

Attributes of modal choice in an industrial-based urban area: A case study on Savar Paurashava

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Abstract: Road transportation does an excellent job of connecting Savar's inner and outer areas, but it might be difficult for commuters to decide which mode of transportation to employ because residents of Savar come from a wide range of socioeconomic backgrounds. It is necessary to do in-depth research on the characteristics of people in the study region who choose different modes of transportation to achieve the goal of selecting a certain mode for their travel. Where a person lives can have a significant impact on their typical patterns of travel behavior. People who live closer to the center of things have access to a wider variety of amenities than those who live further away, and as a consequence, their travel patterns are distinct from one another. The study's findings indicate that several factors, including income, age, gender, and vocational qualities and goals, influence a commuter's preferred method of transportation. When it comes to selecting a mode of transportation, the most predictable factors to take into account are trip time and cost. After conducting research, it was found that most excursions are made from this place to Motijheel, Tejgaon, and Savar Export Processing Zone for their services, businesses, and jobs, respectively.

Keywords: road transportation, sustainability, Savar Paurashava, Bangladesh, transportation, travel

1. Introduction

Savar declared a satellite town, is situated about 29 km northwest of Dhaka city on the Dhaka-Aricha highway. Savar Upazila with an area of 280.13 sq. km, of which the Savar Pourashava is 16.67 sq. km. It consists of 9 wards. It has a population of 161600, and the population density per sq. km is 9694, spread over an area of 16.67 sq. km. (Sharif & Esa, 2014). The transport system consists of both motorized and non-motorized modes, and the people of the study area choices these modes for their different trip purpose. Since the people of this area are involved in various activities within the inner zone (the people are involved in activities within the study area) and outer zone (the people are involved in activities outside the study area), transportation is the critical element for better communication (Cao, Mokhtarian & Handy, 2009).

As its significant location, Savar plays an essential role in accommodating many people. As Savar is well connected with Dhaka and its surrounding areas, the people who migrate from different districts to Dhaka city like to live there (Hossain & Huggins, 2021; Sharif & Esa, 2014). Its urban facilities, infrastructures, and amenities also attract people to live here. There are many employment opportunities in the surrounding area of Savar, like in the Savar Export Processing Zone (E.P.Z.). Some people also go to Dhaka for their employment and various purposes. Savar also manages a large number of employment opportunities for the people. So, modes play an important role in communicating with Dhaka and its surrounding areas (Nakshi & Debnath, 2021). The attitudes and preferences of people towards modes are different, and they like to choose their preferable modes (Kabir & Parolin, 2012).

2. Problem statement

Savar is well communicated by road transport with its inner and outer areas, but there is a significant problem with selecting modes for the commuters because various income groups live in this area (Akter, Shawon & Rahman, 2021; Hasan & Fahim, 2022). The intention of the trip makers for selecting a mode is different concerning the income level. The most common trip purposes of the people of the study area are a journey to work, business, and non-business. So, their travel behavior and travel pattern are different from each other. Therefore, the commuter's modal choice is essential for trip-making. The modes for passenger trips are not adequate in the study area in terms of people's attitudes, perceptions, and utility preferences (Fahim & Miti, 2021; Fahim, Rahman, Abir & Bhuiyan, 2022). The study area's population is increasing daily. Of the rapid growth of population, the land use of the study area is developed in an unplanned way without consistency with the road transport infrastructure. Since different income groups live in the study area, they face a severe problem in selecting modes for their trip making, whereas the lower income group of people prefer cheap public transport, and the middle, higher middle- or higher-income group of people mostly preferred private transport or luxuries public transport (Kabir & Parolin, 2012). Therefore, it is necessary to study in detail the modal choice attributes of the study area's people to select a particular mode for their journey purpose.

3. Methodology

Data from both primary and secondary sources were collected for this study. Primary data were collected through field observation, questionnaire survey, and interviews of the people. A personal interview questionnaire was designed to collect information on modal choice behavior for primary data collection. Information was also collected on the socioeconomic characteristics of an individual trip maker, trip information, and service attributes of the modes. This research survey chose an "individual" as a sampling unit. There are about 161600 people in Savar Municipality Area. It is necessary to obtain a reliable and workable number of samples for the study. A sample of 140 individuals was taken for collecting travel data. The nature of travel behavior depends on where an individual lives. People who live near the central place enjoy different types of facilities than those who live far away from the central places and thus have different travel behavior patterns. The survey was conducted in June 2019. Individuals were selected randomly from their working places during day time. Students and homemakers are interviewed in their respective houses. During the holiday (especially Friday) survey was conducted in the afternoon. An individual opinion survey was undertaken using a structured questionnaire. The questionnaire was divided into socioeconomic characteristics, trip information, and

passenger travel behavior. It included age, sex, occupation, education level, household size, monthly income, number of earning members, family income, and vehicle ownership of the respondents. It also included chosen mode, total travel time, travel cost, traveling distance, waiting time, walking time, the purpose of the trip, starting time and ending time etc. It included frequency of trips, maximum traveling cost, time and distance, maximum acceptable range (distance, time, and cost) for selecting different modes, and minimum distance and travel time for selecting different modes.

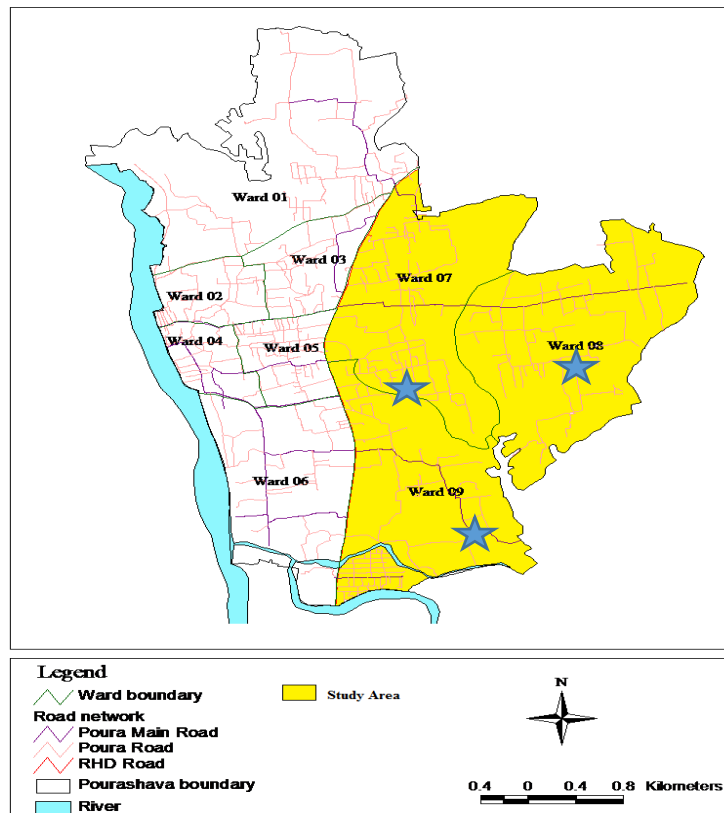
4. Study area

Savar Pourashava covers the northwest side of Dhaka Metropolitan City. It lies between 23°44' and 24° 02' north latitude and 90° 11' and 90° 22' east longitude (Rahman, Islam & Al Mamun, 2009). Savar is located about 29 km northwest of Dhaka city on the Dhaka-Aricha highway (Fahim & Miti, 2021; Sharif & Esa, 2014). Savar Upazila with an area of 280.13 sq. km, of which the Savar urban area or Pourashava area is 16.67 sq. km. It consists of 9 wards. It has a population of 161600, and the population density per sq km is 9694, spread over an area of 16.67 sq. km. The area is surrounded by three rivers-Turag on the east and west, Dhaleshwari and Bongsi on the west, and Buriganga on the south. Only the northern side is without any river. The existing built-up area was declared as 2nd class Pourashava area on December 14, 1991. On July 29, 1997, Savar was upgraded to 'A' Class Pourashava (Fahim & Miti, 2021).

Road transport system of the study area

The road transport network is essential to urban services (Fahim, Rahman, Abir & Bhuiyan, 2022; Hasan & Fahim, 2022). The internal road transport system plays a vital role in better communication within and outside the study area and for different trip-making purposes such as business, service, work, school, shopping, social, religious, recreation, and medical purposes (Fahim & Miti, 2021). In the study area, RHD (Roads and Highways Department) road (Dhaka-Aricha highway) covers 0.005 square kilometers. The Pourashava main road covers 0.017 square kilometers, and the Pourashava local road cover 0.097 square kilometers (Rahman, Islam, & Al Mamun, 2009; Gaglione, Cottrill & Gargiulo, 2021).

Figure 1: Study area



5. Results and discussion

Travel is a function of human activity. The difference among modal choice, priorities, and psychological dynamics is the outcome of the respondent's socioeconomic characteristics and the available facilities.

Basic Information

Respondent's age groups are classified into five groups. These are 0-14, 15-29, 30-45, 46-60, and 60+. Table-1 shows that 1.43 percent of respondents are within the 0-14 age group, 37.85 percent of respondents are 15-29 age group, 29.29 percent of respondents are 30-45 age group, and 16.43 percent in are 46-60 age group and 15 percent respondents are 60+ age groups. According to age group, male and female respondents are classified out of 140. The table shows that male respondents are 5.71% of female respondents are 2.14% within the 0-14 age group, whereas 37.87% of male and 5.71% of female respondents within the 15-29 age group. Within the 30-45, male and female respondents are 25% and 7.86%, respectively. 8.57% and 5% are male and female respondents within the 46-60 age group, respectively. Finally, within the age group 60+, male respondents are 1.43%, and female respondents are 0.71%.

Table 1: Number of respondents and according to sex and age groups

Age group	Sex	No. of respondents
0-14	Male	8
	Female	3
15-29	Male	53
	Female	8
30-45	Male	35
	Female	11
46-60	Male	12
	Female	7
60+	Male	2
	Female	1
Total		140

Source: Field Survey, 2019

Table 2 shows the percentage of education of the respondents. The education level is classified into primary, S.S.C, H.S.C, Degree, Graduate, Technical Education, and Illiterate. Among 140 respondents, three were primary, 23 were S.S.C, 51 were H.S.C, 8 were Degree, 14 were Graduate, 2 were technical education, and 39 were illiterate. The percentage of these education level of respondents is 2.14% are primary, 16.43% are S.S.C, 36.43% are H.S.C, 5.71% are Degree, 10% are Graduate, 1.43% are of technical education, and 27.86% are of Illiterate.

Table 2: Educational level of the respondents

Education Level	Number of Respondent
Primary	3
S.S.C	23
H.S.C	51
Degree	8
Graduate	14
Technical Education	2
Illiterate	39

Source: Field Survey, 2019

Table 3 shows the percentage of occupation of the respondents. The occupation level is classified into service, business, student, housewife, worker, and retired. Among 140 respondents, 20 were in service, 65 were in business, 16 were students, 13 were homemakers, 23 were workers, and three were retired. The respondents' occupation level is 14.29% in service, 46.43% in business, 11.43% are students, 9.28% are homemakers, 16.43% are workers, and 2.14% are retired.

Table 3: Number of respondents and according to occupation and age groups

Age group	Occupation						Total number
	Business	Service	Student	Housewife	Retired	Worker	
0-14	-	-	11	-	-	-	11
15-29	7	2	5	6	-	4	24
30-45	42	13	-	5	-	10	70
46-60	13	5	-	2	-	9	29
60+	3	-	-	-	3	-	6
Total	65	20	16	13	3	23	140
Percentage	46.43%	14.29%	11.43%	9.28%	2.14%	16.43%	100%

Source: Field Survey, 2019

Table 4 shows the percentage of family vehicle ownership. Family Vehicle Ownership is classified into none, motorcycle, and private car. Among 140 respondents, 125 own none, 12 have a motorcycle, and three own a private car. The percentage of these family vehicle owners is 89.29% own none, 8.57% have a motorcycle, and 2.14% own a private car.

Table 4: Number of respondents and according to sex and age groups

Family Vehicle Ownership	Number of Respondent
None	125
Motorcycle	12
Private Car	3

Source: Field Survey, 2019

Modal choice information

Travel time

Travel time varies with different age groups traveling by different modes. Table 5 shows that the average trip time for the 0-14 age groups of respondents is 18 minutes. The average trip time for 15-29, 30-45, 46-60, and 60+ age groups are 21, 20, 24, and 25 minutes respectively.

Table 5: Travel time

Age-Groups	Average Trip Time (minutes)
0-14	18
15-29	21
30-45	20
46-60	24
60+	25

Source: Field Survey, 2019

Mode wise trip time

The average trip time for a walk is 10 minutes. For rickshaws, tempo, and auto-rickshaws, the average trip time is 28, 30, and 18 minutes respectively, in the study area that is found from the survey result. The average trip time for mishuk is 16 minutes.

Table 6: Trip Time by different modes used

Variables	Modes	Average Trip time (minutes)
Modes used	Walk	10
	Rickshaw	25
	Tempo	30
	Auto rickshaw	18
	Mishuk	16

Source: Field Survey, 2019

Mode wise average waiting time

Table 7 shows the waiting time for different modes. The longest waiting time of modes is tempo which is 4-5 minutes. On the other hand, the average waiting time ranged from 2-3 min for a rickshaw, 1-2 min for a mishuk, and 3-4 min for an auto rickshaw.

Table 7: Average waiting time

Attribute Mode	Average Waiting Time (minute)
Rickshaw	2-3
Mishuk	1-2
Tempo	4-5
Auto Rickshaw	3-4

Source: Field Survey, 2019

Mode wise travel cost

Table 8 shows that the average trip cost for auto-rickshaws is the highest in the study area, which is 17.5 BDT. The second position is the rickshaw, for which the average travel cost is 15 B.D.T. The average tempo and mishuk costs are 8.5 and 12.5 BDT, respectively. Table 8 also shows that the maximum and minimum rickshaw costs are 25 and 5 B.D.T., respectively. The maximum and minimum cost for tempo is 15 and 2 B.D.T. The maximum cost is 20, and the minimum is 5 B.D.T. for mishuk. The maximum and minimum cost for auto-rickshaws is 25 and 10 B.D.T., respectively.

Table 8: Average waiting time

Modes	Maximum trip cost (B.D.T.)	Minimum trip cost (B.D.T.)	Average trip cost (B.D.T.)
Rickshaw	60	20	60
Tempo	30	10	15.5
Mishuk	50	10	22.5
Auto-rickshaw	80	10	35.5

Source: Field Survey, 2019

Accessibility of the different modes

The respondents were asked about their accessibility to a mode. The following table reveals that the most available mode is the rickshaw. Around 37.27% of respondents said that the rickshaw is the more available and accessible mode. From the table, we can see that the second highest available and accessible mode is auto-rickshaw. The third and fourth modes are mishuk and tempo from the respondents of the study area.

Table 9: Opinion about the availability of different modes

Modes	Attributes	
	Available near home	Moderately accessible
Rickshaw	37.27%	39.10%
Mishuk	17.27%	15.82%
Tempo	11.82%	12.91%
Auto rickshaw	33.64%	32.17%

Source: Field Survey, 2019

Travel attributes of different modes

Respondents are asked about some of the travel attributes/factors (convenience, comfort, privacy, reliability, safety, and security) for different modes of travel in the Savar urban area. In the study area, buses and rickshaws are the preferable modes by the respondents considering the above factors. Table 10 shows the choice factors for different modes by the respondents.

Table 10: Respondent's opinion about mode choice factors

Modes	Choice factor					
	Convenience	Comfort	Privacy	Reliability	Safety	Security
Rickshaw	39.18%	22.90%	38.67%	43.68%	24.36%	24.20%
Mishuk	15.27%	22.20%	20.32%	18.31%	37.53%	38.18%
Tempo	11.21%	6.72%	4.61%	12.21%	10.80%	15.27%
Auto rickshaw	34.34%	38.18%	36.40%	35.80%	27.31%	22.35%

Source: Field Survey, 2019

Purpose of trip

Table 11 shows that 43.57% of 140 respondents generate most of the trips for business purposes. Trips generated in the study area for work, school, shopping, religious and medical purposes are 31.43%, 10%, 7.14%, 2.14%, and 5.72%, respectively.

Table 11: Purpose of trip

Purpose of the Trip	Number of Respondents
Work	44
School	14
Business	61
Shopping	10
Social	0
Recreational	0
Religious	3
Medical	8

Source: Field Survey, 2019

The reason behind Selecting mode

Table 12 shows the reasons behind selecting mode. The reasons behind selecting mode are 62.86% for easy access, 18.57% for minimum fare, 52.14% for more privacy, 35.71% for more comfort, 44.29% for more convenience, 40% for less waiting time, 21.43% for less crowd, 45.71% for less travel time, 21.43% for having no alternatives, 52.86% for safety and 40% for being the bus stoppage too far.

Table 12: Reason behind selecting mode

Category	Number of Respondents	Percentage (%)
Easy Access	88	62.86
Minimum Fare	26	18.57
More Privacy	73	52.14
More Comfortable	50	35.71
More Convenient	62	44.29
Less Waiting Time	56	40
No so Crowded	30	21.43
Less Travel Time	64	45.71
No Alternatives	30	21.43
Safer	74	52.86
Bus Stoppage is too Far	56	40

Source: Field Survey, 2019

Frequency of travelling by mode:

At present

Table 13 shows the frequency of traveling by mode at present, which is 14% once a day, 30% twice a day, 7% three times a day, 46% four times a day, and 3% five times a day. So, we can say that most people make their trips four times daily.

Table 13: Frequency of traveling by mode

Daily	Number of Respondents
Once a day	20
Twice a day	42
3 times a day	10
4 times a day	64
5 times a day	4

Source: Field Survey, 2019

Five years ago

Table 14 shows the frequency of traveling by mode five years ago, which is 30.71% once a day, 40% twice a day, 22.86% three times a day, 5% four times a day, and 1.43% five times a day. The highest frequency of trip-making is once a day.

Table 14: Frequency Five years ago

Daily	Number of Respondents
Once a day	43
Twice a day	56
3 times a day	32
4 times a day	7
5 times a day	2

Source: Field Survey, 2019

Information about travel by different modes

Table 15 shows the information on travel time, cost, and distance. The mode is ranged into Rickshaw 0.25-3km on average 25 min for 60 B.D.T., mishuk 1-5 km on average 18 min for 22.5 BDT, tempo 1-5 km on average 30 min for 15.5 BDT, auto rickshaw .25-5 km in average 16 min for 35.5 BDT.

Table 15: Information about travel

Mode	Travel Time (min)	Travel Cost (B.D.T.)	Distance (km)
Rickshaw	25	60	0.25-3
Mishuk	18	22.5	1-5
Tempo	30	15.5	1-5
Auto Rickshaw	16	35.5	0.25-5

Source: Field Survey, 2019

Modal share

The modal choice of the respondents of the study area is analyzed based on the selection criteria for different modes, modal share (e.g., walk, rickshaw, auto-rickshaw, tempo, bus, and human haulers that are operating in the study area), travel behavior of the respondents for the frequent selection of mode by the respondents, attitudes towards selecting a mode or maximum acceptable criteria, complain against the selected mode, opinion on safety about traveling by the selected mode and reasons behind selecting a particular mode by the respondents.

Different kinds of modes are operating in the study area. People are making trips by using these types of modes for various purposes. At the time of the survey period, the respondents are asked about their choice of modes that they use to make a trip for their particular purposes.

Table 16 shows the share of different modes in the study area. This table shows that the highest share of mode in the study area is auto-rickshaw, which is 36%. The second highest mode is the rickshaw, which 34% of the respondents made trips by walking 7%, while the misuk made 14% of trips. The modal share of tempo in the study area is 9%, respectively.

The survey result found that in the study area, rickshaws and auto rickshaws are the dominant modes the respondents use to make daily trips for different purposes such as business, service, school, and work.

Table 16: Modal share

Modes	Percentage (%)
Rickshaw	34%
Mishuk	14%
Tempo	9%
Auto Rickshaw	36%
Walk	7%

Source: Field Survey, 2019

The reasons for selecting these vehicles are their availability of it and that no other alternative modes are operating so frequently within the region. 55% of trips are generated by tempo from Ondho market road to Rajasthan village. As a result, there is no option for the people to choose another mode for their particular journey purpose within the study area. Since the rickshaw is the only mode to make the trip by all income groups in the study area, it is not a matter of concern to analyze the factors of selecting the rickshaw mode by the study area's people. However, there is a variation of selection modes by the respondents when they make a trip for their particular purposes outside the study area and one to four kilometers within the study area to reach their destination for their particular purposes. Although different modes are operating in the study area to communicate with outside the region, the bus is the highest selected mode for the respondents to make a particular trip.

6. Conclusion

Savar is well communicated by the road transport with its inner and outer area, but there is a significant problem with selecting modes by the commuters because various income groups live in this area. The transport system consists of both motorized and non-motorized modes such as walking, rickshaw, auto-rickshaw, tempo, bus, and human haulers, and the people of the study area choose these modes for their different trip purpose such as business, service, school, work, shopping, medical, recreational, religious and medical purposes. The modal choices of residents of the study area are varied from each other. Another problem in the study area is that there are no options of various communication modes within and outside the study area.

The analysis findings reveal that the modal choice depends on the commuter's income, age, sex, and occupational characteristics and purposes. Travel time and cost are the most deterministic factors in selecting a mode for trip-making purposes. After analysis, it is also found that most of the trips are distributed from this region to Motijheel, Tejgaon, and Savar Export Processing Zone for their service, business, and work purposes. Only three modes are available in the study area: bus, taxi cab, and auto-rickshaw for long-distance travel. However, regarding travel costs, taxi cabs, and C.N.G. are not affordable for everyone. Only a few people of higher income groups use these modes for their particular purposes but not for all time. The people of the study area preferred bus service to communicate within and outside of the study area for their different trip-making purposes. However, the commuters of the study area gave their opinion that the current bus services could not meet the travel demand, and the fare is also high are not afforded by all income and age groups. In short-distance travel within the study area, the trip makers use only rickshaws because of the absence of alternative modes. However, in the study area, there is an excellent prospect of operating tempo and mishuk as a mode of travel for commuters. There is enough access for these modes. However, there are no options in respect of these modes for commuters. If these modes are introduced in the study area, it would be helpful for the commuters in terms of saving time and cost, and they can easily reach their destinations on time. Variation of commuters' modal choice also depends on lifestyle and occupational characteristics. Some commuters like to use modes that are comfortable for them rather than considering the cost of travel; some of them like to save money rather than comfort.

Declaration statements

The authors report no potential conflict of interest.

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