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MODE CHOICE PREFERENCES OF FEMALE UNIVERSITY STUDENTS AND IMPACTS OF RIDE-SHARING THEREON

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ABSTRACT

The equality of gender is accounted to be an indispensable element when it comes to sustainable transportation infrastructure planning in an inclusive society. Special attention in this regard must be required to reach the growing transportation demands of the urban population- especially in a developing country like Bangladesh. In this inclusive society, females constitute a major portion of the students as well as the workforce and contribute significantly to the economy. Although females have to rely on the different modes available in the existing transportation system for their day-to-day travel, they have different preferences among the alternative modes in terms of accessibility and safety. To assess the travel behavior of female students, this study explores the elements those influence travel choices (travel cost, travel time, security, and comfort) and evaluates the effect of ride-sharing facilities on their choice of mode. Data were collected from 360 female university students through an online questionnaire. The research focuses on two divisions of female students: staying at the residence hall (residents) and not staying at the residence hall (non-residents). Descriptive and inferential statistical methods were utilized to explain female travel behaviors and determine the importance of ride-sharing services in their mode selection (rickshaw, bus, autorickshaw, bicycle, private car, and ridesharing). The study reveals that female students (both resident and non-resident) prefer rickshaws over other modes and the inception of ride-sharing services had a consequential effect on their choice of modes and travel behavior. This analysis will deliver beneficial information to relevant authorities and policymakers in evaluating existing transportation systems and will indicate the required mitigations that can be made to ensure social equity.

Keywords: *Female Students; Travel Behavior; Statistical Analysis; Ridesharing.*

1. INTRODUCTION

All genders must be equally involved in the country's growth to achieve long-term growth, which is seen in present dominant industries. In our country, it is difficult maintaining all the growing economies of the world by outstripping the female population. Although the vast working group is made up of women, the society of Dhaka does not give the mobility independence for female residents that men are given (Nasrin, 2016). In most poor nations, women's access to better transport options is severely restricted. Travel behavior between men and women varies extensively in underdeveloped nations as a result of society and culture (Riverson et al., 2005). Developing agencies (World Bank) are beginning to establish these gender concerns and needs into policies, encouraging borrowers to focus on women's concerns in projects and programs at all levels actively. In addition, the launch of ride-sharing services in Dhaka around 2016 has increased the curiosity of residents and brought about positive changes in their daily commutes.

Students make up the majority of the travel population but are often put aside in travel behavior studies (Khattak et al., 2011). The travel pattern of students of universities turn out that it is very complex and characteristic. To adopt a better transport service for students, their travel pattern needs to be evaluated (Limanond et al., 2011). Studies have discovered that safety, travel cost, environment, and travel time are the most affecting elements on the travel behavior of students (Akar et al., 2012). Studies have been conducted on the mode choice of the female wage earner, but little or no research has been conducted on the mode choice of female students. Therefore, this is important to examine and grasp their traveling behavior to evaluate the connection between travel mode choices and gender. This survey inspects elements that are familiar to determine students' choice of transportation. This study will also examine the effect of the launch of ride-sharing services on mode choices.
Different socioeconomic elements have different influences on travel behavior such as gender, education, age, income, etc. Female tends to travel short distances alone due to the unfavorable environment of our country and

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that is why they use rickshaw and bus as their comfortable transport system. More women have started to be educated and so the traveling of female students is increasing day by day which is a reason to conduct this study. As a citizen of a developing country, wage influences female students' travel behavior, leading them to choose a less expensive form of transportation.

2. METHODOLOGY

An online survey of undergraduate students was conducted at the Bangladesh Institute of Engineering and Technology (BUET), a well-known engineering university in Dhaka to carry out this research. The survey collected student travel information including age, ID, and location (on-campus or off-campus) (Das et al., 2016). The survey included weekly trips, destinations, travel time, preferred mode of transportation, reasons for prioritizing numerous choice questions, whether to use ride-sharing services, reasons for choosing, and information about each mode of the trips they used before the ride-sharing service existed. In the survey, students were given the option of picking among rickshaws, buses, auto rickshaws, ride-sharing facilities, or bicycles as their preferred means of transportation. The group of non-residents had also private car as an option for their mode choice.

In 2019, 1048 female undergraduate students entered the university. A total of 360 responses were gathered through warm reminders and inquiries, with a response rate of 34%. For a population size of 1048 and a confidence level of 95%, the size of the sample needed was 290. To determine the sample size, slovin's formula was applied. Slovin's formula is a random sampling technique to estimate sample size given by-

$$n=\frac{N}{1+N*e^2} \tag{1}$$

where, n = number of sample, N = total population and e = error of margin). As the total population is 1048 and also expected losses exist, a significance level of 5% has been selected.

The survey data consisted of two groups: residents and non-residents and was assessed to determine the elements influencing their modal choice and assess their point of view regarding ride-sharing facilities in the city. A precis of statistics of the data was created with charts indicating inclinations of mode choices of them in terms of security, travel cost, travel time, and comfort. The chi-square statistic was applied to this categorical data. In hypothesis testing, chi-square tests are frequently utilized. Taking into account the sample size and the number of variables involved, the test examines the extent of any disparities between the expected and actual results. Degrees of freedom are used in these tests to determine whether a null hypothesis can be rejected based on the overall number of variables and samples in the experiment. The larger the sample size, like with any statistic, the more dependable the result will be. The formula for chi-square is

$$\chi^2 = \frac{(O_i-E_i)^2}{E_i} \tag{2}$$

where O_i = observed value, E_i = expected value, and χ^2 = Chi-squared.

The null hypothesis in this study is that the launch of ride-sharing facilities did not affect the modal choice of females in both groups, while the alternative one is that it had a significant impact on the modal choice of females in both groups.

3. RESULTS AND DISCUSSIONS

3.1 Descriptive Analysis of Trip Diaries of Non-Resident and Resident Female Students

The informants were between the ages of eighteen to twenty-four, which is typical of most Bangladeshi public university students. Non-residents made up 62.2% of the 360 respondents, while residents made up 37.8%. From the online survey, non-resident students provided their travel time for morning trips (trips from home to university) and evening trips (trips from university to home). Travel time is a concerning factor in every transportation study which is also a key factor in this survey to understand the overall condition of female students' travel behavior.

From Table 1, it is evident that the percentage of students requiring less than 15 minutes to reach their destination decreases from 13.8% in the morning to 5.4% in the evening. Also, the percentage of students requiring more than an hour to reach their destination increases from 17.9% in the morning to 50.9% in the evening. This is an indication that the severity of traffic congestion is less during the morning period than in the evening period in Dhaka. Resident students live on campus, and they do not need to take such tiring trips to travel from their dormitory to the university and vice versa. In addition, students were asked to provide

information about their trips related to two significant purposes- tuition and recreation. Being students of a renowned university in Dhaka, they spend a substantial portion of their time providing private tuition.

Table 1: Percentage of non-resident students and their corresponding travel time.

Time	**Morning trip** (from home to university) **(Total respondents) % of students**	**Evening trip** (from university to home) **(Total respondents) % of students**
<15 min	(31) 13.8 %	(12) 5.4%
15-30 min	(65) 29 %	(27) 12.1%
30-60 min	(88)39.3 %	(71) 31.7%
> 60 min	(40) 17.9 %	(114) 50.9%

Table 2 and 3 presents the summary of trips for non-residential female students and Table 4 and 5 presents the summary of trips for residential female students. Table 2 shows that the number of students who do not provide private tuition is the maximum which may be related to safety reasons since gender issue has a great impact on the difference in the travel behavior of man and woman (Pourhashem et al., 2019). Also, female students feel less safe and comfortable traveling longer distances for providing private tuition. Most of them prefer locations close to their own homes so that they can minimize their travel times. As a result, the 0 to 15 minutes travel time group consists of the highest percentage of female students. On the contrary, recreational purposes include spending time with family, shopping, sightseeing, extra-curricular activities, etc. From Table 2 it is seen that 65.6% of non-resident students on average make 1 to 3 recreational trips per week and 33.9% of the recreational trips take about 30 to 60 minutes (the highest percentage).

Table 2: Trip numbers for tuition and recreational purposes for Non-resident group.

No. of trips (in a week)	**(Total respondents) Percentage of students**	
	Tuition Purpose	**Recreational Purpose**
0	(99) 44.2%	(57) 25.4%
1-3	(61) 27.2%	(147) 65.6%
4-6	(49) 21.9%	(12) 5.4%
7-9	(15) 6.7%	(8) 3.6%

Table 3: Travel time for tuition and recreation-related trips for Non-resident female students.

Travel time	**(Total respondents) Percentage of students**	
	Tuition Purpose	**Recreational Purpose**
0-15 min	(166) 74.1%	(62) 27.7%
15-30 min	(40) 17.9%	(39) 17.4%
30-60 min	(18) 8%	(76) 33.9%
>60 min	0	(47) 21.0%

Table 4: Trip numbers for tuition and recreational purposes for Resident group.

No. of trips (in a week)	**(Total respondents) Percentage of students**	
	Tuition Purpose	**Recreational Purpose**
0	(66) 48.5%	(99) 44.2%
1-3	(42) 30.9%	(61) 27.2%
4-6	(22) 16.2%	(49) 21.9%
7-9	(6) 4.4%	(15) 6.7%

Table 5: Travel time for tuition and recreation-related trips for Resident female students.

Travel time	**(Total respondents) Percentage of students**	
	Tuition Purpose	**Recreational Purpose**
0	(65) 47.8%	(99) 44.2%
5-15 min	(19) 14%	(67) 29.9%
15-30 min	(16) 11.8%	(40) 17.9%

Travel time	(Total respondents) Percentage of students	
	Tuition Purpose	**Recreational Purpose**
30-60 min	(36) 26.5%	(18) 8%

The same information can also be driven from the resident female students' data which has the same scenario as non-resident students for zero private tuition from Table 4. It turns out that 26.5% of students spend 30 minutes to 60 minutes on tuition purposes. Table 5. gives the impression that more resident students spend weeks without any recreational-related trips than non-resident students. They spend more time in the dormitory (away from their own home) than outside. Among the resident students going for recreational trips, 29.9% of them make short trips between 5 to 15 minutes which indicates that resident female students do not travel a long distance from their dormitory. On the contrary, the second highest percentage (26.5%) of female students for tuition trips suggests that they travel long distances for providing private tuition. Also, Women travel more for shopping and leisure activities (visits, restaurants, the movies, etc.) (Pourhashem et al., 2019) which is also evident from Table 5.

3.2 The Influence of Various Elements on Female University Students' Mode Choice-Both Resident and Non-resident

The students were asked to choose one of four primary elements in the survey (travel time, travel cost, comfort, and security) that were essentially accountable to determine the modal choice, as shown in Figure 1. With 59.8% of non-residents and 64.7% of residents saying that comfort was the most important element influencing their choice, both groups of students agreed that it was the most important factor. Although the comfort of mode has always been important, it is rarely explicitly incorporated as a strategy parameter in analytical approaches applied to data analysis. So, it is key to predict the modal choice of females (Algers et al., 1975). As women are not safe in public transport in our society (Brac, 2018), it is predictable that comfort is the main key factor of transportation for female students.

Figure 1 shows that both groups perceive rickshaws to be the safest and most cost-effective mode of transportation. Females and people of low and middle-income groups are probably to be marginalized if rickshaws are outlawed. They have long been the principle form of transportation for the majority of Dhaka residents. (Hossain & Susilo, 2011). It is because rickshaws can be found in almost every region of the city and rates are frequently low because of cheap manpower, low finance, and low operation and maintenance costs. The socioeconomic condition of our country has affected the modal choice of female students. Because of the unwelcoming environment existing in our country, females tend to choose more comfortable transport (e.g. rickshaws) which offers them safety as well as less fare which is also a governing factor because of living standards in a developing country like Bangladesh. Bicycles were reported to be the least utilized means of transportation by both groups. This could be due to the lack of separated bike lanes in the city as well as the likelihood of being assaulted on the road. In research, it was shown that the proportion of young people (aged up to 35) who utilize public transportation is extremely balanced (Pourhashem et al., 2019). In Figure 1, it is clear that a significant amount of university female students use the bus as their transportation mode. Again, when a car is affordable in a study of Casablanca, public transportation is ignored (Chamseddine & Ait Boubkr, 2021).

It has been discovered that the socioeconomic components of an individual or group have a substantial effect on their travel behavior. In this study of Nigeria, non-motorized transport for trip making was also found to be considerable among respondents. Therefore, the socioeconomic conditions and travel patterns of individuals are crucial for the design of an efficient and sustainable transport network (Aderibigbe & Gumbo, 2022)**.** Furthermore, women's mobility is impacted by issues such as personal safety, security, and service quality (*Comparing Women's and Men's Morning Commute Trip Chaining in Atlanta, Georgia, by Using Instrumented Vehicle Activity Data*, n.d.) & (Whitzman et al., 2013).

3.3 The Consequences of Ride-sharing Services on the Female Students' Travel Patterns

Ride-sharing facilities have gone mainstream among women due to two primary elements: safety and comfort. It is a relatively recent invention in Bangladesh but it is gaining popularity. It is discovered that most female users have a favorable opinion of ride-sharing facilities. In Dhaka, harassment of women on public transport is fairly widespread. Ride-sharing businesses strive to provide excellent service, which benefits both drivers and passengers (Hoque & Saumi, 2021).

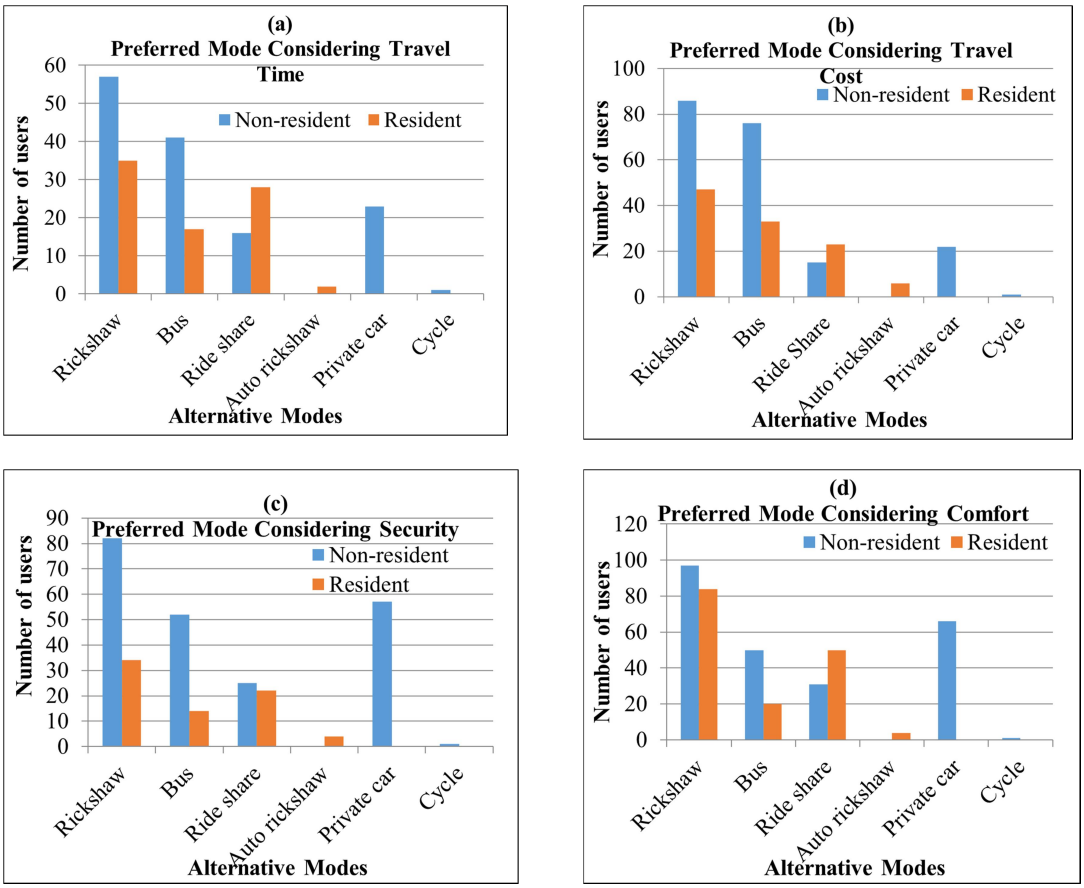

Figure 1: Differences in resident and non-resident female students' modes of transportation established on (a) travel time, (b) travel cost, (c) security, and (d) comfort.

The chi-square test was used for both groups of students to determine the effect of shared mobility services on their mode choice. Participants were asked to estimate their trips in a week after and before ride-sharing facilities were launched as part of the research survey. Given the time difference between the two estimations, an increase in travel is predicted over this period. Tables 6 and 7 indicate the expected number of trips by participants after and before the launch of ride-hailing facilities. Non-resident students had a 41.9% increase, while resident students saw an 85.9% increase. The expected trip number for the available modes after the introduction of ride-sharing facilities was estimated using a 41.9% and 85.9% growth in the frequency of trips for non-residents and residents correspondingly, and evaluated by comparing it to the observed number of trips to conduct the chi-square test.

The degree of freedom of Chi-square is obtained using the following formula:

$$df = (r-1)(c-1) \quad (3)$$

where r is the number of rows and c is the number of columns. If the observed Chi-square value is higher than the critical value, the rejection of the null hypothesis is valid (*Chi-Square Test of Independence - Statistics Solutions*, n.d.). In this study, the degree of freedom is selected by (N-1)(n-1) where N=number of alternative modes excluding rides-haring services and n=number of studies. By convention, the significance level is usually 5% (*Chi-Square Test of Independence | Formula, Guide & Examples*, n.d.). The p-values for both groups of students are indicating that the null hypothesis has a less than 5% chance of being true. This shows that there has been a considerable variation in female students' mode choices since ride-sharing facilities are established in Dhaka. Increasing numbers of women in the city of Dhaka are utilizing ride-sharing services for a lot of reasons, including travel to social gatherings, college, or university, and job. It is increasingly typical for women to use app-based ride-sharing companies. All interviewees stated in research that ride-sharing services are more fast-moving than buses, which are slower means of transportation for travelers due to the number of time commuters waste waiting for buses, the number of stops buses make, and their longer itineraries. Because Dhaka lacks a transportation system that is accommodating to women, educated working women and female university students, who have comparatively greater mobility needs, are using ride-sharing services. (Nowshin, 2020). A

study reveals that in Denmark, variables like as lack of safety, availability, awkwardness, annoyance, and social disbarring lead to unfavorable impressions of ride-sharing, whereas positive factors focus on low costs, speed, comfort, socializing, and flexibility (Nielsen et al., 2015).

Table 6: Calculation of chi-square test value for the non-resident female group using a significance level of 5% with a degree of freedom of 4 (after and before the launch of ride-sharing facilities).

Alternative modes	Before launch	After launch (Observed, x1)	After launch (Expected, x2)	Percentage change from Expected estimation (%)	Chi-square (p-value)	Remarks
Rickshaw	109	154	155	-0.65		
Bus	76	99	108	-8.33		$\chi^2>\chi^2_{0.05}$
Auto rickshaw	23	0	32	-100.00		
Bicycle	3	1	4	-75.00	35.30 (<0.05)	**Null hypothesis rejected.**
Private car	61	92	87	5.75		
Ride-sharing	0	40	0	-		
Total	272	386	386			

Table 7: Calculation of chi-square test value for the resident female group using a significance level of 5% with a degree of freedom of 3 (after and before the launch of ride-sharing facilities).

Alternative modes	Before launch	After launch (Observed, x1)	After launch (Expected, x2)	Percentage change from Expected estimation (%)	Chi-square (p-value)	Remarks
Rickshaw	93	119	173	-31.21		
Bus	46	99	85	16.47		$\chi^2>\chi^2_{0.05}$
Auto rickshaw	14	8	26	-69.23		
Bicycle	3	0	6	-100.00	37.63 (<0.05)	**Null hypothesis rejected.**
Ride-sharing	0	64	-	-		
Total	156	290	290			

Table 6. shows an increase in trips by private car by about 5.75% which is a result of the economic growth of our country. It also manifests a considerable drop in the trip number taken by auto rickshaw (100.00%), bicycle (75.00%), and bus (8.33%) by non-resident female students because of the emergence of ride-sharing facilities and economic growth. The most striking variations were perceived in the modal selection in the resident group. All existing means of transportation have lost a significant portion of market share to ride-hailing facilities. Bicycles were not a viable means anymore and they lost their whole share of journeys, followed by rickshaws and auto rickshaws, which lost 31.21% and 69.23% of trips correspondingly. Bus facilities, on the other hand, had a 16.47% rise in trips. This is especially true for the resident group, who do not have an access to private vehicles like non-resident students. A survey indicates that the majority of women prefer to travel by public transit (Meshram et al., 2020).

4. CONCLUSIONS

The major goal of this analysis is to assess the mode choice of an educated but underprivileged group of females in our country. The travel pattern of this less affluent sector of society is shown through data derived from the analysis of travel diaries and influencing elements. The study can pinpoint the major positive effects that ride-sharing services have on females' modes of transportation. Because they live away from their families and do not have access to their vehicles, resident students benefited the most from ride-sharing services. The strength of this study is its capacity to aid policymakers in formulating appropriate regulations to transform the present transportation framework in a fair form so that female and male students receive an equal degree of system. Furthermore, because this study employed data from a single higher educational institution, there is room for more research including multiple institutions and contexts.

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