



PASSENGER TRAVEL BEHAVIOR BEFORE & DURING THE COVID-19 OUTBREAK: A COMPARATIVE ANALYSIS

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Abstract

COVID-19 undoubtedly remains one among the most significant disruptive occurrences of the 21st century, initially recorded in China and spread swiftly throughout the globe. Countries used varied measures to prevent it, from just advising them to levy complete lockdown. This article seeks to examine, through an analytical study done online in between 3 May to 4 July 2021, the influence of the pandemic on travel in Dhaka City, Bangladesh. Questionnaires were utilized to provide views on traveling number and mode choices for different "before" or "during" COVID-19 travel reasons by respondents from different socio-economic backgrounds. The results were utilized in the analysis of (i) travel frequency and (ii) the preferences of mode using Mann Whitney, Kruskal Wallis with Wilcoxon Test. Analyses show that COVID-19 produced a wide variance in mode choices with travel frequency, Males continue to go to work and shopping and risk them more than women. Despite being a public transport, busses continue to be most preferred during Covid situation. In addition, most individuals continue to use busses at the cost of health because of the absence of cheaper alternatives. The government should have to maintain adequate sanitary procedures in public transport and the ICTs and foot and bicycle facilities must be upgraded to prevent the consequences.

Keywords: Mode choice, covid-19, travel patterns, travel behavior

Introduction

The COVID-19 (coronavirus disease 2019) pandemic poses a significant threat to mankind and is a major 21st-century disaster (Barbieri et al., 2021). COVID-19 is a coronavirus, which are respiratory infections that are extremely infectious (Gkiotsalitis & Cats, 2020).

By March 11, 2020, the World Health Organization (WHO) declared COVID-19 as a worldwide pandemic (Awad-Núñez et al., 2021). Unprecedented health, educational, and economic problems and disruptions have resulted from the shortage of vaccines or scientifically successful medical treatments after the outbreak of COVID 19 (Andersen et al., 2021).

The first case of COVID-19 in the Bangladesh was reported on March 8, 2020, and the first COVID-19 related death was reported on March 8, 2020 (Anwar et al., 2020). Bangladesh postponed mass congregations

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until the first week of March, banned international flights, imposed thermal scanner checks, and closed educational institutions in response to the virus's arrival (Anwari et al., 2021). Following the rise in the number of cases, one nation after another enacted so-called "social distancing" policies that impacted colleges, stores, workplaces, public transportation, and a variety of other industries (Ahmed et al., 2021).

To delay the spread of the COVID-19, most countries have implemented a variety of mobility restrictions (Barbieri et al., 2021). Furthermore, multiple prevention and protective steps regarding trip making have been recommended or implemented by governments of various countries to control the transmission of the virus and 'flatten the curve' (Kraemer et al., 2020).

Mode preference during travel is a complicated subject that is influenced by a variety of variables such as age, individual independence and gender (Borkowski et al., 2021). The COVID-19 pandemic, which has affected people all over the world, has had a major effect on how they live and travel (Shakibaei et al., 2021).

Several studies have shown that mobility could increase the risk of COVID-19 infection, putting residents' health at risk (Kwok et al., 2020). Under epidemic circumstances, we see substantial reductions in travel times. Those drops are consistent regardless of age or gender (De Vos, 2020). It appears that travel restrictions and fear of the pandemic have negatively affected residents' long-distance travel (de Haas et al., 2020). (Abdullah et al., 2020) Found that human mobility and contact patterns play a direct role in the spread of infectious diseases, particularly during pandemics. Without proper control, infected travelers can create a new exponential outbreak (Truong & Truong, 2021).

The findings suggest that certain interventions, such as increasing availability and disinfecting vehicles, result in a higher propensity to use public transportation in post-COVID-19 periods (Molloy et al., 2020). Another study indicates that the COVID-19 outbreak's emergence was closely linked to global mobility (Linka et al., 2020).

Regarding travels in the United States, a study showed that COVID-19 reduced vehicle travels in all Florida counties (Truong & Truong, 2021). 75% of respondents reported that they would avoid public transportation and 20%–30% would try to stay indoors at all time (Borkowski et al., 2021). 90% said they had resigned or shortened their usage. When the disease crisis has improved, almost 75% of them expect to return to using public transportation (Przybylowski et al., 2021).

Since the Lunar New Year, network surveys revealed no significant changes in the transportation network (Gibbs et al., 2020). Fear of infection and perceived risk also significantly influence travel behaviors, particularly for transit use (Abdullah et al., 2020). During the lockdown in Spain, mobility to workplaces dropped 80% compared with pre-COVID-19 trends. The most affected mode was public transport rather than private cars (Awad-Núñez et al., 2021).

It's critical to figure out why Bangladeshis haven't been able to fully adapt to the pandemic situation and haven't modified their habits. Furthermore, while there have been a few studies on changes in travel behavior in Bangladesh, none of them have looked at the travel situation in the country's capital city. The study's major goal is to analyze the city of Dhaka's changing travel patterns caused by COVID-19. Characteristics and variables affecting such changes are investigated before and throughout COVID-19.

Materials and Methods

Study area

Dhaka City Corporation, with a total size of 306 square kilometers, is located between latitudes 23.55 and 24.18N and longitudes 90.18 and 90.57E (Sikder et al., 2018). A number of administrative entities are based in Dhaka. Dhaka City was selected to conduct this research since it is quickly becoming one of the world's most densely populated megacities, with a population density of 68,561 people per km² in 2016 (Akash et al., 2018). As a result, a considerable number of journeys within the city are generated every day. So, it is assumed to be significant to assess the travel pattern change in Dhaka City.

Survey design and sampling

The data for this study was collected by an online survey that ran from 3 May to 4 July, 2021 using a questionnaire under three major groups. The groups were: 1) sociodemographic traits, 2) variables associated to travel behavior, and 3) factors connected to COVID-19.

In this study, non-random sampling techniques (Snowball) were applied. These sampling methods were chosen because they were the most practical for surveys in the early phases of the pandemic. (Shakibaei et al., 2021). Because of the significant risk of viral transmission and breaches of the rules governing physical and social distance, conducting face-to-face surveys during the early pandemic era was nearly impossible. As a result, this study, like many others at the time (Molloy et al., 2021), was therefore rooted on an online survey. It was found that a majority of the respondents of this study were young citizens and from well-off groups, similar to other studies based on online surveys. Despite the fact that this may have resulted in some biases in the study, sample characteristics suggest that we were still able to acquire samples from a wide range of socioeconomic categories (Table 1).

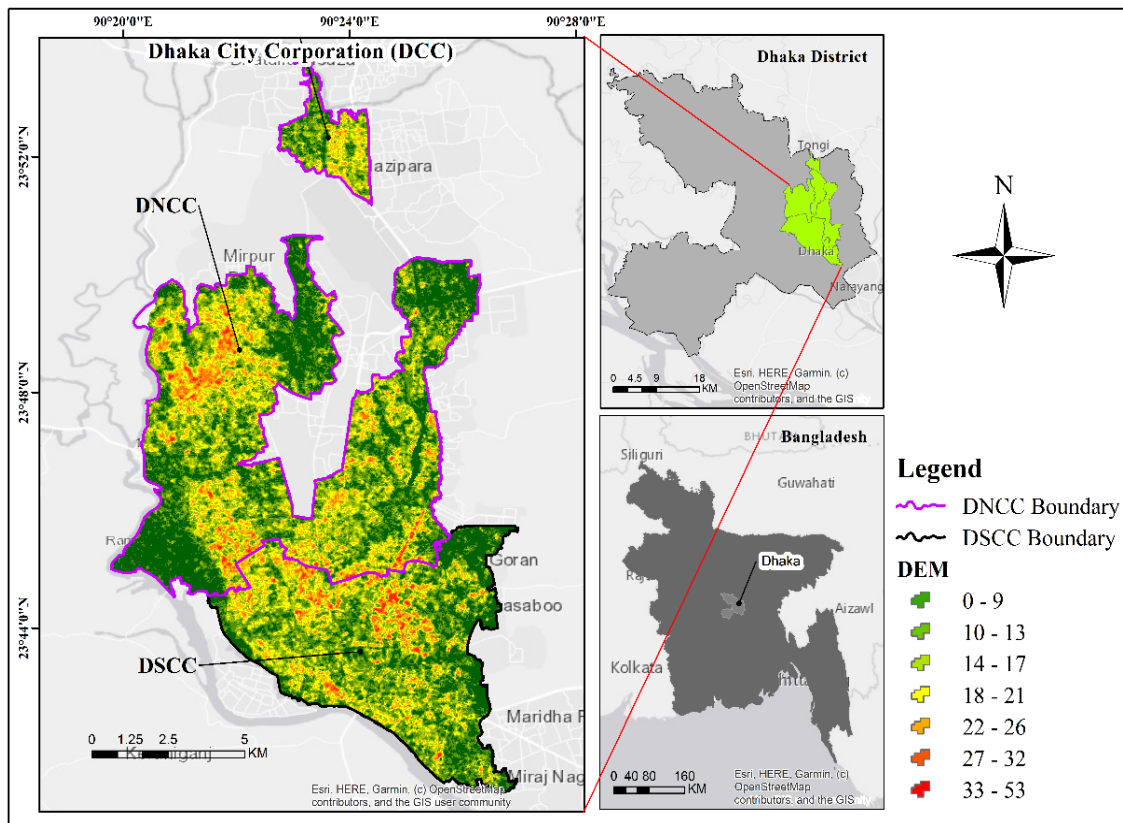


Figure 1. Study area map.

Analysis method

Descriptive Statistics and specifically frequency analysis with each other was performed to show the general Information and their relationships with each other's.

Parallely quantitative comparative analyses were conducted on the collected data. (Nahm, 2016)

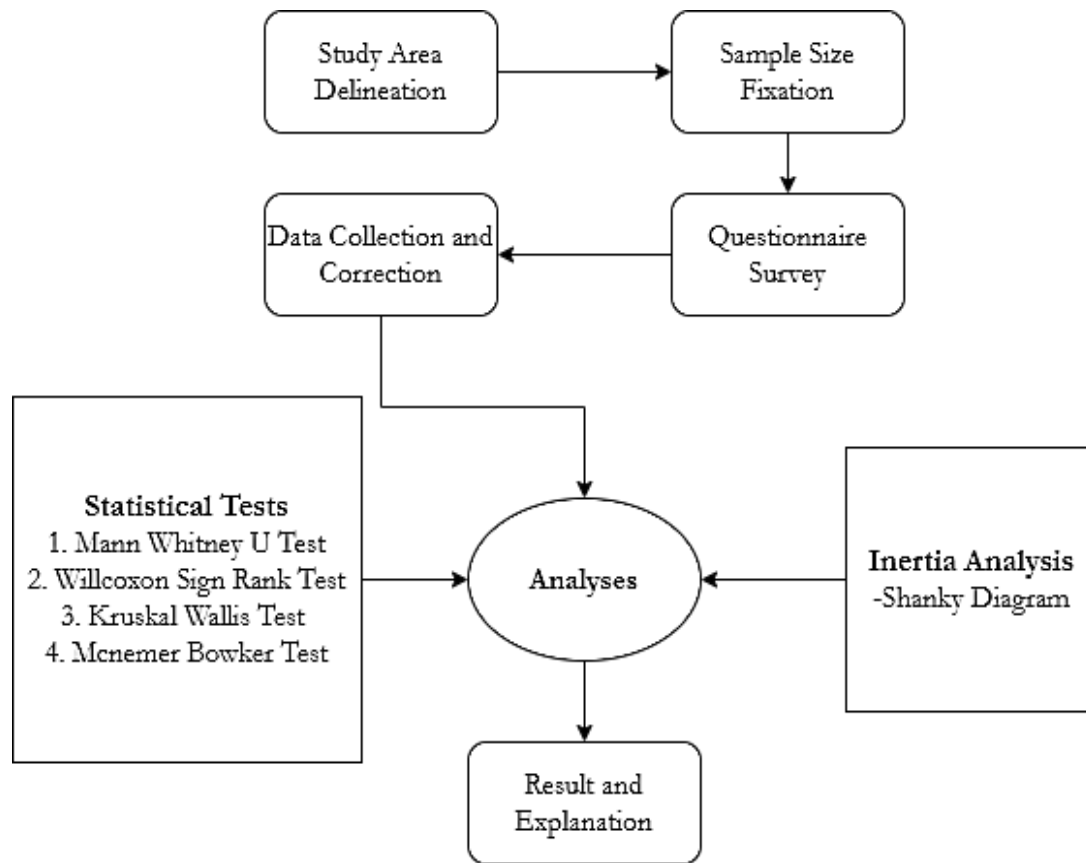


Figure 2. Methodological framework.

suggested utilizing a non-parametric test in place of a parametric test whenever available unless there is experimental evidence about how the errors are distributed. This study deals with both independent and paired observations about travel trends prior to and during COVID-19. Therefore, proper attention was paid while carrying out statistical analyses on the data as described. The methodological process is depicted on Figure 2.

Although a sample size of 610 people may not be fully representative of a district such as Dhaka, it may be enough to provide ideas and proposals for key strategy developments to address transportation challenges after pandemic and serve as basis for future research.

About 69% are of Male and Maximum (37) are of them are bachelor students (63%) among the respondents. As major of the respondents are students of different grade, they barely have the ownership of motorcycle or car. The percentage of having these are only 10% and 7% respectively. However, the data is highly skewed in the context of ages, as most of the respondents are in a major group of “less than 25” which is about 58% of total responses.

Statistical analyses

Mann Whitney U Test was used for independent variables, such as the impact of automobile ownership on distances travelled primarily (McKnight & Najab, 2010). Furthermore, the association between ordinal or

continuous variables such as monthly income and distance travelled for primary purpose was examined using Spearman Correlation.

Table 1. Basic Demographic Information

Items	Category	Frequency	Percent	Items	Category	Frequency	Percent
Gender	Male	400	66%	Monthly household income (Tk)	Below 15000	12	21%
	Female	180	30%		15000–30000	18	30%
	Prefer not to say	20	3%		30000-45000	23	38%
Age	Less than 25	340	56%		Above 45000	7	11%
	25-50	140	24%	Emergency Service worker	Yes	6	10%
	>50	120	20%		No	54	90%
Education level	Higher Secondary and below	17	28%	Number of people in the household	1–2	3	5%
	Bachelors	37	62%		3–4	39	65%
	Masters and above	6	10%		5 and more	18	30%
Employment	Student	34	57%	Motorbike ownership	Yes	10	17%
	Employed/ Business	10	16%		No	50	83%
	Other	16	27%	Marital status	Unmarried	35	59%
Car ownership	Yes	7	11%		Married	24	40%
	No	53	89%		Prefer not to say	1	1%

Kruskal-Wallis test evaluates significant variations in a continuous dependent variable by a categorical independent variable with two or more groups, such as the Impact of Covid-19 on major trip purpose (Ostertagova et al., 2014).

Wilcoxon Sign Rank test is widely used to compare two groups of nonparametric data, which means, those that are not measured precisely but rather as falling between certain limits such as before and after pandemic concern of selecting vehicle comparison (Taheri & Hesamian, 2013).

Sankey Diagram focus on portraying the subjects' quantitative change/flow across event categories while highlighting their temporal convergence and divergence patterns while examining event sequence data (Anwari et al., 2021). In this study, individual respondents' tendency is assessed through inertia analysis of travel modes using Sankey diagrams.

For paired nominal data with several categories in a k*k (2*2) contingency table, where k is the number of categories for each nominal variable, the McNemar-Bowker test—a non-parametric test—was run (Celik & Dane, 2020). As several hypotheses have been tested, a correction has really been necessary in order to prevent false positives, i.e., to reduce errors of type I. In instances where alpha is significant and n is the number of incidents to be conducted, the Bonferroni correction was used. The Wilcoxon signed rank test comparable to the paired T-test is done to compare the regular paired observations between groups, such as distance traveled and number of trips per week.

Results

Effect of no. of total trips made per week and distance travel throughout COVID-19 on socio demographic factors

Socio demographic factors like automobile ownership, gender and finally have you affected by covid showed significant difference between their groups during COVID 19. As the P value is less than 0.05 in the case of vehicle ownership which means the people who have motorcycle and car, travelled more distance and made more trips than the people who does not have car or motorcycle rejecting null hypothesis (Table 2).

Table 2. Effect of no. of total trips made per week and distance travel throughout COVID-19 on Socio demographic factors

* $P < 0.05$

		Effect of no. of total trips made per week throughout COVID-19 on Socio demographic factors:					Effect of no. of distance travelled throughout COVID-19 on Socio demographic factors:			
		N	Mean Rank	Sum of Ranks	Z	Asym p. Sig(2-tailed)	Mean Rank	Sum of Ranks	Z	Asymp. Sig(2-tailed)
Have you been affected by COVID-19 yet?	Yes	103	328.02	33786			328.02	33786		
	No	507	300.93	152569	-1.588	0.043*	300.93	152569	-0.348	0.047*
	Total	610								
Motorcycle Ownership	Yes	102	409.52	41771			389.55	39734		
	No	508	284.61	144584	-6.799	0.00*	288.62	146620	-5.133	0.00*
	Total	610								
Car Ownership	Yes	50	408.86	20443			308.39	15419		
	No	557	294.59	164085	-4.922	0.00*	303.61	169108	-0.261	0.794
	Total	607								
Gender	Female	267	254.78	68026			274.31	73241		
	Male	339	341.87	115894	-6.799	0.00*	326.49	110679	-5.133	0.00*
	Total	606								

And the most important part is that people who travelled more distance and made more trips per week got effected by corona more frequently than the people who made less trip and travelled less distance as the p value are 0.043 and 0.047 which are less than 0.05 rejecting null hypothesis. Finally, in the case of gender, male travelled more distance and made trip per week more frequently than women as P value is 0.00.

Before and after pandemic concern of selecting vehicle comparison

By the results (Table 3), it can be said that concerns like infection, travel time, social distance and travel cost played an important role for selecting vehicle during covid 19 as P value is less than significance level 0.05 which are 0.00 in all the cases rejecting null hypothesis and there is a median of differences between before and after mode choice concern. So, we can say that during covid pandemic people concerned about social distancing, infection, travel cost and travel time more than before while selecting their preferred vehicle. It can be said that people become more careful than before while selecting vehicle during this pandemic.

Mode choice preferences for primary trips

For the principal outside excursions before and during COVID-19, Figure 3 compares travel modes shares. The majority (73 percent) of respondents stated that they used public transportation before COVID-19 for main reasons of travel.

Table 3. Major concern selecting different vehicle

Major concern selecting different vehicles	Mean Rank	Sum of the Rank	Z	Asymp. Sig. (2-tailed)
during COVID-19 [Passengers with face masks/ Social distance] - before COVID-19 [Passengers with face masks/ Social distance]	254.52	99517.5		
	145.48	11638.5	-15.024	0.00
during COVID-19 [Infection concern] - before COVID-19 [Infection concern]	233.7	84834		
	168.9	13512	-13.347	0.00
during COVID-19 [Travel cost saving] - before COVID-19 [Travel cost saving]	166.47	23639		
	204.84	48751	-6.064	0.00
during COVID-19 [Travel time saving] - before COVID-19 [Travel time saving]	181.13	25358.5		
	192.09	45141.5	-6.064	0.00
during COVID-19 [Cleanliness] - before COVID-19 [Cleanliness]	144.29	32754.5		
	145.27	8861.5	-4.859	0.00

In COVID 19 it remained the same since most utilize it as primary means of transit. In comparison, in COVID-019 utilization of private vehicles grew from 20% in advance to 32% (Figure 3). Overall, during pandemics, individuals prefer to shun public transit. But the usage of public transport, e.g., influences cost saving, availability of vehicles and comforts such variables. On contrary, as part of the control of viral transmission, public transportation activities are halted by authorities. Thus, individuals are increasingly reliant online since it is safer and more costly than private transportation or other options, such as taxis.

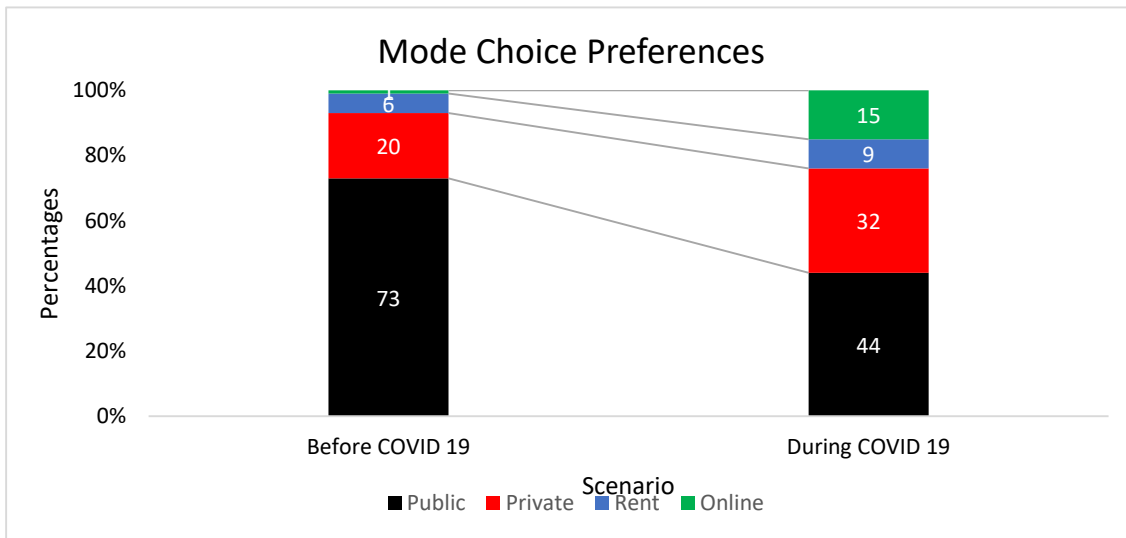


Figure 3. Mode choice preferences before and during covid 19.

The transition from public transport to private transportation and rental services, as can be understood in Figure 4, was not substantial. However, there was a substantial change from public to internet and public transportation modes to rental services.

Impact of Covid-19 on major trip purpose

Table 4 summarizes that in all the cases the significant P value is 0.00 which is lower than 0.05. The result illustrates that there is a significant mean difference between different groups of purposes and it rejects the null hypothesis of accepting that there is no significant mean difference between different groups of purposes.

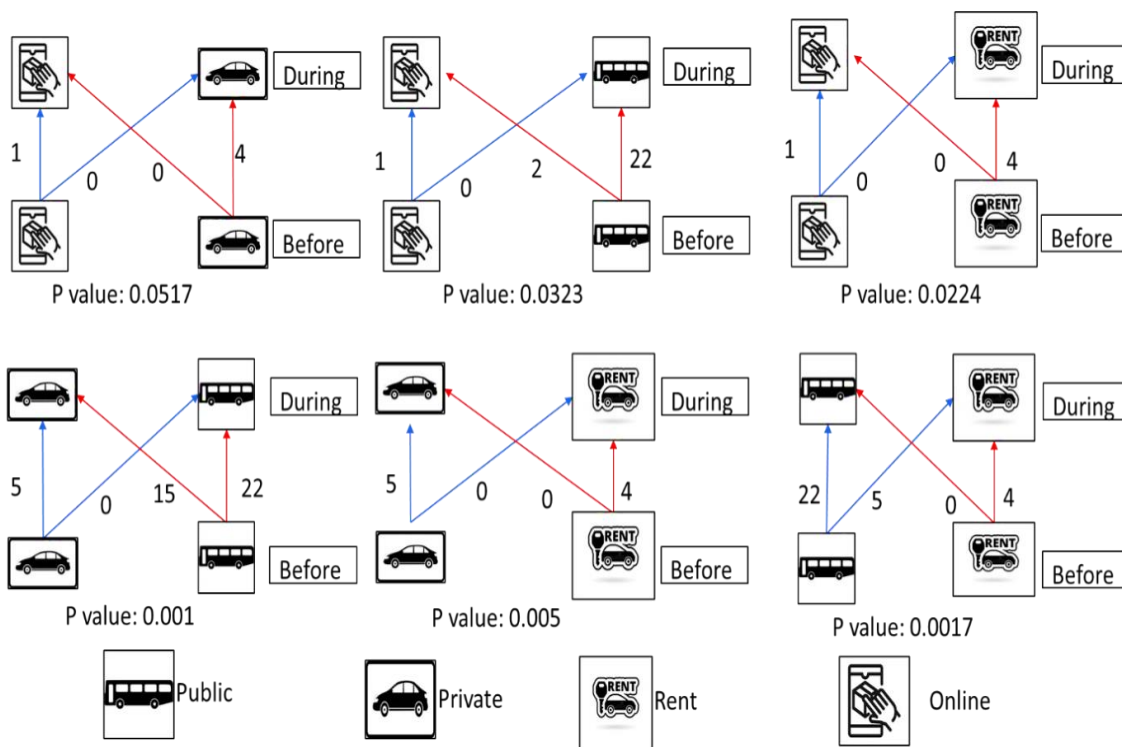


Figure 4. Mode shift for the primary purpose and McNemar test results.

In the first case of daily distance travelled during Covid-19 major trip purpose was different across the group. And it remains unchanged in the case of total trips made per week and monthly travel cost. And as per the respondent's response we can say purposes like work recreation get more attention as the mean rank is higher. As the online classes started during the pandemic purposes like study get least attention.

Table 4. Impact of covid-19 on major trip purpose finally, it can be said that people travelled people distance, made more trips and travel cost was higher for working and recreation purposes and it was least for the purpose of study purpose.

Impacts of socio demographic factors on number of trips

The Mann - Whitney method was conducted to test how sociodemographic characteristics affected the distance traveled for the main purpose of the trip. A summary of the findings is shown in Figure 5.

There was no discernible difference in distance traveled by males and females prior to COVID19.

Table 4. Impact of covid-19 on major trip purpose.

	Major trip purpose during COVID-19	N	Mean Rank	Asymp. Sig.
Daily distance travelled during COVID-19	Work	193	384.4	0.00
	Study	90	276.6	
	Recreation	196	265.1	
	Shopping	131	269.5	
	Total	610		
No. of total trips made per week during COVID-19	Work	193	423.8	0.00
	Study	90	249.5	
	Recreation	196	238.4	
	Shopping	131	270	
	Total	610		
Monthly travel cost in BDT during COVID-19	Work	193	403.8	0.00
	Study	90	333.4	
	Recreation	196	256.8	
	Shopping	131	214.4	
	Total	610		

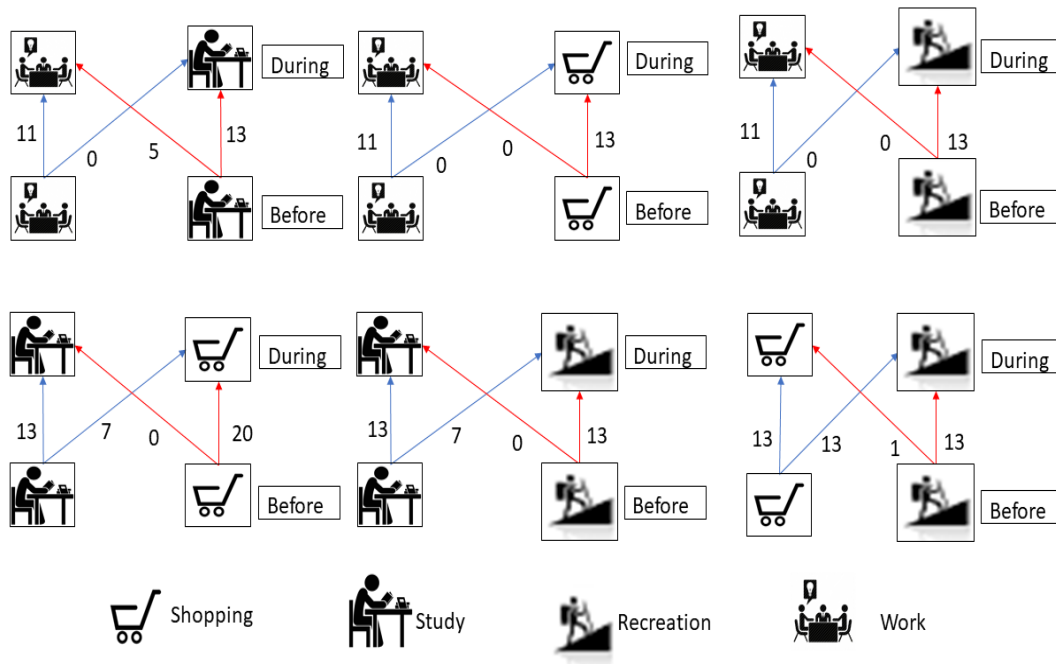


Figure 5. Change in Primary Trip Purpose and McNemar Test Results.

However, during COVID19, this result suggests that males traveled more than females. Prior to COVID19, those who owned a motorcycle traveled much further than those who did not. However, car ownership had no significant effect on the distance traveled for the main trip purpose during COVID19. Prior to and during

COVID19, critical personnel traveled much greater distances. Because emergency workers must perform both their regular duties and additional duties during a pandemic.

As shown in Figure 6, around 88 percent of respondents went a distance between 0 and 3 km during COVID19, but only 37 percent did so prior to COVID19. The distance traveled for the principal trip purpose before and during the COVID19 pandemic was statistically significant ($Z = 21.049$, $p < 0.001$), according to the Wilcoxon signed ranks test. The respondents who traveled mostly for work before and during COVID19 traveled an average of 3.4 to 1.2 km, respectively.

The average distance traveled by students prior to and during COVID 19 was 5.6 km to 4.9km, respectively. Those who went primarily for shopping before and during COVID19 went an average of 4.4 km to 1.5 km, respectively.

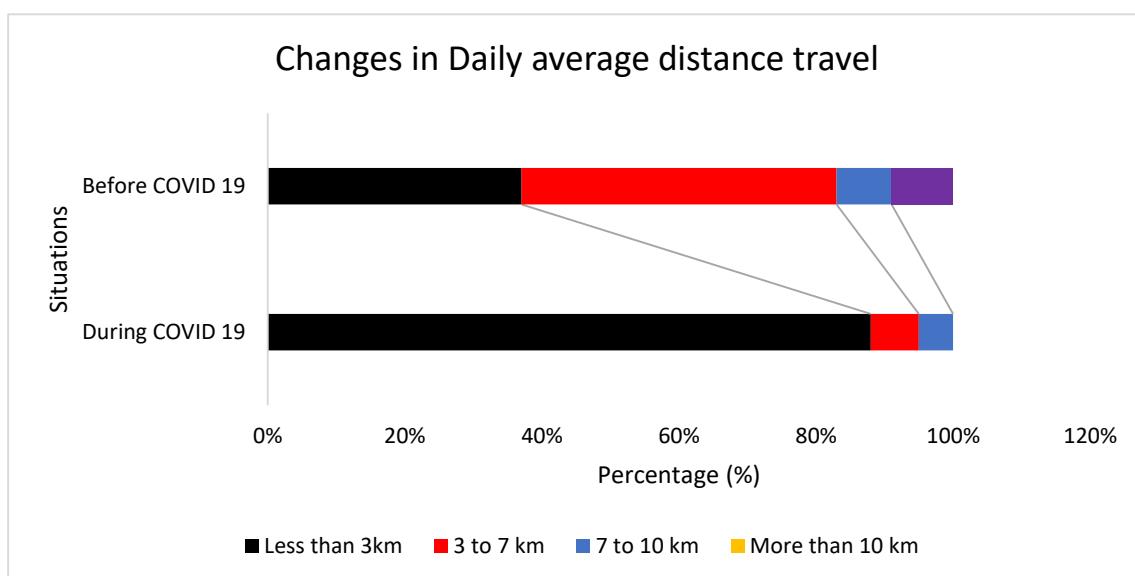


Figure 6. Changes in Daily average distance travel.

Inertia analysis for travel modes and trip frequencies

Figure 7 shows the mode preference of the respondents before COVID-19 and after COVID-19. There has been a notable shift from public transport to private. 40% of people used to prefer public transport before COVID-19 where 53% of people prefer private transport during COVID-19. Only 20% of them still prefer public transport during COVID-19. While other modes remain almost the same in terms of percentage of preference.

Figure 8 shows the number of weekly trips of the respondents before COVID-19 and after COVID-19. There is a notable shift from greater than 7 trips per week to less than 2 trips per week. 30% of the people used to have more than 7 trips a week before COVID-19. But 43% of them now have less than 2 trips per week during COVID-19.

Discussion

This study compared the changes in travel patterns during the COVID-19 pandemic to the pre-pandemic scenario in a developing nation. The two primary assessment themes were (i) evaluating changes in trip frequency and (ii) evaluating variations in mode choices. It is found that travel patterns and mode choices are different during the COVID-19 situation compared to the normal situation because there are a lot of restrictions on travelling. This study demonstrates the outcomes of a survey conducted through the internet.

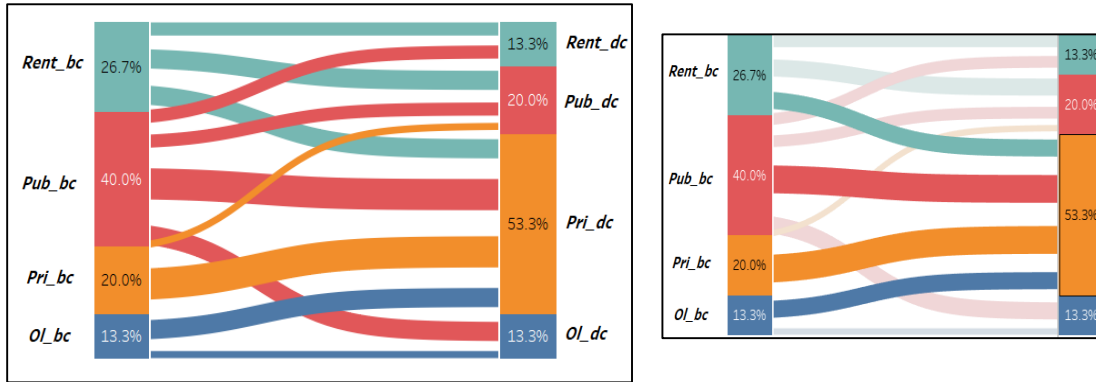


Figure 7. Inertia of various mode preferences before and during COVID-19.

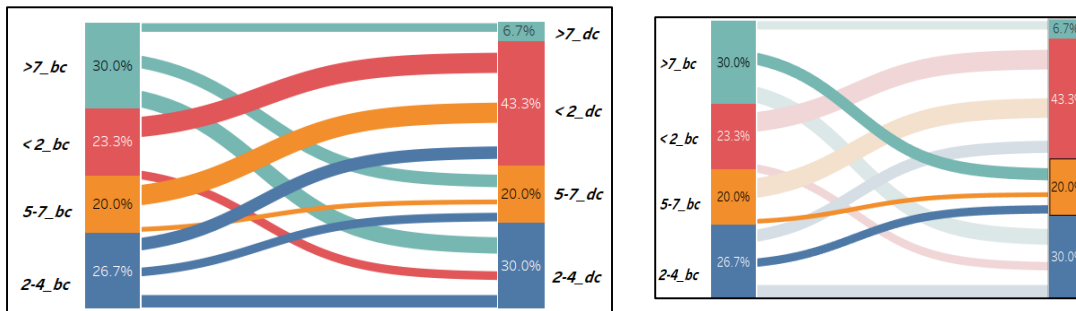


Figure 8. Inertia of weekly travel frequencies before and during COVID-19.

According to the findings, Dhaka remains a public transportation-centric area, with over 40% of the population using the public transport as their major mode of transportation on a daily basis. Despite this, some factors like safety conscious encourages the use of private vehicles, with over 20% of residents opting for them for everyday travel.

This research focused on the effects of the COVID-19 epidemic on urban mobility while also attempting to provide light on people's changing travel patterns. Travel behaviors and mode preferences are thought to be significantly different during pandemic conditions compared to normal (pre pandemic) settings, owing to government limitations and individual fear of infection. However, in the capital of a developed nation like Bangladesh, the bus remains the most popular mode of transportation (73 percent before Covid and 44 percent under Covid circumstances).

During COVID19, it was found that recreation became the major reason for trip where shopping is in 2nd position. The considerable shift from work, study, and other activities to shopping and recreation trips suggests that during a pandemic, shopping trips increases in a significant manner.

Whether, by disobeying Govt. protocol of lockdown, people have to made trip for different purpose (Kamruzzaman & Sakib, 2020). Some of them are unintentionally (like for earning livings) and others are intentionally (like travelling). Authorities enforced self-isolation or lockdowns to limit travel for job or study (Brough et al., 2021). However, regardless of the amount of restriction, such as total, partial, or smart lockdown, shopping may be the major reason why people need to travel during a pandemic.

Furthermore, the results of this study show that travel distances tend to be shorter and travel during pandemics are less common. Since most responders were mainly for shopping during the pandemic, the criteria for social distance are necessary for a significant period of time. This study's findings might have significance for forecasting user demands, requirements, and concerns may be identified, which is crucial in meeting the transportation needs of the general population, particularly in the event of a future pandemic.

Conclusion

This study looked at how travel patterns changed during the COVID 19 pandemic compared to the pre-pandemic scenario in a developing nation looking at a number of demographic factors as well as different types of trips. The study looked into both virtual and traditional forms of transportation.

It should be emphasized that there are certain limitations to this research. It was impossible to obtain a truly representative sample due to the online survey. The authors did all possible to expand the distribution of the questionnaire survey (like contacting respondents via social media sites with personal and professional contacts). Those with internet connection and the ability to comprehend and speak in English answered to this questionnaire. As a result, true representation of the population was quite impossible. Future research can use more complex modeling approaches, such as discrete choice models, because this work focused on exploratory data analysis. This study's findings might have significance for transportation planning in the post-COVID or new normal period. Furthermore, user demands, requirements, and concerns may be identified, which is crucial in meeting the transportation needs of the general population, particularly in the event of a future pandemic.

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