



## TRAVEL MODE CHOICE BEHAVIOR OF SCHOOL-GOING CHILDREN IN KHULNA CITY

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### Abstract

School-going children's trips play an essential role in transport planning. The change in transport mode choice to school might look insignificant, but it contributes to a great extent to growing transportation. Children's mode choice behavior has dramatically shifted from active modes, mainly walking, to non-active modes over the last few years. This research analyzes the influential factors affecting travel mode choice for school travelers in Khulna City. A multinomial logit model was developed for school trip makers. The results show that majority of the children ride motorized rickshaws on school trips. With the increase in travel cost and travel time, the odds of choosing the selected mode decrease. The findings revealed that female children are more likely to choose a car over other modes of transportation than male students. Children from higher-income households are more likely to use a car than any other income group. Compared to children from higher-income backgrounds, those from lower-income families were significantly more likely to walk to and from school. Regarding parents' perceptions of traffic safety, if parents perceived their neighborhood to be safe for children, children were also more likely to walk to school. The findings of this research also show that active travel, e.g., walking, is associated with the environmental characteristics (walking and safe environment, heavy traffic volume) of walking routes. This information should be taken into account when policy-making and school plans to enhance the safety of children walking to and from school.

**Keywords:** Mode choice, school trips, multinomial logit, discrete choice, traffic safety, parental perception

### Introduction

Mode choice behavior of travel plays a vital role in transportation planning and management. Travelers choose modes out of many available ways according to their travel purpose (van den Berg et al., 2020); (Ashalatha et al., 2013). Other research has shown that individual and household socio-economic characteristics have a decisive role in mode choice decisions. They identified that income, gender, vehicle ownership, and employment status are the most influencing factors in mode choice decisions (Miller et al., 2005). Modal choice behavior modeling has been predominantly on activity-travel based on adults. However, the modal choice of children to school now has been widely discussed in recent years. These discussions have primarily taken place in the Western context, owing to the increasing use of automobiles to transport children to and

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from school, as well as a decline in walking and cycling in these countries (Li & Zhao, 2015; McDonald, 2008). School travel mode behavior mainly depends on their parents. Parental escort decisions influence their children's travel mode while traveling to school (He & Giuliano, 2017). Researchers have found that several factors influence children's modal choice for school trips, such as distance to school, household car availability, safety and security, gender, and parent escort preferences (McDonald, 2008; McMillan, 2007).

Many studies have shown that school-going children's mode choice behavior has various influencing factors in recent years. They found that individual characteristics, children's socio-economic and travel-related variables, play a significant role in mode choice (Ewing et al., 2004; McMillan, 2007). Bhat & Sardesai (2006) found that income, gender, vehicle ownership, and employment status are the most influencing factors that strongly influence mode choice behavior. The change in travel mode to school may look insignificant to the extensive transportation system, but it represents a substantial amount of growing transportation (McMillan, 2007). The distance to school has been a significant component in the study of children's transport mode choice (van den Berg et al., 2020; Beck & Greenspan, 2008; McDonald, 2008). Children who travel longer distances are more likely to prefer motorized transportation, whereas those who travel small distances to school are more likely to walk or ride a bicycle (van den Berg et al., 2020; Ashalatha et al., 2013). McDonald and Aalborg (2009) conducted a study on the mode choice of school-going children in California. They found that distance to school plays a significant role in mode choice decision making where about 75% of the children living within half a mile of school travel there by walking or cycling, and only 18% of those living 1.5 miles from their school use different active modes.

Socio-economic characteristics play a significant role in mode choice decision-making. Because of the low income of the poor, people depend highly on non-motorized modes of transportation like walking and bicycling as their primary modes (Srinivasan & Rogers, 2005). Gender, age, family size, automobile ownership, and years of schooling all impact mode choice selections (Sarkar & Mallikarjuna, 2018). However, the low-income group primarily uses non-motorized modes, and public transportation is selected (Abane, 1993; Enam & Choudhury, 2011; Srinivasan et al., 2007; Tuan, 2015). A study conducted by Badri (2013) in UAE found that gender, level of study, number of cars owned, nationality, and the number of children in the family are the significant factors determining the mode choices to school.

According to a CDC study, children who live close to school do not walk or cycle in huge numbers; just 31% of children aged 5 to 15 who lived within a mile of school walked or biked (Centers for Disease Control and Prevention (CDC), 2002). Because of insufficient walking environments, children are less likely to walk or bike to school (Ewing et al., 2004). Also, school travelers are more likely to use private modes and motorized vehicles because of fewer walking environments. Residential location, neighborhood type, and urban land infrastructure play a vital role in determining the preferred mode choice for commuting (Frank et al., 2008; Pinjari et al., 2007; Wee et al., 2002). The literature identified that those children who don't need to cross major roads and have good walking facilities and safe sidewalks are more likely to walk or cycle to schools (Helbich, 2017). In his research, Johansson et al. (2006) concluded that mode choice depends on travel time and comfort, accessibility, and flexibility. They used a latent variable approach and found that flexibility, convenience, and pro-environment social factors affect an individual's mode choice. McMillan et al. (2006) investigated the gender difference in mode choice in California and found that 40% of the girls are less likely to walk or cycle to school than boys. Clifton et al. (2010) explored the gender differences in school travel behaviors. The authors discovered that females who lived in mixed-use areas were more likely to drive to school than children who lived in communities with well-connected streets and were more likely to have automobiles. Rahman & Shah (2018) investigated the existing travel patterns of school children in Dhaka city and found that travel time, distance traveled, and family income strongly correlates with mode choice behavior. They found out that most children (56.5 %) walk to school, while 18.5% drive and 17.5% take rickshaws on school trips. They also identified that children are more likely to walk to school for short-distance trips, so the distance to school plays a significant role in mode choice behavior. Khan et al. (2011) discovered that the majority of children (57%) use a car to travel to school in Dhaka city, while 29% use a

rickshaw and only 6% walk to school. The study area, Khulna city, is one of the largest cities in an urbanizing region in the southwest of Bangladesh. In Khulna city, the available modes of transportation are buses, easy bikes, motorized rickshaws, and three-wheelers. However, the city's road networks do not ensure smooth travel for a large number of people, resulting in traffic congestion in the city (Islam & Hasan, 2014). Also, narrow roads, parking on streets, limited parking, unauthorized roadside activities, and pedestrian movement increase congestion (Banik et al., 2009).

Few studies have examined the travel behavior of school travelers. No studies to date have examined the perception of traffic safety for determining mode choice in Bangladesh context. Therefore, the purpose of this study is to address the modal choice behavior of school-going children in Khulna city. Also, this study attempts to find out various factors which contribute to the choice of particular modes by trip makers and examine if parents' perception determines mode choice for school travelers.

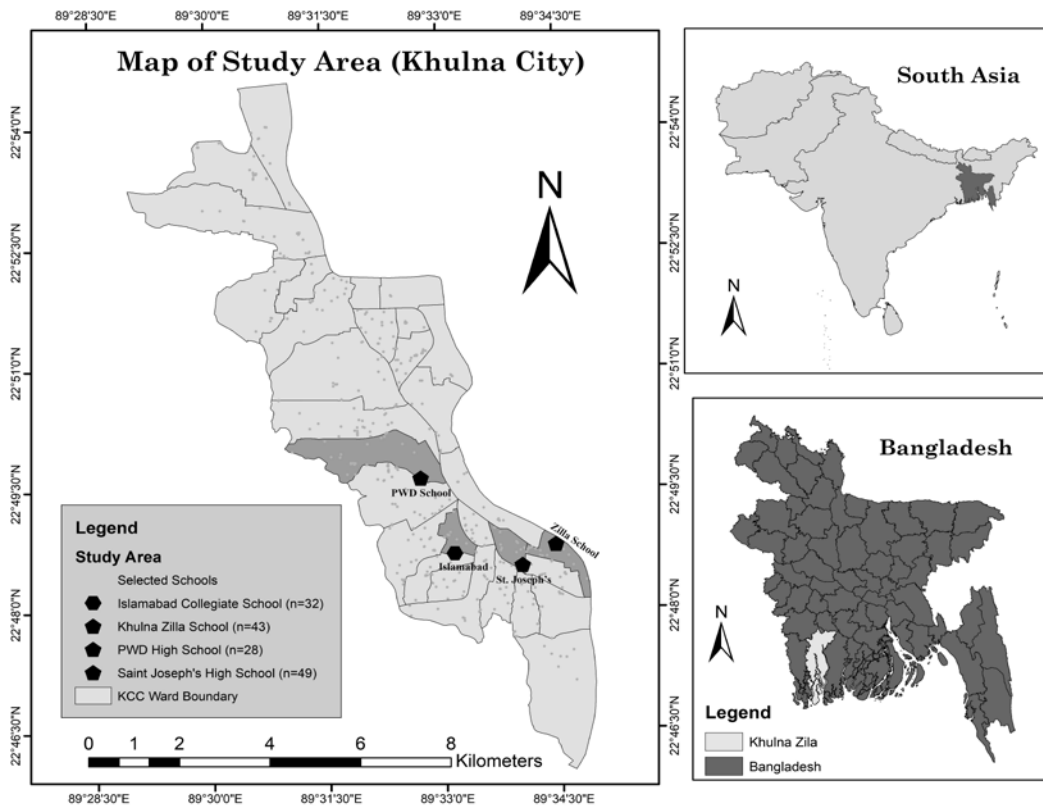


Figure 1. Map of the study area

## Materials and Method

### *Study area*

After Dhaka and Chittagong, Khulna is Bangladesh's third-largest city. Khulna city is in the southwest of Bangladesh, and it has an area of 59.57 square kilometers. According to United Nations (2014), Khulna has a population of 1.022 million. The study area comprises four schools in the Khulna city corporation area for this research. School travelers use a variety of modes of transportation in this area. The most popular modes of

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transportation are motorized rickshaws, easy bikes, private cars, walking, and motorcycles. Few children ride bicycles, public buses, and three-wheelers for school trips. As motorized rickshaws and easy bikes are the cheapest transportation, school travelers mostly use them, although they lack comfort, safety, and security. It is a matter of the fact that there is no school with its own bus service. So, children have to take private or shared transportation to get to school. During the school hour, traffic congestion is an ordinary matter because of the enormous traffic volume on the road. Four schools were selected: Khulna Zilla school, Saint Joseph High School, Islamabad Collegiate School, and PWD School for the data collection. These schools are at the city's core, where various groups of children use multiple modes of transportation to school.

### ***Sampling and data collection***

Four schools were chosen to get a sufficiently representative sample of a school population. The total population size in this study is the total number of students in the study area. There are around 5391 students in the four schools (Field Survey, 2020). An empirical formula given by Levy and Lemeshow (2008) was used to determine the sample size.

$$n = \frac{z^2 pq N}{e^2 (N - 1) + z^2 pq}$$

Where  $n$  = sample size for the finite population;  $N$  = population size. In this research accepted margin of error is 7%, and the confidence level is 92%, where the value of  $z$  is 1.75. So, the total number of respondents was 152, which is over 2% of the total population of the data set. For the survey, a random sampling technique was used to collect the data from the household.

Data was collected using a closed-ended questionnaire that included home, personal information, and travel information through a telephone interview. The sample population was purposefully kept limited to children in grades 4 through 7 to avoid behavioral variations caused by varying levels of cognitive ability and independence. And the parental survey was conducted to extract their perception of mode choice of school-going children, their household characteristics, and children's travel characteristics to school. Demographic information, household income, parent education, children's age, sex, and car ownership data were collected under socio-economic factors. In addition, travel-related information, including travel cost, preferred mode choice, travel time, comfort, and environmental factors such as access to the sidewalk, walking environment, and parental escort, were collected.

### ***The multinomial logistic regression model***

For mode choice modeling, Multinomial regression was applied for this research. The multinomial logit model is the simplest and most popular practical discrete choice model (Ashalatha et al., 2013). The user perceives the various alternatives as an independent. The random terms of every option have the same probability distribution (Domencich & McFadden, 1975). Mode choice behavior depends on many factors, such as socio-economic variables and demographic variables, and trip-related variables. So, these variables such as mode choice, travel cost, travel time, and income variable that influence mode choice behavior was used in MNL. R studio software has been used for discrete choice modeling because it is most famous for discrete mode choice modeling.

### ***Multinomial logistic regression model fit***

The maximum likelihood ratio estimates the multinomial logistic regression model for model fitting statistics (Garson, 2014). A logarithmic likelihood function, commonly known as the log-likelihood function, is required. The procedure is given below (Favero & Belfiore, 2019):

$$LL = \sum_{i=1}^n \sum_{m=0}^{M-1} \left[ (Y_{im}) \cdot \ln \left( \frac{e^{Z_{im}}}{\sum_{m=0}^{M-1} e^{Z_{im}}} \right) \right]$$

The likelihood ratio can be deviance, model chi-square, or chi-square goodness of fit. Model significance is required for fitting the model. The likelihood-ratio test rejects the null hypothesis if the number is too low. In the null hypothesis for model fitting, the last model needs to be significant. For the goodness of fit, if the Pearson chi-square test of the significance level is above 0.05, we will accept the model (Favero & Belfiore, 2019). To compare the ultimate model with the null model, McFadden R<sup>2</sup> is used. The Equation is given below (McFadden, 1977):

$$R_{McFadden}^2 = 1 - \log(L_e) / \log(L_{null})$$

This ratio explains the total unexplained variability of the model. The total unexplained variability of 1 shows the total explained variability of the model.

Table 1. Description of the variable selected in modeling

Variable	Description	References
Child's age	Age of the trip maker	Sarkar & Mallikarjuna, 2018 Miller et al., 2005
Vehicle ownership	Family vehicle ownership	Bhat & Sardesai, 2006 Miller et al., 2005
Income	Monthly income of the household	Balcombe et al., 2004 Chen et al., 2008
Household size	Family size of the trip maker	Dargay and Hanly, 2007 Kim and Ulfarsson, 2008
Child's sex	Sex of the trip maker	Miller et al., 2005 Guliani et al., 2015
Employment status	Occupation of the household head	Badri, 2013 Miller et al., 2005
Parent education	Education level of the children's parent	Van Goeverden & De Boer, 2013
Trip distance	Distance to school	Kim and Ulfarsson, 2008 Scheiner et al., 2019 McDonald & Aalborg, 2009
Travel cost	Travel cost to the school	Ashalatha et al., 2013
Travel time	Travel time to school	Ashalatha et al., 2013
Escort decision	Parental escort children to school	Badri, 2013
Comfort	The comfort of the trip maker regarding mode choice	Sarkar & Mallikarjuna, 2018 Johansson et al., 2006
Security	Importance of security and safety regarding mode choice	Pirdavani et al., 2016
Sidewalk	Availability of sidewalk to school	Helbich, 2017 Clifton et al., 2010
Walking environment	Importance of walking environment regarding mode choice	Ewing et al., 2004
Traffic safety	Importance of traffic safety regarding mode choice	Pirdavani et al., 2016

**Selection of variables for the model**

This research's primary aim focuses on identifying the most influencing variables that impact mode choice decision-making among school-going children in Khulna city. The selected variables for modeling in this research are shown in the following Table-1.

Table 2. Socio-demographic characteristics of the sample

Variables	Frequencies (%)	Mean ±SD	Range	Test statistics (p value)
Age (years)	151	12 ± 1.09	6.0	t (150) =134.94 (0.001) *
Sex				
Male	109 (72.2%)			X <sup>2</sup> (1) =29.72(0.001) *
Female	42 (27.8%)			
Family size	151	4.48 ±1.31	7.0	t (150) = 41.81 (0.001) *
Home Ownership				
Own	55 (36.4%)			X <sup>2</sup> (1) =9.76 (0.02) **
Rent	93 (61.6%)			
Family Income				
< 20,000	36 (23.8%)			X <sup>2</sup> (1) =85.26 (0.001) *
20,000-40,000	66 (43.7%)			
40,000-60,000	20 (13.2%)			
> 60,000	13 (8.6%)			
Non-responded	16 (10.6%)			
Vehicle ownership				
Car	13 (8.65%)			X <sup>2</sup> (1) =43.62 (0.01)**
Motorcycle	41 (27.2%)			
Bicycle	3 (2%)			
None	57 (37.7%)			
Sidewalk availability				
Yes	91(60.3%)			X <sup>2</sup> (1) =6.36 (0.015)**
No	60(39.7%)			
School distance (Km)	151	1.56 ±1.31	6.0	t (150) =14.59 (0.001) *

\* Significant at 1% level, \*\* Significant at 5% level

### Data Analysis

Table 2 shows the sociodemographic characteristics of the respondents. Figure 2 shows the age distribution percentage of the children in the sample. According to the data, the sample contains a higher proportion of children aged 11-13 years old and a lower proportion of children aged 9-10 to 14-15 years old.

Socio-economic characteristics are a significant factor for mode choice behavior. It plays a vital role in travelers' decision-making. For example, different researchers have found that family income is an influential factor in the mode choice model (Balcombe et al., 2004; Chen et al., 2008). Higher-income families are more likely to use motorized transportation, whereas lower-income families are more likely to walk. Vehicle ownership is also an essential factor for mode choice decision-making. People who have a vehicle are more likely to choose it for traveling. However, the survey data revealed that only around 6% of the respondents have a car, 27.2 % own a motorcycle, and only 2% own a bicycle. Mode choice behavior varies according to the sex of the travelers. Figure 3 shows the modal share for school-going children according to their gender. Male children mostly choose motorized rickshaws as a preferred mode; female children are more likely to choose walking as a travel mode for their school because of the short distance. About 40% of the female children walk, and only around 25% of males walk to school. On the other hand, 40% of the male students use a motorized rickshaw, whereas female mode choice for motorized rickshaw is below 25%. The reason is that female children do not want to ride because of their fear of safety. However, female mode share for car and the easy bike is higher than the male student.

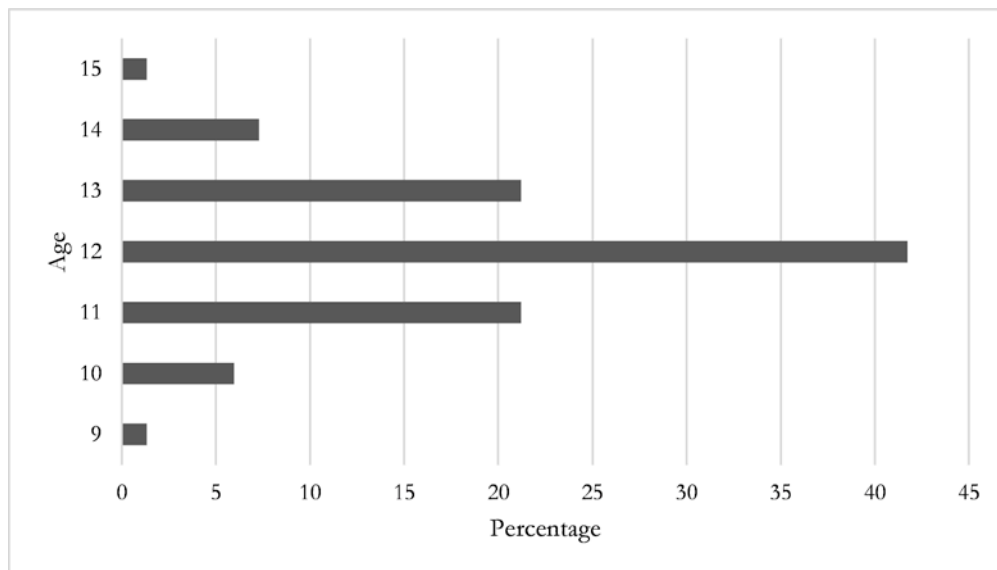


Figure 2. Age distribution of the children

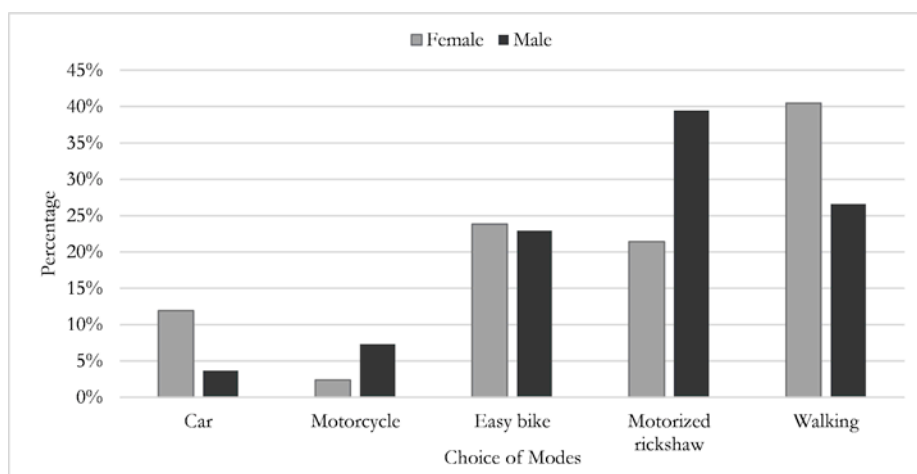


Figure 3. Modal share of the trip makers according to gender

Different income levels of the trip makers influence mode choice (Willumsen & Ortuzar, 2001). For this research, family income was categorized into five classes. Figure 4 represents children's mode choice and their family income level. The share of walking modes by low-income groups (less than 20,000) is more than other income groups. Trip makers in the lower-income class, less than 20,000, mostly walk to school. Children in high-income groups prefer mostly cars and walking for short-distance traveling.

Figure 5 shows the modal share of the children's trip to school. Motorized rickshaw has the most portion of the modal share of the children's trip to school which is 34% and then walking is the second most used mode having 31% of the whole sample followed by Easy bike. The share for personal vehicles (Motorcycle and Car) is equal, contributing about 6% each to the total modal share. The percentage of motorized transport is significant compared to non-motorized modes of transportation (e.g., walking).

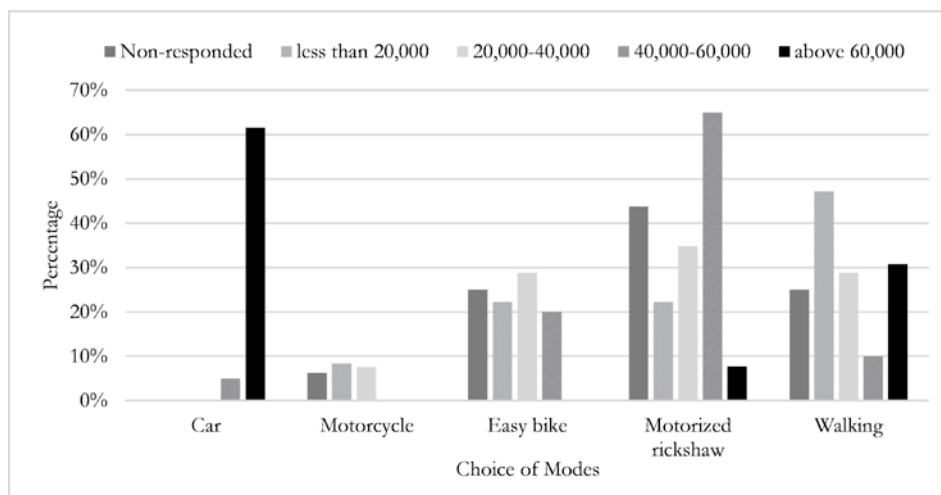


Figure 4. Modal choice according to household income group

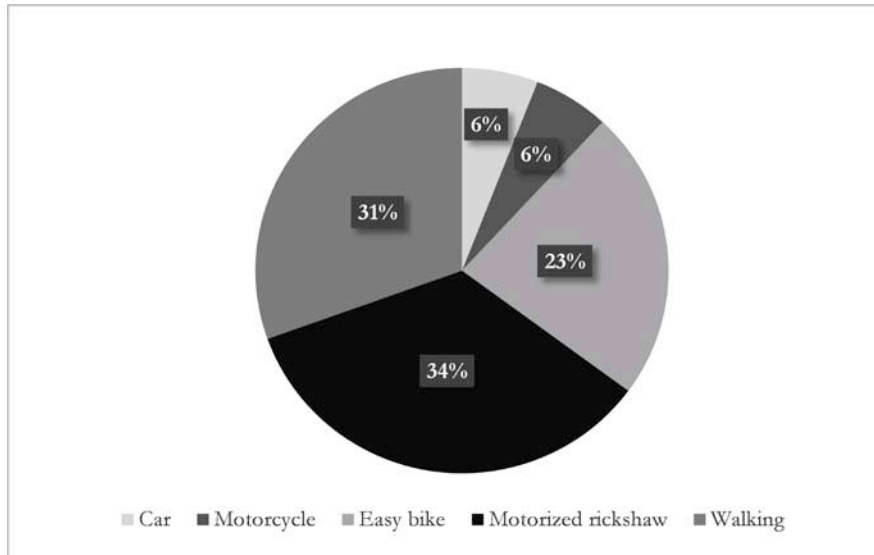


Figure 5. Modal share of the school trip makers

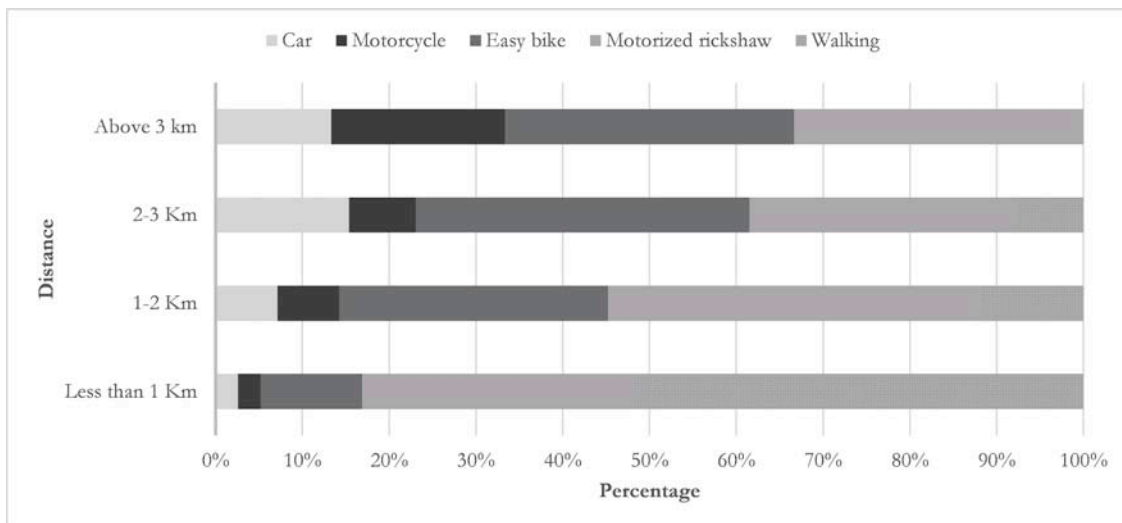


Figure 6. Mode share in respect to travel distance

Travel distance has a significant impact on mode selection decisions. Walking is a popular mode of transportation for school-age children who live within walking distance of their school. Figure 6 depicts the modal share regarding travel distance between home to school. Here, walking dominates the mode share for less than 1 km distance significantly; about 52% of the school trip are less than 1 km. However, above 1 km, motorized rickshaw and easy bike modal share are considerably higher than other modes. The percentage of motorcycles and cars increases proportionately with travel distance.

## **Results and Discussion**

### **Model formulation**

Formulation of a multinomial logit model for mode choice among school-going children in Khulna city has been done with the help of "RStudio". The final mode choice model has been developed using the "mlogit" package in the environment of "R" for better estimation and prediction of the model.

### **Choice set determination**

Choice set determination means the selection of travel modes that are the elements of an individual's choice set. To reduce complication, we assume that all means of transportation are a subset of the individual's decision set. This research has selected five travel modes in the choice set

{Car, Motorcycle, Easy bike, Motorized rickshaw, Walking}

In the mode choice model, the dependent variable is travel mode choice. Independent variables are children's sex, income, parent education, vehicle ownership, travel distance, travel cost, traffic safety, comfort, and walking environment.

The motorized rickshaw was used as the reference level in this investigation. This is because motorized rickshaws have been prominent in the study area, and people of all income levels use it. So, a motorized rickshaw is more representative and appropriate as the reference level in this model.

### **Model fitting information**

From the model, the pseudo  $R^2$  value of the final model according to McFadden tests was 0.488, which is a method for calculating the explained variation in the model. Thus, based on the pseudo  $R^2$  values, the model developed in the present study explains approximately 48% variation. Therefore, the model can be considered statistically significant.

## **Influencing factors of mode choice among school-going children**

### ***Personal and socio-economic influences***

Children's sex plays a vital role in mode choice decision making. Male children have 7.26 times fewer chances of choosing a car than motorized rickshaws than female travelers. Female trip makers are more likely to select a car because a car is more comfortable, secure, and flexible than a Motorized rickshaw. In fact, parents are much more worried about the safety of their female children, and they are more likely to choose car over a Motorized rickshaw. For male children, the probability of choosing walking for a school trip is 1.2 times less likely than the female children. However, other modes of transportation such as Motorcycle and easy bikes haven't been found to have a statistically significant influence on children's sex. Age seemed to have no significant association with travel modes, possibly because all age groups used all modes.

Parent education impact is positive on car and negative on Easy Bike. It means if the value of the parent education increases by 1 unit, then the likelihood of choosing car would increase by 3.57 times compared to Motorized rickshaw (Table 3). On the other hand, the likelihood of choosing an Easybike would decrease by 0.66 times compared to Motorized rickshaw. As educated parents are more concerned about their children's health and traffic safety, they prefer to use car for distanced traveling. With the increasing of parent education, parents are less likely to choose walking mode for their children.

Family income has been one of the most prominent factors in choosing mode. Different researches have shown that high-income people use faster and more comfortable modes like private vehicles more often. However, the low-income group people mostly use non-motorized modes, and for distant traveling, public transportation is selected (Abane, 1993; Enam & Choudhury, 2011; Srinivasan et al., 2007; Tuan, 2015). In the case of the influence of family income of the children, the MNL regression model reveals that, compared to

the lower income group, the higher income group has 3.84 times more chances of choosing Car over Motorized rickshaw where the middle-income group has 1.95 times more probabilities of choosing car. Also, children of higher-income and middle-income groups are less likely to walk to school over Motorized rickshaws. The likelihood of selecting walking for middle-income children is 2.29 times less likely than for low-income group children. So, it can be concluded that higher-income people are more likely to use cars because they own a car.

Table 3. Variable influencing mode choice of school-going children (Motorized rickshaw as reference).

Variables	Categories	Travel Modes			
		Car	Easy Bike	Motorcycle	Walking
Travel time		-0.287***			
Travel cost		-0.031***			
Children Sex (Female = ref)	Male	-7.263**	0.177	0.395	-1.274*
Family Income (Low = ref)	Middle Income	1.95	-0.18	1.688	-2.296**
	High Income	3.844	0.3036	0.32	-1.481
Parent education		3.572**	-0.664***	0.268	-0.208
Walking Environment		0.091**	-0.481***	-1.034**	0.522**
Comfort		5.047***	-1.1103	-0.391	-0.339
Sidewalk Availability (No = ref)	Yes	4.086	-0.145	1.665*	0.575
Heavy traffic		3.871**	-0.292	0.567*	-0.536**
Live in Safe area		-3.829*	-0.131	-0.651	0.365*
Constant		-49.105**	10.078***	-3.061	3.44
Pseudo R <sup>2</sup> (McFadden) = 0.488					

\* Significant at 10% level, \*\* Significant at 5% level, \*\*\* Significant at 1% level

### ***Travel related influences***

Travel cost is a significant factor that influences travel mode choice. Travel costs depend on travel distance and according to different vehicles. Travel cost has a negative impact on alternatives. With the increment of 1 taka of cost, the probability of choosing that mode decreases by 0.03 times (Table 3). In other words, when travel cost increases, children are more likely to choose alternative modes of transport.

Travel time is a significant factor that influences travel mode choice. Travel time has a negative impact on alternatives. When travel time is increased by 1 minute, the probability of choosing that mode decrease by 0.28 times. In other words, when travel time increases, children are less likely to prefer that mode and more

likely to choose alternative modes. However, parents are less likely to select Motorcycle and easy bike for their children than Motorized rickshaw. Parents prefer that their children walk to school, but because of the lack of footpaths and illegal encroachment, parents tend to choose motorized vehicles for their children.

Comfort plays a vital role in mode modal choice behavior. Johansson et al. (2006) concluded that along with modal time and cost for mode choice, preferences for flexibility and comfort are essential. Comfort has a negative impact on Walking, Motorcycle and easy bike, where car has a positive influence. The probability of choosing car is 5.04 times more likely than Motorized rickshaw. Those who emphasize comfort in selecting mode choice are less likely to use Motorcycle, walking, and Easy bike than Motorized rickshaw. Motorized rickshaw is more comfortable and the privacy is higher than an Easy bike. With the increase in comfort, children's parents are more likely to choose car over any other modes available.

### ***Environmental influences***

The absence of sidewalks was associated with a decreased odd of walking. Those who have sidewalks available for going to school from home are more likely to choose cars than Motorized rickshaw. The likelihood of choosing walking and Motorcycle is 0.57 times and 1.66 times more likely than Motorized rickshaw. Car is more likely to be selected compared to any other mode. Most of the available sidewalks are not accessible for the pedestrian because these sidewalks are encroached by different local vendor shops and other obstacles.

Traffic safety is an essential factor for mode choice. According to the findings for traffic safety perceptions, the possibility of walking to/from school appeared to be higher for children who perceived that they lived in a safe area. Compared to Motorized rickshaw, the chances of walking to school are 0.36 times higher. The likelihood of choosing Car, Easy bike, and Motorcycle is less likely than choosing a Motorized rickshaw when children's parents perceive that they live in a safe area.

The odds that children would walk to school appeared to be higher for children whose parents perceived that their walking environment was good. The likelihood of choosing walk is 0.52 times higher for children than Motorized rickshaw. For the traffic environment of the school trip, increased traffic volume near home variable got significant. The likelihood of choosing walking is 0.53 times less than Motorized rickshaw when children's parents perceive heavy traffic near their home. According to the findings, the car is more likely to be chosen when parents perceive that there is heavy traffic near their house.

### **Conclusion**

This paper analyzes the travel behavior of school-going children in Khulna city. It identified that most of the student uses motorized rickshaw for traveling to school, which is around 34% of the whole mode share. In this specific study, a multinomial logistic regression model is used to determine the influencing factors of mode choice. The sex-wise comparison revealed that female children are more likely to prefer a car over any other mode, whereas preference for a motorized rickshaw is higher among male children. Children who have their own Motorcycle are more likely to use a motorcycle than a motorized rickshaw, as most houses have a motorcycle. Children from higher-income households are more likely to use a car, and middle-income groups are more likely to choose motorized rickshaws as a travel mode for school. But the percentage of car ownership is meager in Khulna city. So, children are more likely to use motorized rickshaws, as privacy is higher than Easy bike. However, the low-income group of children mostly use non-motorized modes like walking, and higher distance public transport is preferred (Abane, 1993; Enam & Choudhury, 2011). Children from lower-income families were more likely to walk home from school than those from higher-income families (Guliani et al., 2015). This finding is consistent with previous research, as many studies have found that children from higher-income families have lower rates of ATS (Guliani et al., 2015; Larsen et al., 2013; Mitra et al., 2010). With the increase in travel cost, children are less likely to prefer the chosen mode of transport. When travel time increases for the selected mode, the likelihood of choosing that vehicle is reduced. Parent's education was significant for school trips. Children's parents who have higher education levels are

more likely to choose cars and less likely to choose walking and Easybike. This may be related to traffic safety and privacy. Comfort has been found to be an influential factor for children traveling to school. Children are more comfortable in cars and Motorized rickshaws. Lack of comfortable negatively influences easy bike, Motorcycle, and walking.

Khulna city has not enough walking infrastructure, and most sidewalks are encroached by different local vendor shops and obstacles. So, parents perceive that walking to school could be risky for their children. So, parents don't want their children to walk to school. The current study's findings indicate that when parents perceive that the walking environment feature is missing, the likelihood of walking decreases. Increased traffic volume may also be associated with an increased risk of pedestrian injury or death from a safety standpoint. Many parents have strongly agreed that their children have to cross major intersections, which is very risky for walking to school as there is no traffic signal or crosswalk facility in Khulna city. The results show a correlation exists between the built environment of children's home to school and children's likelihood of walking to/from school. These findings have immediate policy implications for sidewalk development; no new development should take place until a comprehensive network of sidewalks is built.

The study has some limitations. First, the study population was purposefully limited to children in grades 5 to 7 to avoid behavioral variations due to varying levels of cognitive ability and independence. Second, only parental perceptions of a child's traffic safety were investigated. Third, this study examined subjective environmental characteristics such as parental perceptions of safety and perceived quality of walking paths. It may be worthwhile to include additional objectively quantifiable characteristics of the built environment in future research. Finally, additional factors may affect children's satisfaction with their travel that were not captured by the parental survey. Also, further research can be conducted with extensive coverage of an area, which can help in transportation policy-making and management in Khulna city.

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### **Conflict of interests**

The authors have declared no conflict of interests.

### **Author Contribution**

Md. Toslim Hossen: Writing – review & editing, Writing – original draft, Validation, data collection, Methodology, Investigation, Data analysis, interpretation, Conceptualization. Mahmud Uz Zaman: Writing – review & editing, Methodology, Conceptualization, Supervision.

### **References**

- Abane, A. (1993). Mode choice for the journey to work among formal sector employees in Accra, Ghana. *Journal of Transport Geography*, 1(4), 219–229. [https://doi.org/10.1016/0966-6923\(93\)90046-3](https://doi.org/10.1016/0966-6923(93)90046-3)
- Ashalatha, R., Manju, V. S., & Zacharia, A. B. (2013). Mode choice behavior of commuters in Thiruvananthapuram City. *Journal of Transportation Engineering*, 139(5), 494–502. [https://doi.org/10.1061/\(ASCE\)TE.1943-5436.0000533](https://doi.org/10.1061/(ASCE)TE.1943-5436.0000533)
- Badri, M. A. (2013). School travel modes: Factors influencing parental choice in Abu Dhabi. *International Journal of Education Economics and Development*, 4(3), 203–218.
- Banik, B. K., Chowdhury, A. I., & SARKAR, S. (2009). Study of traffic congestion in Sylhet city. *Journal of the Indian Roads Congress*, 70(1).

- Hossen, M. T., and Zaman, M. U. (2022). Travel mode choice behavior of school-going children in Khulna city. *Khulna University Studies*, Volume 19 (1): 90-104
- Bhat, C. R., & Sardesai, R. (2006). The impact of stop-making and travel time reliability on commute mode choice. *Transportation Research Part B: Methodological*, 40(9), 709–730. <https://doi.org/10.1016/j.trb.2005.09.008>
- Chen, C., Gong, H., & Paaswell, R. (2008). Role of the built environment on mode choice decisions: Additional evidence on the impact of density. *Transportation*, 35(3), 285–299.
- Clifton, J., Akar, G., Smith, A. L., & Voorhees, C. C. (2010). Gender Differences in 1 Adolescent Travel to School. *Exploring the Links with Physical Activity and Health. In*, 2, 203–222.
- Enam, A., & Choudhury, C. F. (2011). Methodological Issues in Developing Mode Choice Models for Dhaka, Bangladesh. *Transportation Research Record: Journal of the Transportation Research Board*, 2239(1), 84–92. <https://doi.org/10.3141/2239-10>
- Ewing, R., Schroer, W., & Greene, W. (2004). School location and student travel analysis of factors affecting mode choice. *Transportation Research Record*. <https://doi.org/10.3141/1895-08>
- Favero, L. P., & Belfiore, P. (2019). *Data science for business and decision making*. Academic Press.
- Frank, L., Bradley, M., Kavage, S., Chapman, J., & Lawton, T. K. (2008). Urban form, travel time, and cost relationships with tour complexity and mode choice. *Transportation*, 35(1), 37–54. <https://doi.org/10.1007/s11116-007-9136-6>
- Guliani, A., Mitra, R., Buliung, R. N., Larsen, K., & Faulkner, G. E. J. (2015). Gender-based differences in school travel mode choice behaviour: Examining the relationship between the neighbourhood environment and perceived traffic safety. *Journal of Transport & Health*, 2(4), 502–511. <https://doi.org/10.1016/j.jth.2015.08.008>
- He, S. Y., & Giuliano, G. (2017). Factors affecting children’s journeys to school: A joint escort-mode choice model. *Transportation*, 44(1), 199–224.
- Helbich, M. (2017). Children’s school commuting in the Netherlands: Does it matter how urban form is incorporated in mode choice models? *International Journal of Sustainable Transportation*, 11(7), 507–517. <https://doi.org/10.1080/15568318.2016.1275892>
- Johansson, M. V., Heldt, T., & Johansson, P. (2006). The effects of attitudes and personality traits on mode choice. *Transportation Research Part A: Policy and Practice*, 40(6), 507–525.
- Khan, M., Choudhury, C. F., & Wang, J. (2011). Modeling Preference for School Bus Service in Dhaka, Bangladesh: Stated Preference Approach. *Transportation Research Record*, 2239(1), 64–73. <https://doi.org/10.3141/2239-08>
- Larsen, K., Buliung, R. N., & Faulkner, G. E. J. (2013). Safety and school travel: How does the environment along the route relate to safety and mode choice? *Transportation Research Record*. <https://doi.org/10.3141/2327-02>
- Li, S., & Zhao, P. (2015). The determinants of commuting mode choice among school children in Beijing. *Journal of Transport Geography*, 46, 112–121.
- McDonald, N. C. (2008). Household interactions and children’s school travel: The effect of parental work patterns on walking and biking to school. *Journal of Transport Geography*, 16(5), 324–331. <https://doi.org/10.1016/j.jtrangeo.2008.01.002>
- McDonald, N. C., & Aalborg, A. E. (2009). Why Parents Drive Children to School: Implications for Safe Routes to School Programs. *Journal of the American Planning Association*, 75(3), 331–342. <https://doi.org/10.1080/01944360902988794>
- McFadden, D. (1977). *Quantitative methods for analyzing travel behavior of individuals: Some recent developments*. Institute of Transportation Studies, University of California Berkeley.

- McMillan, T., Day, K., Boarnet, M., Alfonzo, M., & Anderson, C. (2006). Johnny walks to school—does Jane? Sex differences in children's active travel to school. *Children Youth and Environments*, 16(1), 75–89.
- McMillan, T. E. (2007). The relative influence of urban form on a child's travel mode to school. *Transportation Research Part A: Policy and Practice*, 41(1), 69–79.
- Miller, E. J., Roorda, M. J., & Carrasco, J. A. (2005). A tour-based model of travel mode choice. *Transportation*, 32(4), 399–422. <https://doi.org/10.1007/s11116-004-7962-3>
- Mitra, R., Buliung, R. N., & Roorda, M. J. (2010). Built Environment and School Travel Mode Choice in Toronto, Canada. *Transportation Research Record*, 2156(1), 150–159. <https://doi.org/10.3141/2156-17>
- Pinjari, A. R., Pendyala, R. M., Bhat, C. R., & Waddell, P. A. (2007). Modeling residential sorting effects to understand the impact of the built environment on commute mode choice. *Transportation*, 34(5), 557–573. <https://doi.org/10.1007/s11116-007-9127-7>
- Rahman, M. S. U., & Shah, N. A. (2018). Analysis of school trips in Dhaka City: A case study on primary school students. *PLAN PLUS*, 8(1), Article 1. <https://planplusjournal.com/index.php/planplus/article/view/26>
- Sarkar, P. P., & Mallikarjuna, C. (2018). Effect of perception and attitudinal variables on mode choice behavior: A case study of Indian city, Agartala. *Travel Behaviour and Society*, 12, 108–114. <https://doi.org/10.1016/j.tbs.2017.04.003>
- Scheiner, J., Huber, O., & Lohmüller, S. (2019). Children's mode choice for trips to primary school: A case study in German suburbia. *Travel Behaviour and Society*, 15, 15–27.
- Srinivasan, K. K., Pradhan, G. N., & Naidu, G. M. (2007). Commute mode choice in a developing country: Role of subjective factors and variations in responsiveness across captive, semicaptive, and choice segments. *Transportation Research Record*, 2038(1), 53–61.
- Srinivasan, S., & Rogers, P. (2005). Travel behavior of low-income residents: Studying two contrasting locations in the city of Chennai, India. *Journal of Transport Geography*, 13(3), 265–274.
- Tuan, V. A. (2015). Mode choice behavior and modal shift to public transport in developing countries—the case of Hanoi City. *Journal of the Eastern Asia Society for Transportation Studies*, 11, 473–487.
- van den Berg, P., Waygood, E. O. D., van de Craats, I., & Kemperman, A. (2020). Factors affecting parental safety perception, satisfaction with school travel and mood in primary school children in the Netherlands. *Journal of Transport & Health*, 16, 100837. <https://doi.org/10.1016/j.jth.2020.100837>
- Van Goeverden, C. D., & De Boer, E. (2013). School travel behaviour in the Netherlands and Flanders. *Transport Policy*, 26, 73–84.
- Wee, B. van, Holwerda, H., & Baren, R. van. (2002). Preferences for modes, residential location and travel behaviour. *European Journal of Transport and Infrastructure Research*, 2(4). <https://doi.org/10.18757/ejtir.2002.2.4.3729>