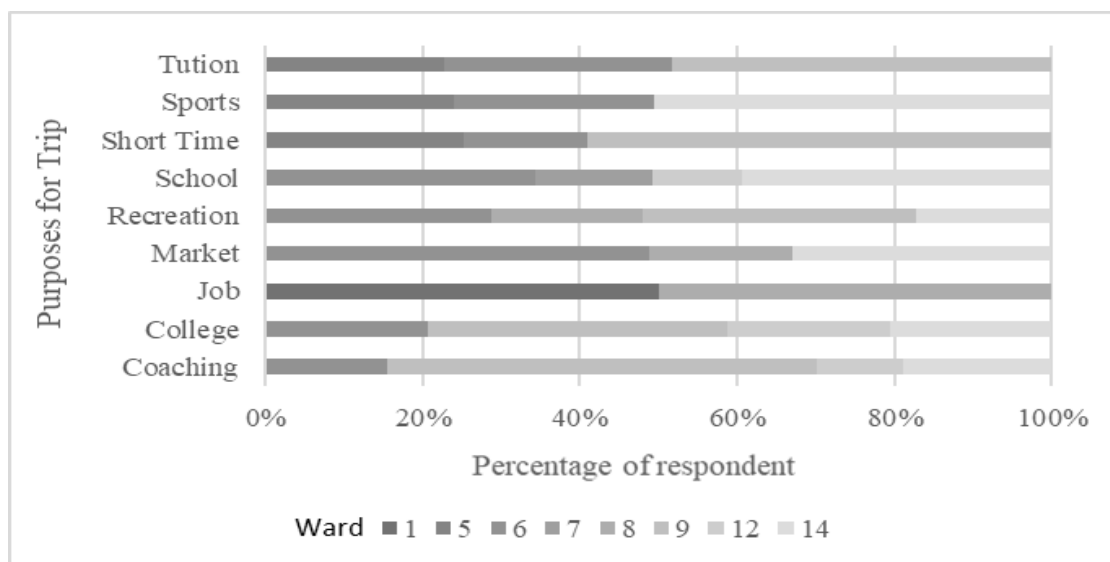


Figure 4: Trip distribution according to purpose

Rest of the respondents were university level students who generally used bicycle for going part-time job, tuition and coaching. Because of having advantage of taking shortcut bicycle was also popular to the students for their daily trip like for recreation, going to play ground, market and other purpose (Figure 4). There was no significance difference between the generated trips in the two-trip time considered in the study. But in morning it was comparatively generated more trip as almost 40 percent (Table 3) of the students went to school and college in the morning except the students who study in collage second year and University (National and Public). They usually did not go to college in the morning period.

Table 3: Trip distribution of the students in different time

Purpose	Percentage of trips in different time	
	Evening	Morning
Coaching	19	8
College	3	14
Job	0	6
Market	3	0
Recreation	6	0
School	3	25
Short Time	3	3
Sports	3	3
Tuition	3	0
Total	42	58

3.4 Speed Scenario

The value of correlation analysis of trip time and the speed of the bicycle was 0.147. Which indicates there was no relation between trip time and bicycle speed. That means speed was not affected by the time of the trip. From Table 4, it was found that the average speed of a bicycle in Khulna City was quite same in the morning and evening when the school and colleges start and close. At the evening students usually went to coaching center.

Table 4: Average speed of the student bicycle users

Trip time	Average speed (Kmph)
Evening	11.43
Morning	10.14
Average	10.68

Overall average speed was found 10.68 kilometers per hour. Where the usual average speed of a bicycle was 15-16 kmph (Eriksson, *et al.*, 2019). So, it seems that the average speed of the bicyclist was hampered due to bad condition of roads in Khulna City.

3.5 Accident Scenario

Table 5 showed that the students between age of 15-20 years, having an average speed of 11.15 kmph and rush speed 16.08 kmph and the age of 20-25 having a speed of 9.3 kmph and rush speed 14.37 kmph.

Table 5: Average speed of different age bicycle user students

Age (Years)	Speed (kmph)	Rush Speed (kmph)
13-15	10.79	19.61
15-20	11.15	16.08
20-25	9.30	14.37

On the other hand, the teenagers having almost the same average speed but have a high rush speed of 19.61 kmph, which indicated the teenagers ride was more rush compare to adult. So, the teenagers (13-19) faced more accident on the road while riding bicycle.

Around 45 percent of the bicycle rider students lost their control while riding rush and slipped on the road and get knee and elbow injury. And all this type of accident faced by the teenagers. But crash with other vehicles on major roads was faced by all age group students, which was almost 40 percent (Table 6). And this type of accident was faced by the other occupation bicycle riders as well. And this crash was happening due to heterogeneous traffic mode and absence of bicycle lanes.

Table 6: Accident faced by the students while riding bicycle in the study area

Types of accident	Age (Years)			Total (%)
	13-15	15-20	20-25	
Crash with Vehicle	17	11	11	39
Crashed with rickshaw	0	6	0	6
Lose control	17	28	0	45
Slide/Crash with Auto	0	6	0	6
Street Barrier	0	6	0	6
Percentage	33	56	11	100

3.6 Other Mode Choice Scenario

Students used other mode of transportation in bad weather condition and for mechanical problem of bicycle. They usually choose walking while the distance was short and can be reached within 15 minutes.

Table 7: Students preference according transport mode according to distance

Mode	Travel Distance (km)					Total Trip
	Less than 2 km	2-4 km	4-6km	6-8 km	8-10 km	
Walking	11%	4%	0%	0%	0%	14%
Rickshaw	7%	14%	0%	0%	0%	21%

Mode	Travel Distance (km)					Total Trip
	Less than 2 km	2-4 km	4-6km	6-8 km	8-10 km	
Auto	32%	18%	0%	4%	0%	54%
Mahindra	0%	0%	7%	0%	4%	11%
Percent	50%	36%	7%	4%	4%	100%

They also preferred auto when the travel distance was up to 4 km as it took low travel cost. Some portion of the student used Mahindra who traveled a long distance of more than 4 km in short time. And the students who traveled more than 6 km mostly did not travel in the bad weather (Table 7).

3.7 Relation with Trip Generation:

A linear regression model between the number of trips and other socio-economic parameters was established. Here we considered family income, other transport cost and travel distance as socio-economic parameters. In our regression model, number of trips per month was considered as the dependent variable. Travel distance (km), monthly family income and other transportation mode cost were taken as explanatory variables. The model showed that with the increasing of travel distance number of trips decreased. If the family income was increased the number of trips might increase and with the increasing of travel cost by other transport mode, the number of trips by bicycle might increase. And the explanatory variables were significantly correlated with the dependent variable (Table 8).

Table 7: Modeling results of trip number

Variable	Coef.	Std. Error	t	Sig.
Travel Distance (km)	-0.287	0.128	-2.234	0.037
Family Income	0.056	0.028	2.006	0.049
Other Transportation Mode Cost	0.450	0.081	5.568	0.002
Constant	0.177	0.225	0.788	0.440

Co-efficient of Determination $R^2 = 0.656$

Logarithm was used for normalized the data of variable number of trips, travel distance and other transport mode cost for formulating the regression model. So, in the regression equation of this model would take \log_{10} with the variables that were normalized. The coefficient of determination of this model was 0.656 which indicates the dependent variable number of trips was explained 65.6 percent by the explanatory variables. The regression model is following.

$$\log Y = 0.177 - 0.287 \log X_1 + 0.056 \log X_2 + 0.45 \log X_3 \quad (2)$$

Here, Y = the number of trips per month, X_1 = travel distance in km, X_2 = family income per month and X_3 = the cost of another mode of transportation.

4. CONCLUSIONS

According to the result, the average speed and travel distance of the bicycle was found 10.68 kmph and 2.71 km respectively in the study area. In ward 09 and 14, the number of destinations were higher. Most of the students used bicycles for going to coaching centres and schools and their average trip number were 10 per week. Maintenance cost of a bicycle was found BDT 115 per month. Around 80 percent of bicycle user students were aged between 13-18 years. Other than bicycle, students preferred walking and auto for short distance travel. The regression model indicated that a total

number of trips were mostly affected by travel distance, here the distance travelled by the cyclist had a negative impact on the generated trips. Besides family income and other transport cost had a positive influence on the total number of the generated trips. Students face most accidents by losing control over the cycle for the bad condition of roads and crash with other type of vehicles for heterogeneous traffic composition and lack of different bicycle lane. The results of the research might help the concern authority in decision making for solving transport related problems. This research is conducted on the northern part of Khulna city and for only to explore the scenario of students using bicycle. Bicycle users of other occupation of Khulna city are not considered in the study. Further research would include the other part of Khulna city and the parameter which are not considered like relation between bicycling and influence of built environment of students and other occupations.

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