Travel Behavior of Female University Students and Impacts of Ride-Sharing on Mode Choice: a Case Study

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TRAVEL BEHAVIOR OF FEMALE UNIVERSITY STUDENTS AND IMPACTS OF RIDE-SHARING ON MODE CHOICE: A CASE STUDY

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ABSTRACT
In recent times, gender is gradually being considered as an important factor in the planning of transportation infrastructure in the context of developing countries like Bangladesh, especially when dealing with the transportation needs of individuals in urban areas. Females and males have differing preferences when it comes to mode choice as their experiences differ in terms of approachability and safety of the available modes within the overall transportation system. With a view to better comprehend the travel behavior of female students, factors which have an impact on their preferred mode of transportation as well as the impact ride sharing applications have made on their travel behavior was investigated in this study. Travel pattern data was collected from 360 female university students via a web-based questionnaire. The study focused on two groups of female students: those living in dormitories (residents) and those who were not (non-residents). A summary of the data was presented explaining key features of their travel behavior. An inferential statistical technique was applied to identify the significance of ride sharing services on their mode choice. The outcomes show the significant distinction the introduction of these services has made in their travel behavior and mode choice. The findings of this study will provide useful insight in the evaluation of existing transportation systems and furthermore, point towards necessary modifications that can be made. Consequently, this may help concerned authorities and policy makers ensure that the same level of service is provided by the transportation system to both genders to ensure an equitable society.

Keywords: Women; Developing country; Travel behavior; Statistical analysis; Ride sharing.

INTRODUCTION
Inclusion of females and males alike in the national economy is of utmost importance for achieving sustainable development and is evident in today's leading economies. For a developing nation like Bangladesh, it is quite impossible to compete with other societies in the global market leaving almost half of the population i.e. females behind. Equitable treatment of females is a must-have in all walks of life- whether it be education, healthcare, job-opportunity or mobility, for sustainable growth of the economy. However, females in most developing countries have very limited access to better transport services and technology. Even though a large work group consists of females, society in Dhaka does not provide the degree of mobility independence to

female inhabitants that is afforded to males (Nasrin, 2016). Again, travel patterns between male and female differs widely in developing countries, which is mainly a consequence of society and culture (Riverson et al, 2006). Certain groups of trip makers, in particular females, do not feel safe, secure and comfortable on Dhaka's transport system (Zohir, 2003). Optimistically, development agencies like the World Bank has started to integrate these gender concerns and needs in its policies and has encouraged borrowing countries to address the concerns of females in their national, regional and local level projects and programs. Also, introduction of real time ridesharing services like Pathao, Uber etc. in Dhaka around 2016 has generated some genuine interest among the Dhaka dwellers and brought positive changes in their daily commuting.

Travel behavior of university students has been found to be complicated and distinctive (Limanond et al, 2011). Although they make up a large percentage of the traveling population, they are often marginalized in studies of travel behavior (Khattak et al, 2011). While some studies have been carried out on the travel pattern of working women, little to none have been done on the travel behavior of female students. It is, therefore, vital to study and understand the travel behavior of female university students to better comprehend the relationship between gender and choice of travel mode. This research considers the factors that are usually known to influence a female student's choice when selecting a mode of transport. It also investigates the impact that the introduction of ride sharing services has made on their mode choices.

METHODOLOGY
For the purpose of this study, an online questionnaire survey was carried out amongst the undergraduate female students of a renowned engineering university- Bangladesh University of Engineering and Technology (BUET) located in Dhaka, Bangladesh. The questionnaire collected the travel information of the female students including- age, identification and information regarding their location (i.e. whether on campus in the university's only female dormitory or off campus). The survey also collected information on the number of weekly trips, destinations, average travel time, their preferred modes of travel and the reason behind their preference using multiple choice questions, whether or not they use ride sharing services and the reasons behind their choice and finally which mode of travel they used prior to the existence of ride sharing services. When choosing their preferred modes of transport in the questionnaire, the students were asked to choose from the following options: rickshaw, bus, ride sharing services, auto rickshaws, cycles and non-resident students were also offered the option of private cars. As of 2019, 1048 female students were enrolled in undergraduate studies at the university. A total of 360 responses were collected by means of cordial reminders and requests which is a 34% response rate. At a 95% confidence level and for a population size of 1048, the required sample size for the survey is 290 (using Slovin's formula), which is well satisfied for this study.

For analysis, the obtained data was divided into two groups: residents (on campus students) and non-residents (off campus students). This particular way of carrying out a web-based survey on students and their division into two groups has already been done in another study (Das et al, 2016). However, while they carried it out on all students this study was only done on female students and different techniques were used for data analysis. The collected data in this study was evaluated to determine the factors commonly affecting female students' mode choice as well as study their opinions regarding ride sharing services in Dhaka city. A statistical summary of the survey data was prepared along with charts showing modal preferences of female university students considering travel time, travel cost, security and comfort. Since the collected data was

categorical in nature, the chi-square inferential statistic was used to determine whether the introduction of ride sharing services has had any significant impact on their mode preferences and can be expressed by the following equation-

$$\chi^2 = \sum \frac{(Observed\ Value - Expected\ Value)^2}{Expected\ Value}$$

(1)

The null hypothesis states that the introduction of ride sharing services has had no impact on the mode choice of the students in each group and the alternative hypothesis being that the introduction of ride sharing services has made a significant difference in the mode choice of the students in each group.

RESULTS AND DISCUSSIONS

Impact of different factors on *mode choice of resident and non-resident female students:*
In terms of age, the respondents were 18 to 24 years old which is common for most public university students in Bangladesh. Among the respondents, 62.2 % were non-resident students while 37.8% were resident students. The questionnaire inquired of the students to select out of the four major factors (i.e. travel cost, security, comfort, travel time) which were primarily responsible for influencing mode choice and is displayed in [Fig.1] below. Also, both groups of students considered comfort of the mode to be the most significant factor impacting their choice with 64.7% of the residents and 59.8% of the non-residents reporting so. Comfort of a travel mode has always been considered to be significant but has seldom been clearly included as a policy oriented variable in statistical models used in econometrics (Algers et al, 1975). A staggering 94% of women has reported being harassed on public transport in Bangladesh (Brac, 2018). Hence, it comes as no surprise that feeling comfortable is the biggest factor for female students while traveling.
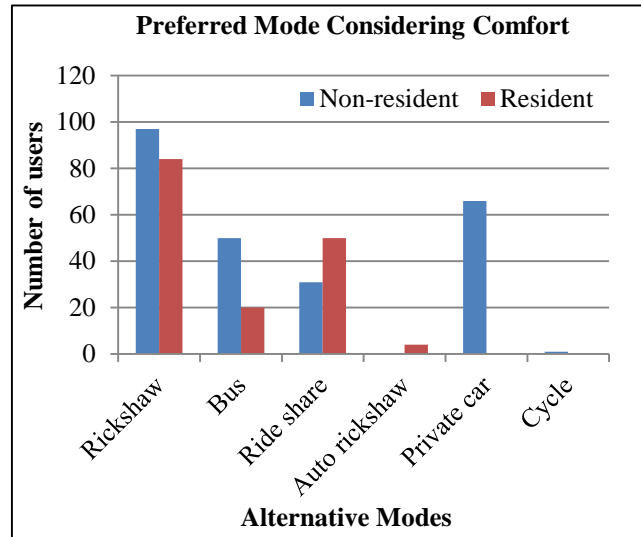

(a)

(b)
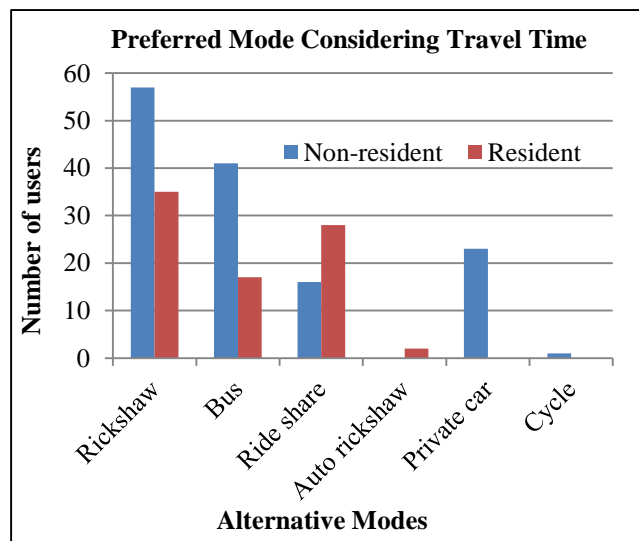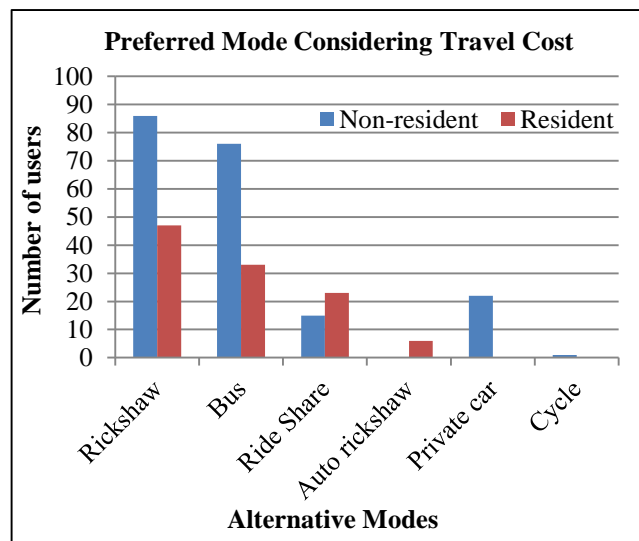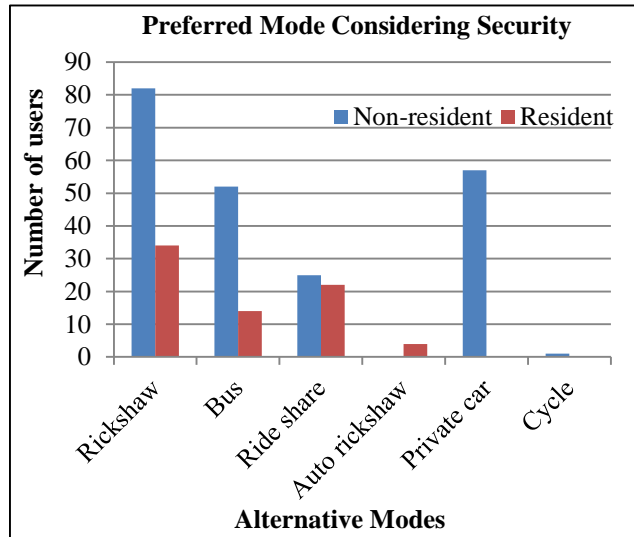
[Fig.1]: Differences between mode choices of non-resident and resident female students based on (a) travel time, (b) travel cost, (c) security and (d) comfort.

From [Fig.1], it can be seen that both groups of students consider rickshaws to be the safest and most efficient in terms of travel time and cost. Rickshaws have been used as the primary mode of transport for the majority of the population in Dhaka city and females as well as people from middle- and low-income groups are likely to be ostracized if rickshaws were to ever be banned (Hossain and Susilo, 2011). This can be explained by the fact that rickshaws are found abundantly all over the city and fares often tend to be low due to their immense availability and competitiveness. Among all the modes, cycles were found to be the least used by all female students. This may be because of the absence of dedicated lanes for cyclists in the city as well as the probability of being harassed on the road.

Impact of ride sharing services on the travel behavior of female students:
In an effort to infer on the impact of ride sharing services on mode choice of female university students, the chi-square test was carried out for both resident and non-resident students. As part of the questionnaire survey, respondents were asked to provide a best estimate on their weekly trips before and after ride sharing services were introduced. Since there was a time lag between the two estimates, a natural growth in trips is expected during this time period especially in a developing economy like ours. This is also evident from the total number of trips estimated by the respondents before and after introduction of ride sharing services as shown in tables 1 and 2 below. For non-resident students, the increase was about 41.9 percent, whereas for resident students it was 85.9 percent. In order to carry out the chi square test, the expected number of trips for the available modes after the introduction of ride sharing services were estimated considering a 41.9 and 85.9 percent increase in number of trips for resident and non-resident students respectively and compared with the observed or stated number of trips.

Table 1. Determination of chi square value for non-resident female students with degree of freedom=4 and significance level, α=5%.

Alternative modes	Before ride sharing services	After ride sharing services (observed values, x1)	After ride sharing services (Expected values, x2)	Percent change from expected values (%)	χ^2-Statistic (p-value)	Comment
Rickshaw	109	154	155	-0.65		
Bus	76	99	108	-8.33		
Auto rickshaw	23	0	32	-100	35.30 (<0.0005)	As, $\chi^2 > \chi^2_{0.05}$; Reject null hypothesis.
Cycle	3	1	4	-75		
Private car	61	92	87	5.75		
Ride-sharing	0	40	0	-		
Total	272	386	386			

Table 2. Determination of chi square value for resident female students with degree of freedom =3 and significance level, α=5%.

Alternative modes	Before ride sharing services	After ride sharing services (observed values, x1)	After ride sharing services (Expected values, x2)	Percent change from expected values (%)	χ^2-Statistic (p-value)	Comment
Rickshaw	93	119	173	-31.21		
Bus	46	99	85	16.47		
Auto rickshaw	14	8	26	-69.23	37.63 (<0.0005)	As, $\chi^2 > \chi^2_{0.05}$; Reject null hypothesis.
Cycle	3	0	6	-100		
Ride sharing	0	64	-	-		
Total	156	290	290			

For both resident and non-resident students, the p-value for chi-square tests are lower than 0.05 i.e. there is less than 5 percent chance for the null hypothesis to be true. This in turn implies that there has been a significant difference in the mode choices of female students after ride sharing services were introduced in Dhaka city in 2016 (Shams et al, 2017).

In case of non-resident female students, significant decrease in number of trips by auto rickshaw (100%) and cycle (75%) were observed as can be seen from table 1. However, the most significant changes were observed in the mode choices of resident female students. Almost all of the available modes lost a mentionable part of their share to ride sharing services. Cycle was no longer an option i.e. losing its total share, followed by auto rickshaw and rickshaw which lost a staggering 69.23 percent and 31.21 percent of trips respectively. However, bus services gained a 16.47 percent increase in trips. This in turn implies a partial shift in mode choice i.e. from the conventional modes towards ride sharing services. And this is particularly true for the resident students, who unlike the non-resident students do not have access to private vehicles. The survey also identified the relatively short travel times, especially for motor cycle ride sharing services, as the main reason for this shift.

CONCLUSIONS
The prime focus of this study was to evaluate the travel behavior of a highly educated but less privileged group in a developing country- the female university students. The study was able to

effectively identify the significant positive impacts imparted by ride sharing services in their mode choice. Resident students were the ones to benefit most from ride sharing services, since they live away from the comfort of their homes and lack the access to private vehicles. The forte of this research is its ability to assist the decision makers in adopting appropriate policies to transform the existing transportation infrastructure in an equitable manner so that female students can experience the same level of service provided to their male counterparts. Also, as data from a single higher educational institution was used in this study, there is scope for further analysis involving multiple institutions and from different settings.

ACKNOWLEDGMENTS

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