



Impact of COVID-19 Pandemic on Motorcycle Purchase in Dhaka, Bangladesh

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The impacts of COVID-19 on the transportation system have received attention from researchers all over the world. Initial findings reveal that patronage of public transport has gone down, while the use of active transport has increased in general. To the best of our knowledge, no study has focused on the pandemic's effects on motorcycle mode, let alone in the context of an Asian city. We attempted to fill this void in literature by investigating if COVID-19 has influenced people to purchase motorcycles and determining the factors driving their intentions. The study is based on an online survey of 368 people in Dhaka, the capital of Bangladesh. The study found that around 46% of the respondents were expected to increase travel by motorcycle during the post-lockdown period. About 21% of the respondents were also expected to do the opposite. Around 31% of the respondents planned to purchase a motorcycle by August 2021, and the results indicated that the pandemic has influenced more people to purchase motorcycles compared to the pre-pandemic period. The study further identified factors that influenced the respondents' plan for purchasing a motorcycle during the post-lockdown period applying the binary logistic regression. Based on the findings of the study, policy measures were proposed for controlling the growth of motorcycle numbers and increasing the use of active transport modes as its alternative, and consequently, helping to achieve sustainable transportation outcomes.

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BACKGROUND

COVID-19 has been creating havoc in the lives of people around the world for more than a year now. Termed as a pandemic by the World Health Organization (WHO) on March 11, 2020, Coronavirus has profoundly impacted sectors such as public health, economy, and transportation (ILO 2020; New Scientist, 2020). As of February 08, 2021, in 218 countries worldwide, the virus has infected 106 million people, killing 2.32 million of them (worldometer, 2021). The spread of the virus from its origin, Wuhan city of China, was possible through air transport (Jiang et al., 2020; Linas 2020). Therefore, one of the first measures taken by the countries was to close the border and cancel international flights (Aljazeera, 2020). The countries adopted different lockdown measures to prevent the internal spread, from movement restrictions to complete curfews (ABC News, 2020; Baker et al., 2020). People have been advised and sometimes forced to adopt preventive measures at

personal levels in the form of wearing face masks, sanitizing hands, and maintaining a distance of 1–2 m according to WHO and CDC guidelines (CDC, 2020; WHO, 2020).

The first case of COVID-19 infection was declared on March 8, 2020 in Bangladesh, with the first casualty due to the disease ten days later (The Business Standard, 2020). Since then, the virus has infected more than half a million people, and more than eight thousand of them died (GoB, 2020). The majority of the infections and deaths (54%) occurred in Dhaka, the densest city in Bangladesh. Like other countries, the immediate response was the suspension of international flights and shutdown of offices, educational institutions, commercial outlets, and urban public transport and inter-district transport services from March 26, 2020 for about two months (Medicalxpress, 2020). People were allowed to make only essential trips in this period. After that period, the lockdown measures were supplemented by advice to wear face masks, use hand sanitizers, and maintain appropriate social distance in public places. These personal measures had to be strictly applied later on as the virus infection cases mounted, and people were found to be not paying attention to the advice (TBS, 2020). At one stage, the government started to impose fines through mobile courts for non-compliance. The educational institutions are yet to open in Bangladesh (New Age, 2020).

Impacts of COVID-19 have drawn incredible attention from transport researchers all over the world. They have covered different modes of transportation, especially shift in modes. The lockdown measures have dictated travel behavior, but people have chosen one mode over the others based on a few factors outside the lockdown period (Bhaduri et al., 2020). The modes which drew wider attention from the researchers include public transport, walking, and cycling. During the lockdown phase, De Vos (2020) had opined that it would be difficult to maintain physical distance inside a public transport vehicle. Evidence of the decline in the public transport passenger numbers both in absolute and relative terms emerged from almost all over the world (Bucsky, 2020; Jenelius and Cebeauer, 2020; Spivack, 2020; Tirachini and Cats, 2020). Active transport modes benefitted from the situation as there were reports of increased walking and cycling (Davies and Sherriff, 2020; Duggal, 2020). In many cases, people's interest in these modes was supported by providing appropriate infrastructure, though they were mostly temporary arrangements (Davies and Sherriff, 2020; Jacks, 2020; McCarthy, 2020; Schulz, 2020).

There is hardly any study on travel behavior issues related to motorcycles in the pandemic, particularly in Asian countries. Though comprehensive research on modal shift to cars and other private modes is still unavailable at this point in time, it is plausible to predict that a loss of public transport patronage has increased usage and purchase of private modes, including motorcycles (Beck and Hensher, 2020; Bhaduri et al., 2020; De Vos, 2020). People are likely to perceive private modes as safer modes than public transport modes considering the possibility of COVID-19 transmission (Tirachini and Cats, 2020). Especially in Bangladesh, switching to motorcycles can be expected considering the pandemic situation, lack of bicycling

infrastructure, and unaffordability of cars to the majority of the population.

The motorcycle is becoming a prominent mode in Asian countries. Asia is home to about four-fifth of motorcycles in the world (Nguyen, 2013). Motorcycle ownership is on the rise in these countries and has been associated with several transportation issues. Previous studies found several factors behind motorcycle ownership, including income, motorcycle license, car ownership, and service quality of public transport (Hsu et al., 2007; Leong and Ahmed, 2007; Wong, 2013; Oyedepo et al., 2015). These studies showed that motorcycle ownership was prevalent among low and middle-income earners who would even purchase more than one motorcycle. People possessing a car were less likely to purchase a motorbike. It seems people who cannot afford a car are more inclined to purchase a motorbike as their preferred alternative. Furthermore, better public transportation service in the city was likely to reduce motorcycle ownership. However, there is still a lack of empirical evidence on whether the COVID-19 pandemic will increase motorcycle purchase. This research attempts to fill the void in knowledge about the pandemic's impacts on motorcycle use by examining if COVID-19 is likely to influence more people to purchase motorcycles in Dhaka, Bangladesh's capital city, and determine the factors behind the influence. Motorcycles offer an option of travel, especially for lower-to middle-income people in developing countries (International Business Forum of Bangladesh, 2012). Still, an increase in the motorcycles on the roads will pose some issues affecting sustainable transportation goals.

MOTORCYCLE USE IN DHAKA

Motorcycle use has been on rise in Bangladesh, particularly in Dhaka, as evident from the increase in the new registrations in the last decade (Figure 1). The average annual growth of motorcycles was more than 10% (RAJUK, 2015). While modes such as new private cars have been increasing in numbers over the years, the increase in motorcycle number has been the highest in this period. Figure 1 shows that the difference in the rise in the number of motorcycles and cars widened since 2015.

In the absence of adequate research investigating the factors influencing motorcycle sales, from news items, it can be reasonable to assume that people who prefer cars but cannot afford them and perceive that they can easily maneuver through the traffic are likely to purchase motorcycles. Government measures to make the motorcycle easily accessible by offering modest import duties and giving incentives to set-up motorcycle assembling and manufacturing plants are likely to have played a role in this regard (Pervaz et al., 2020; Wadud, 2020). Industries related to motorcycle assembly and manufacture are the fastest-growing ones in Bangladesh, with sales reported to grow by 25% every year on average (International Business Forum of Bangladesh, 2012). The rise of ride-sharing services through motorcycles has also driven the demand for this vehicle. Based on analyses, Wadud (2020) reported that these services inflated the number of motorcycles in Bangladesh by 7.45% by the end of 2018.

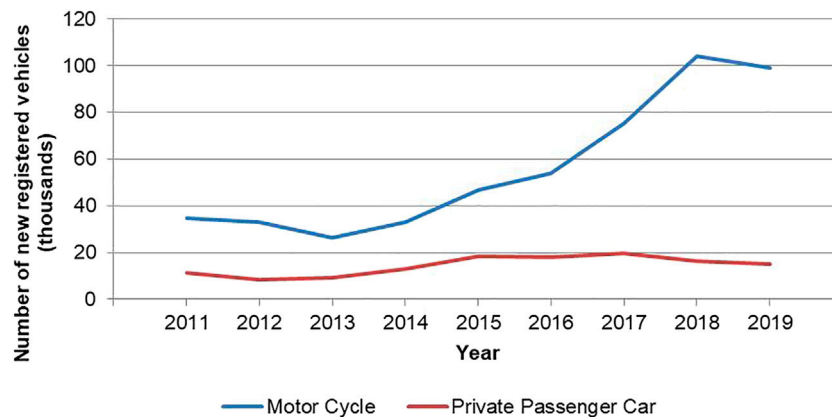


FIGURE 1 | Motorcycle and private car ownership in Dhaka between 2011–2019 (BRTA, 2020).

Consistent with the experience in other countries, motorcycle use has been associated with road accidents and fatalities in Dhaka and other regions in Bangladesh. One study reported 460 accidents involving motorcycles in Dhaka in the period 2000 to 2014, resulting in 581 deaths (Akter and Pervaz, 2019). Motorcycle accidents have become a growing transportation issue in Bangladesh with a rapid increase in motorcycle ownership (Hoque et al., 2014). According to a study by Hoque et al. (2014), accidents occur mostly due to speeding. Another recent study corroborated this finding and revealed that 88% of the motorcyclists involved in the fatal crashes did not wear a helmet (Pervaz et al., 2020). Motorcycle riders in Dhaka are often blamed for erratic and unsafe driving (Antara, 2018). When the roads are congested, they are often found to be moving on the footpaths, disturbing pedestrians' comfort, and even putting their lives at risk (Ullah, 2019). The motorbikes are labeled as unfriendly modes for other road users. They are also responsible for worsening air quality in Dhaka. More than 77% of motorcycles failed to maintain emission standards in a study conducted in Dhaka by the Department of Environment (2019) about a year ago.

METHODOLOGY

Data Collection

We conducted an online questionnaire survey from July 1, 2020 to August 31, 2020 to collect the data for this study. Participation was voluntary in this survey. We informed the respondents about the purpose of the study, information to be collected, the confidentiality of the collected information, and associated benefits and risks of participating in the survey at the beginning of the survey. Then, we took the consent of the participants at the beginning of the survey. A total of 368 people from Dhaka participated in the survey. Through the questionnaire survey, we collected data of the respondents under four broad categories. The categories were: 1) respondents' socio-demographic characteristics, 2) travel behavior-related factors, 3) motorcycle-specific factors, and 4) COVID-19 related factors.

Following the literature review, we constructed a draft questionnaire. After pilot testing, the draft questionnaire was finalized. We hired five surveyors to disseminate the questionnaire through electronic means. They were trained to familiarize themselves with survey objectives and expected outcomes through arranging an orientation meeting. We promoted the survey via social media pages and groups through Facebook advertisements and directly contacted the administrators of social media groups and pages with a request to share the survey questionnaire among their members as well as utilizing our personal networks. These steps, especially Facebook advertisements, helped to reach a broader audience of Dhaka and helped to collect data from a diverse sample. Samples were not selected through a random sampling procedure. Rather non-random (e.g., haphazard and snowball) sampling techniques were used in this study. These sampling techniques were selected as they were the most viable sampling techniques available for surveys during the early pandemic period (Shakibaei et al., 2020). The reason behind it is that the risk of COVID-19 transmission associated with other sampling techniques was much higher than this one.

It was almost impossible during the early pandemic period to conduct face-to-face surveys due to the high risks of virus transmission and violation of physical/social distancing restrictions. Therefore, like many other studies during that period (Bhaduri et al., 2020; Dunton et al., 2020; Shakibaei et al., 2020; Dong et al., 2021), this study was based on an online survey. Though the online survey provided the scope to reach many people, respondents from all socio-economic groups might not have been included, especially those who do not have access to the internet or do not use online platforms. Thus, the data collected for this study is not free from selection bias. It was found that a majority of the respondents of this study were young adults and from well-off groups, similar to other studies based on online surveys (Table 1). These groups might be more willing and face fewer affordability issues to buy a motorcycle. Though this might have induced some biases in the study, sample characteristics show that we could still collect samples from diverse socio-

TABLE 1 | Details and descriptive statistics of the independent variables.

Variable acronym	Variable description	Variable type or outcomes	%	Mean
Socio-demographic variables				
Gender	Respondent's gender	Female	39.64	
		Male	60.35	
Age group	Respondent's age	Young (<30 years)	74.85	
		Middle-aged (30–60 years)	24.55	
		Old (>60 years)	0.59	
Income group	Respondent's income group based on his/her monthly household income	Low-income group (<20,000 BDT)	9.46	
		Middle-income group (20,000–60,000 BDT)	54.73	
		High-income group (>60,000 BDT)	35.81	
Household size	Number of members in the respondent's household	Continuous		4.41
Travel behavior-related factors				
Bicycle ownership	Whether respondent's household owned any motorcycle	Yes	24.26	
		No	75.73	
Car ownership	Whether respondent's household owned any private car	Yes	36.39	
		No	63.61	
Expected change in trip frequency	Expected change in the frequency of travel during the post-lockdown period by the respondent	More than pre-COVID-19	21.89	
		Same as pre-COVID-19	28.99	
		Less than pre-COVID-19	49.11	
Travel frequency	Frequency of travel by motorcycle during pre-COVID-19 situation by the respondent	Regularly (>3 days per week)	2.67	
		Usually (1–3 days per week)	8.57	
		Rarely	88.75	
Motorcycle-specific variables				
Affordability	Agree with the statement: "Considering my family's current level of income, I can afford a motorcycle."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		3.16
Road safety	Agree with the statement: "I feel safe from injury/crash in the roads while riding a motorcycle."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		3.17
Accessibility	Agree with the statement: "Motorcycle is accessible to a wide range of places and faster than active travel modes (cycling and walking)."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		3.57
Parking	Agree with the statement: "Motorcycle parking would be easier and cheaper."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		3.39
Convenient	Agree with the statement: "Motorcycle is very convenient to use."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		3.56
License availability	Agree with the statement: "I do not have a license to ride a motorcycle."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		3.42
License issue	Agree with the statement: "Issuing a motorcycle license would be complicated."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		3.30
Registration cost	Agree with the statement: "Motorcycle registration cost is high."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		2.97
Maintenance	Agree with the statement: "Maintenance of a motorcycle would be a hassle."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		2.74
Motorcycle riding ability	Respondent's ability to a ride motorcycle	Can ride	11.65	
		Cannot ride	88.35	
COVID-19-related variables				
Concern about COVID-19 impact on the health	Agree with the statement: "I am concerned about the health impacts of COVID-19 in Bangladesh."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		4.16
Trust in preventive strategies	Agree with the statement: "The more we take precautions and follow the health guidelines, the less is the risk of being affected by the COVID-19."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		4.19
Risk perception	Respondent's perceived risk of COVID-19 transmission through motorcycle	Five-point likert scale (1 = extremely high, 5 = extremely low)		3.53
Helmet use	Agree with the statement: "Using a helmet while riding a motorcycle will give me extra protection from COVID-19."	Five-point likert scale (1 = strongly disagree, 5 = strongly agree)		3.41

economic groups (Table 1). A sample size of $n = 368$, collected through non-random procedure, might not be fully representative for a megacity like Dhaka, but it might be sufficient enough to

provide insights and indications for the key policy developments to tackle post-pandemic transportation challenges and provide a base for future studies.

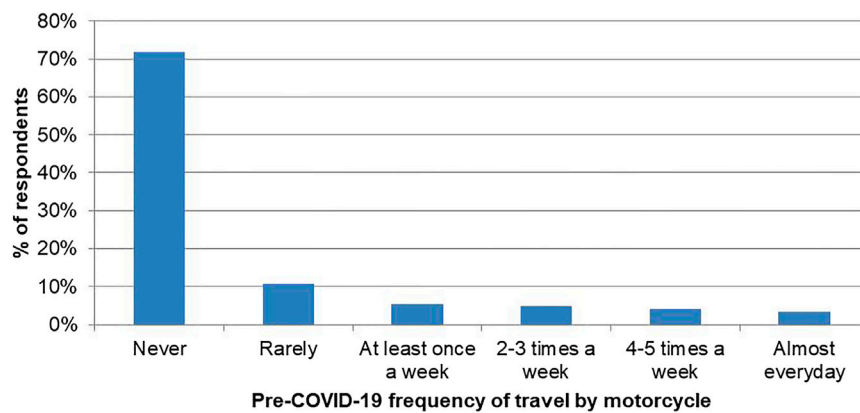


FIGURE 2 | Pre-COVID-19 frequency of travel by motorcycle.

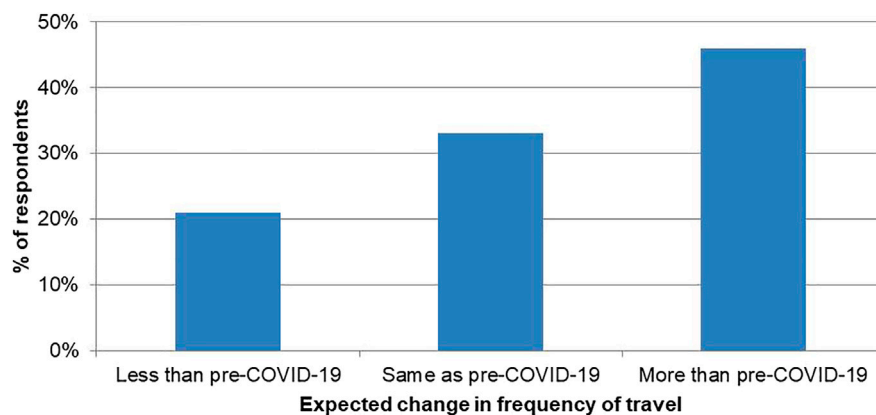


FIGURE 3 | Expected change in frequency of travel by motorcycle during the post-lockdown period.

Data Analysis

First, we used descriptive statistics to investigate the frequency distributions of travel of the respondents by motorcycle during the pre-pandemic period. Then their expected changes in the frequency of travel by motorcycle during the post-lockdown period, and their plan to purchase a motorcycle in the upcoming days (within 1 year from August 2020) after the lockdown period were also analyzed through descriptive statistics. Finally, we developed a binary logistic regression model to identify the factors influencing the plan to purchase a motorcycle. Our study considered “plan to purchase a motorcycle in the upcoming days after lockdown” as the dependent variable, having binary outcomes: yes or no. Binary logistic regression is a widely used technique to analyze the relationship between a binary nature dependent variable (e.g., sex [male vs. female], health condition [disease/no disease], purchasing willingness [purchase/no purchase], response [yes vs. no], score [high vs. low]) and one or more nominal, ordinal, interval or ratio-level independent variables (Nisel, 2001; Dziwornu, 2013; Wilson et al., 2015). Therefore, we found the binary logistic regression modeling technique

suitable for identifying the factors influencing the likelihood of purchasing a motorcycle by the respondents. We considered the data of the factors which were collected under the four broad headings mentioned earlier as independent variables. We excluded respondents who already owned a motorcycle from our sample while developing the model. Therefore, a total of 338 samples were used to develop the model. Details and descriptive statistics of the independent variables are presented in **Table 1**.

RESULTS

Impact of COVID-19 Pandemic on the Use of Motorcycle

Figure 2 shows the frequency of travel by motorcycle during the pre-COVID-19 situation. In this era, almost 72% of the respondents never traveled by motorcycle. Around 10% of the respondents rarely traveled by motorcycle. Only a small portion of the respondents regularly traveled by motorcycle (3% traveled almost every day, 4% used 4–5 times in a week, 5% used 2–3 times a week) (**Figure 2**). People might change their frequency of travel

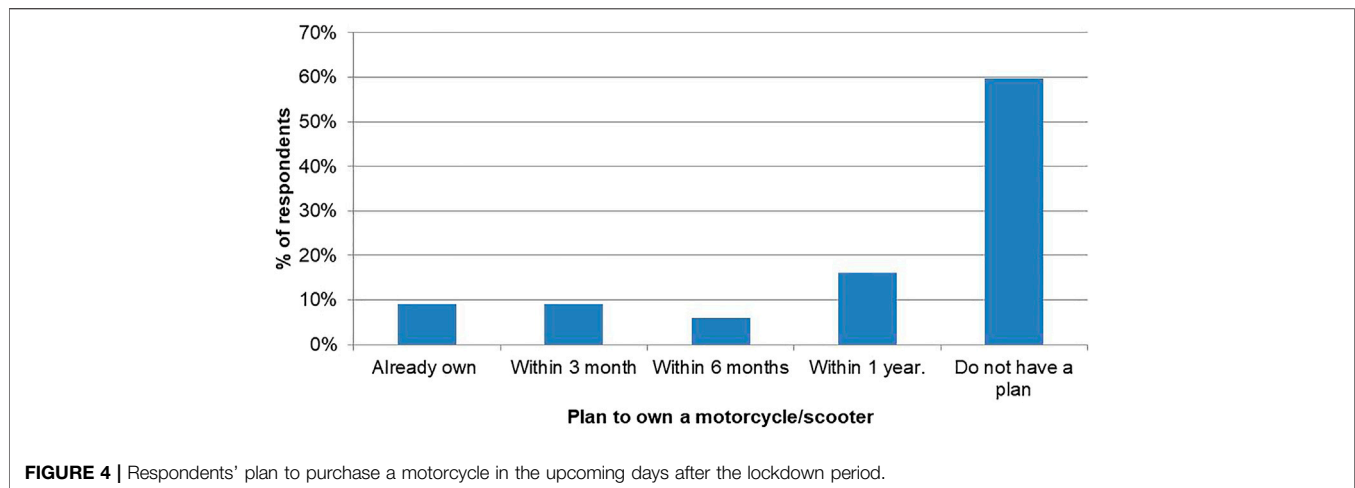


FIGURE 4 | Respondents' plan to purchase a motorcycle in the upcoming days after the lockdown period.

TABLE 2 | Results of the binary logistic regression model.

Factors	Coefficient	Std. error	p-Value	OR
Constant	-5.801	1.355	0.000 ^a	0.003
Gender (ref: Female)				
Male	0.881	0.318	0.006 ^a	2.412
Bicycle ownership (ref: No)				
Yes	0.785	0.305	0.010 ^a	2.193
Travel frequency (ref: Rarely)				
Occasionally	1.485	0.446	0.001 ^a	4.416
Road safety	0.228	0.111	0.039 ^b	1.256
Accessibility	0.774	0.258	0.003 ^a	2.168
Convenient	0.402	0.220	0.068 ^c	1.494
Motorcycle riding ability (ref: Can ride)				
Cannot ride	-0.391	0.148	0.008 ^a	0.677
Risk perception	0.215	0.120	0.074 ^c	1.240

Model summary: $n = 338$, $\chi^2 = 65.823$, $df = 08$, $p\text{-value} = 0.000$, $-2 \text{ Log likelihood} = 325.929$, $\text{Nagelkerke } R\text{-square} = 0.258$, $\text{Correctly classified} = 75.7\%$, and $\text{Highest VIF value} = 1.3$. $\text{Hosmer and Lemeshow test: } \chi^2 = 07.536$, $df = 08$, $p\text{-value} = 0.480$.

^aIndicates significance at the 1% level.

^bAt the 5% level and.

^cAt the 10% level.

by motorcycle during the post-lockdown period than the era before the pandemic. The expected change in travel frequency by motorcycle during the post-lockdown period is represented in **Figure 3**. Results show that about 46% of the respondents were expected to travel more by motorcycle during the post-lockdown period than the pre-COVID-19 situation. On the other hand, about 21% of the respondents were expected to decrease travel by motorcycle (**Figure 3**). Around 33% of the respondents did not expect any change in their travel frequencies by motorcycle.

Impact of COVID-19 on the Plan for Purchasing a Motorcycle

The respondents were asked about their plan to purchase a motorcycle in the upcoming days (within three months to one year from August 2020) during the post-lockdown period. From the results of the survey, it was found that around 9% of the respondents already owned a motorcycle (**Figure 4**). About 9% of the respondents planned to purchase a motorcycle within three months from August 2020, while 6% more planned to purchase it within six months. An additional 16% of the respondents planned to purchase a motorcycle in the next six months. Therefore, in total, 31% of the respondents showed their intention to purchase a motorcycle in the one-year period following the survey, and the COVID-19 pandemic is likely to have influenced their plan. However, most of the respondents (60%) had no plan to purchase a motorcycle within this time-frame.

Factors Influencing the Respondents' Plan to Purchase a Motorcycle

We developed a binary logistic regression model to identify the factors that could influence the likelihood of purchasing a motorcycle by the respondents in the upcoming months after lockdown. The developed model is presented in **Table 2**, including the coefficient (B), standard error, p -value, and odds ratio (OR) for each significant independent variable, and model summary statistics. Model summary statistics show a p -value of 0.000, which was found to be significant at a 99% confidence level. We found the highest VIF value of 1.3, indicating no multicollinearity among the predictor variables. The Nagelkerke R -square value was found to be 0.258, indicating that the model would be able to explain 25.8% of the variation in the likelihood of purchasing motorcycles by the respondents. In addition to that, the Hosmer–Lemeshow statistic shows a p -value of 0.480, which was not found to be significant for this model at a 95% confidence level (p -value > 0.05). All the model statistics indicated that the developed model fitted the data well.

It was found that the likelihood of purchasing a motorcycle by the respondents in the upcoming months after the lockdown was influenced by eight factors (**Table 2**). Female respondents had lower odds of purchasing a motorcycle than male respondents ($OR = 2.4$). Respondents who owned a bicycle had higher odds of purchasing a motorcycle ($OR = 2.2$) than respondents who did not own a bicycle. Furthermore, respondents who occasionally traveled by motorcycle during the pre-COVID-19 era had higher odds of purchasing a motorcycle ($OR = 4.4$) compared to those who rarely traveled by motorcycle. The odds of purchasing a motorcycle increased if the respondents felt safe while traveling by motorcycle in terms of road safety ($OR = 1.2$). If the respondents believed that a wider range of locations was accessible by motorcycles as well as it was a faster travel mode than active transport modes, then they had higher odds of purchasing a motorcycle ($OR = 2.2$). Additionally, the odds of purchasing a motorcycle increased if the respondents considered that travel by motorcycle was convenient ($OR = 1.5$). Respondents who could not ride a motorcycle had lower odds of purchasing a motorcycle ($OR = 0.68$) compared to those who could ride. Lastly, the odds of purchasing a motorcycle increased if the respondents perceived a lower level of risk of COVID-19 transmission through riding a motorcycle compared to those who perceived a higher level of risk ($OR = 1.2$).

DISCUSSION

Though the number of motorcycles is increasing day by day in Dhaka (about 30,000 motorcycles registered every year on average), its modal share is still negligible (less than two percent) (DTCA, 2015; Gallagher, 2016). Our study results showed that more than 70% of the respondents never traveled by motorcycle; whereas, a few respondents used it regularly before COVID-19. Researchers around the world predicted that people might decrease travel by public transport and shared transport modes due to the COVID-19 pandemic; whereas, they might increase travel by active transport modes (e.g., walking and cycling) and private modes (e.g., motorcycle and car) during the post-lockdown period (Bucsky, 2020; De Vos, 2020; Tirachini and Cats, 2020). This study found that 46% of the respondents were expected to travel more by motorcycle than the pre-COVID-19 period, which was consistent with the predictions of the previous studies. On the other hand, a portion of the respondents was expected to travel less by motorcycle. Their travel demand might be reduced due to pandemic's concerns and restrictions as well as due to the increased virtual activities in this period (Bhaduri et al., 2020; Budd and Ison, 2020).

Results of the study showed that around 9% of the respondents already owned a motorcycle (**Figure 3**). The rate of motorcycle ownership in Dhaka was found to be 9.4% in 2015 (DTCA, 2015), which gives an indication that the sample is likely to resemble the population. The study also found that around 31% of the respondents were planning to purchase motorcycles in the one-year period as a large portion of the respondents were expected to increase travel by motorcycle

during the post-lockdown period. Comparing this figure with the motorcycle ownership rate (9.4%) and average annual growth of motorcycles (10%) in Dhaka indicates that more people are interested in purchasing motorcycles than in the pre-COVID-19 situation (DTCA, 2015). Therefore, it would be reasonable to state that COVID-19 influenced more people to buy motorcycles. Though using a motorcycle has several advantages, it has already become a huge concern for the transportation planners of Dhaka. It contributes to deteriorate traffic congestions and increase air pollution in the city. Moreover, it makes road safety conditions worse. Furthermore, the reckless and risky behavior of the motorcycle riders complicates the traffic management system (DTCA, 2015). Therefore, a sharp rise in motorcycle ownership might further deteriorate the transportation and environmental condition of Dhaka, which will be a backward step from sustainable development goals. Therefore, necessary steps need to be taken to control the number of motorcycles and increase the use of active transport modes. Active transport modes might reduce pressure on public transport and shared transport modes, and help people avoid these risky travel modes in terms of viral transmission. These steps might be helpful to improve the transportation condition in Dhaka and achieve sustainable development goals.

Among the identified factors that influenced the respondents' plan to purchase motorcycles in the upcoming months after the lockdown period, gender was significant. As expected, the male respondents were more likely to purchase a motorcycle than female respondents. As motorcycle riding is comparatively risky and motorcycle-related road crashes in Dhaka are on the rise, women are less interested in riding motorcycles as they generally show less risky behavior than men (Zafri et al., 2020b; Dryhurst et al., 2020). Moreover, social stigma plays an important role in discouraging women from riding motorcycles. In Dhaka, the social and physical environment is not yet entirely suitable for women to ride motorcycles (Rahman et al., 2019).

Results also showed that the probability of purchasing a motorcycle increased if the respondent's household already owned a bicycle and the respondents perceived this mode useful for accessing a wide range of places and considered it faster than active transport modes. In Dhaka, modal shares of walking and bicycling are around 20% and less than 2%, respectively (Gallagher, 2017). Though walking is one of the major means of travel in Dhaka, the condition of pedestrian facilities is poor. A large portion of the roads has no footpaths and road-crossing facilities. On the other hand, roads where footpaths are available, most of them are difficult to use because of faulty designs, obstructions, low hanging wires, uncovered drains, hawkers, and parked vehicles (Gallagher, 2017). These dis-amenities make pedestrians one of the most vulnerable road user groups in Dhaka (Zafri et al., 2020a). In the case of bicycles, very few facilities are available on the roads of Dhaka. Historically, the policymakers have not paid attention to this travel mode (RAJUK, 2015). Without proper facilities, it is difficult and risky to use a bicycle on the roads of Dhaka. Therefore, many distant places become inaccessible by these active travel modes, while the operational

speeds of these two modes are significantly less than their potential limits. Therefore, people are likely to prioritize motorcycles over active transport modes, which might lead to influence their plans to purchase motorcycles after lockdown, considering that using public transport and shared transport modes might still be risky in terms of virus infection. The average trip length and duration in Dhaka by walking are around 1.25 km and 15 min, respectively (Sharmeen and Houston, 2019). Availability of improved facilities might increase these average values. On the other hand, although the average trip length by bicycling in Dhaka is not available, its potential range is 15 km or more (Gallagher, 2016). Walking accounts for 30–40% of all trips, while cycling accounts for 10–30% of all trips in a large number of cities in developed countries (Gallagher, 2017). Therefore, we can assume that there are ample scopes to improve active transport facilities, which might help to increase the trip share of active transport modes and control the number of motorcycles on the streets in Dhaka.

The probability of purchasing a motorcycle increased if the respondent traveled by motorcycle occasionally during the pre-COVID-19 situation. In general, people who used motorcycles for regular travel before the pandemic might already own motorcycles. However, those who occasionally used motorcycles might feel comfortable traveling by this mode. As a motorcycle is a safer travel mode in terms of viral transmission, occasional users of motorcycles might be more likely to purchase motorcycles to travel more using this mode.

Road safety factor was also found to be statistically significant in the developed model. Although motorcycle has less than 2% modal share in Dhaka city, it has already contributed about 10% of the total crashes (Aker and Pervaz, 2019; Rahman et al., 2021). In addition, the risky behavior of the motorcycle riders makes the road safety condition worse for other road user groups. Therefore, respondents who believed the motorcycle as a risky mode in terms of road safety were unlikely to purchase a motorcycle. On the other hand, motorcycles are not only affordable but also faster and more convenient than public transport and active transport modes in Dhaka (DTCA, 2015). The study found that a large number of people considered motorcycles as a convenient mode for travel, and therefore, the results of the study showed that respondents who perceived motorcycle as a convenient mode were more likely to purchase it.

Finally, the study further found that respondents who perceived a lower risk of COVID-19 transmission via motorcycle were more likely to purchase it. Risk perception is an important factor that influenced the risk-taking behavior of people (Dryhurst et al., 2020). People engage in riskier behavior and take less preventive measures to protect themselves from certain exposures if they perceive lower risk associated with the exposures (Barua et al., 2020; Khosravi, 2020). Hence, respondents who perceived lower risk of viral transmission in motorcycles were more likely to purchase them as they might want to avoid the modes in which there is a higher risk of viral transmission.

CONCLUSION AND POLICY MEASURES

The unprecedented effects of COVID-19 have been felt in the transportation sector as well. Most of the countries worldwide imposed lockdown measures immediately to combat the transmission of the disease. The number of trips dropped to a great extent as a result. With the relaxation of the lockdown measures, the trip numbers picked up gradually. However, changes in travel behavior were observed, mostly due to the perception of Coronavirus transmission risks associated with traveling. It was assumed that people might decrease travel using public transport and shared transport modes due to the pandemic and instead increase the use of active transport modes and private modes during the post-lockdown period. However, no study has yet focused on the pandemic's effects on the usage of the motorcycle mode, especially in the context of an Asian country. We attempted to fill this gap in knowledge by investigating the influence of COVID-19 on the purchase of motorcycles in the upcoming days after lockdown in Dhaka and determining the factors influencing the intention.

The study found that around 46% of the respondents were expected to increase travel by motorcycle during the post-lockdown period. Around 21% of the respondents were also expected to behave oppositely. This study also found that COVID-19 has resulted in an increase in the intention to purchase a motorcycle. Around 31% planned to purchase a motorcycle within August 2021. The study also developed a binary logistic regression model to identify factors that influenced the respondents' plan for purchasing a motorcycle during the post-lockdown period. Eight factors were found to be significant in the model. They are gender of the respondents, bicycle ownership, pre-COVID-19 travel frequency by motorcycle, motorcycle-related road safety perception, perception related to motorcycle accessibility and speed, perception related to the convenience of using a motorcycle, motorcycle riding ability, and perceived risk of COVID-19 transmission through motorcycles.

Though a motorcycle is an affordable mode, from the perspectives of safety, environmental pollution, and traffic impacts, it cannot be termed as a sustainable transportation option. Motorcycles need to exist as a modal choice for the residents of Dhaka. However, their number should not be allowed to exceed a limit beyond which they pose safety issues, create environmental pollution, contribute to traffic congestion, and cause discomfort for other road users. We believe it is time to restrict the rise in the number of motorcycles and impose measures to modify existing motorcycle riders' behavior. We recommend the following policy measures:

- Traffic rules should be strictly imposed on motorcycle users for their own safety as well as the safety of other road users. The amount of fine should be raised for not wearing helmets and violating traffic rules such as speeding and riding on spaces reserved for other road users.
- The government has already invested in setting up motorcycle manufacturing and assembling plants. They have economic benefits, including the creation of skilled

employment. The focus of the plants should be shifted to foreign markets from the locals.

- The registration tax and import duties for motorcycles should be raised to make it an unattractive mode for those who are contemplating to purchase them.
- As the majority of the motorcycle owners and potential riders are likely to belong to low-to middle-income groups, the viable alternative modes should be improved so that they find them more attractive than motorcycles. As mentioned in the discussion, there is an opportunity to complete most of the trips in Dhaka by cycling and walking. Pedestrians should be given preference. Barriers to cycling and walking should be identified through research, and steps should be taken to remove them.
- Risk perception of Coronavirus transmission is going to be an important determinant of modal choice in the new normal situation. There should be awareness programs, backed up by research and evidence, to highlight that buses are not as unsafe as initially perceived. Similarly, the benefits of using active transport in this period should also be promoted. Awareness programs should also cover the negative aspects of using motorcycles, including higher chances of accidents, fatalities, contribution to road congestion, and environmental pollution.

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- The findings of this study are limited to Dhaka, Bangladesh. However, many countries in Asia and other regions have similar contexts. Therefore, the findings and policy recommendations should be useful there as well.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because we did not receive respondents' consent to share their data publicly. Our consent form stated that the data will be kept in a secure place and accessed only by the investigators themselves. Requests to access the datasets for potential collaboration should be directed to NZ (zafri@urp.buet.ac.bd) or SJ (jamals16@mcmaster.ca).

AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: NZ and AK; data collection: SJ and NZ; analysis and interpretation of results: NZ, SJ, and BA; draft manuscript preparation: AK, NZ, and BA. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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