Proceedings of the 6th International Conference on Civil Structural and Transportation Engineering (ICCSTE'21)
~~Niagara Falls, Canada~~ Virtual Conference – May 17-19, 2021
Paper No. 163
DOI: 10.11159/iccste21.163

Assessment of Railway Transport Safety in Bangladesh: A Before-After Study of COVID-19 Case

Armana Huq[1], Hamim Tasin[2], Syeda Manila Jannat[3]
[1]Assistant Professor, Accident Research Institute (ARI)
Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh
ahuq002@fiu.edu; ashuq@ari.buet.ac.bd
[2]Graduate Research Assistant
Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh
hamimtasin2208@gmail.com
[3]Lecturer
Military Institute of Science and Technology (MIST), Dhaka 1216, Bangladesh
syedatonny15@gmail.com

Abstract - The COVID-19 pandemic in Bangladesh is part of the global pandemic of coronavirus disease 2019, caused by extreme acute respiratory syndrome, coronavirus 2 (SARS-CoV-2). In March 2020, the virus was reported as having spread to Bangladesh and the Institute of Epidemiology Disease Control and Research (IEDCR), announced the first 3 (three) identified cases on 8 March 2020. In order to protect the population and to prevent the outbreak of novel coronavirus-2, the government implemented non-therapeutic measures such as declared "lockdown" throughout the nation from March 26, 2020 to May 30, 2020 and prepared some necessary steps to spread awareness to keep this syndrome away from them as Bangladesh being the second most affected country in South Asia, after India. Due to transport restrictions put in place to mitigate the pandemic, commercial road transport, both passenger and goods, has been severely impacted by COVID-19 in Bangladesh. The COVID-19 also contributed to the accident patterns and casualties of railway related accidents. An attempt has been made in this study to demonstrate the before-after effect of COVID-19 pandemic to highlight the variation in the perspective of railway transportation accidents. A comprehensive descriptive analysis has been conducted to find the major factors contributed to the railway accidents. The study also includes hotspot analysis using ArcGIS. The study has been conducted utilizing two years (2019-2020) of daily newspaper-based data which is classified by two categories: 299 days (May 14, 2019 to March 7, 2020) before and 299 days (March 8, 2020 to December 31, 2020) after the first case of COVID-19 was reported on March 8 in Bangladesh. The results reveal that railway accidents are significantly declining due to this pandemic situation. Finally, based on the findings, probable countermeasures to the guidelines for the prevention of certain incidents have been discussed with recommendations.

***Keywords*:** COVID-19, Lockdown Period, Safety, Railway Accidents, Before-After Study.

1. Introduction

The transportation sector in Bangladesh has evolved in mostly with land vehicles and rail is as an important method of mass transport in Bangladesh as many districts are connected by rail and Bangladesh Railway (BR) in particular, has always played a vital role in the economic growth and development of Bangladesh. Railway is known to have competitive advantage in bulk goods transport and long haul due to cost effectiveness and safety issues. However, railway dominates in carrying stone, iron, steel and food grains and it is found that the commodities carried by rail are mostly sea port and land port based. Besides providing transportation services, railway is also a major employer of civilian labor force with almost 34168 employees. But it still needs improvement with safety standards as it has an alarming rate of accidents occurring every year which endangers the life of civilians with immense amount of property damage. In general, risk monitoring in a railway system is a critical step for ensuring train operation safety. Consequently, knowing how to monitor the risks associated with railway systems and identifying the trend of accidents patterns is increasingly important. Also, the accident pattern and injuries of railway related accident changed a lot as the swelling pressure level caused by global pandemic of coronavirus disease 2019 (COVID-19) and due to transport restrictions put in place to mitigate the pandemic, commercial road transport, both passenger and goods, has been severely impacted by COVID-19.

So, an in-depth performance study of before-after accidents pattern and investigation of the major contributing factors and accident trends can help to highlight the variation in the perspective of railway transportation accident regarding the pandemic situation.

2. Literature Review

Many studies have been carried out in different countries regarding the railway accident modelling and causation factors. Ouyang et al. [1] used the STAMP approach to analyze the railway accident and the accident spreading processes have also been discussed and modeled. Song et al. [2] developed a new accident model called Systems-theoretic Accident Modeling and Processes (STAMP) by Leveson to explain accidents to analyse the China-Yongwen railway accident. Ma et al. [3] constructed a new model for the causation analysis of railway accident based on the complex network theory. Chen et al. [4] performed an AcciMap analysis to describe the entire accident trajectory and assemble the contributing factors. Park et al. [5] developed accident scenario models for the risk assessment of railway casualty accidents by identifying hazardous events and hazardous factors by gathering various accident reports and information. Kwak [6] conducted a comparative study on railway accident statistics and various transportation modes and demonstrated that the results of this research can be used for the determination of weak areas of railway safety and the level of safety to be achieved. Hua et al. [7] used text mining and natural language process (NLP) techniques to analyse railway accident reports. Lam & Tai [8] proposed a network analytical framework to identify the factors and effects of railway incidents. Belmonte et al. [9] presented an application of functional resonance accident models (FRAM) for the safety analysis. Klockner & Toft [10] was interested in using the CFF to model the previously unseen non-linear network interactions. Yu et al. [11] proposed the Cognitive Reliability and Error Analysis Method - Railway Accidents (CREAM-RAs) taxonomy framework was proposed to classify human, technology, and organization factors in railway accidents. Liu et al. [12] established a fault tree logic diagram based on a high-speed railway accident. Marsh & Bearfield [13] described a method of modelling organizational causes of accidents, using Bayesian Networks. Y. Wang et al. [14] applied the cusp catastrophe model to describe the dynamic changing process of railway system safety.

Also, due to transport restrictions put in place to mitigate the pandemic, commercial road transport, both passenger and goods, has been severely impacted by COVID-19 and it also contributed to the accident patterns and casualties of railway related accidents. In March 2020, the virus was reported as having spread to Bangladesh IEDCR announced the first 3 (three) identified cases on 8 March 2020. Since then, the pandemic has spread day by day over the whole nation and the number of affected people has been increasing which is shown in fig.1. So, it's very important to investigate the influence and effect of COVID-19 on railway accidents.

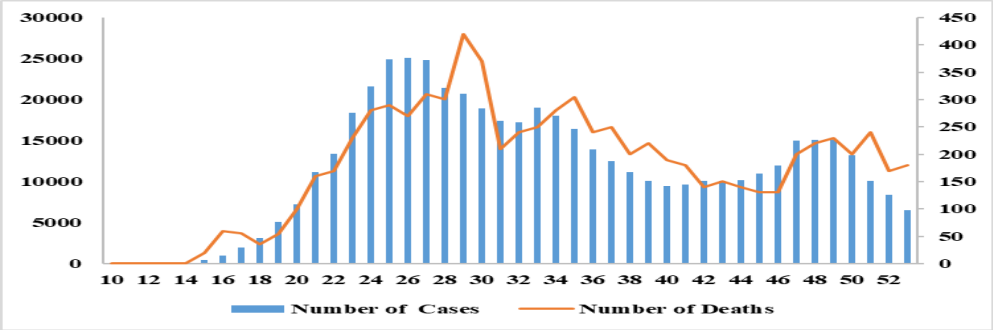

Fig. 1: Number of cases and deaths of COVID-19 from March 8, 2020 to December 31, 2020.

Also, Various researcher tried to investigate the effect of pandemic on railway accident such as Naweed et al. [15] gave recommendations regarding how the Human Factors and Ergonomics discipline can support safe and effective rail operations in the context of widespread crises such as pandemics. Tan et al. [16] tried to understand whether commuters will take rail transit during the COVID-19 pandemic and constructed a logistic regression model based on 559 valid questionnaires Wiseman [17] stated that the current COVID-19 pandemic has discouraged many people from travelling

by trains and travelling in crowded trains will be a worrisome choice for a substantial portion of the population even when a COVID-19 vaccine is available. Bagotia [18] stated that the Indian Railways being an essential part in the economy, the national and international economy will bear the impact of the COVID-19 pandemic because of the deceleration of growth in center sectors of economy and concluded that the financial impact of this pandemic will wait any longer than the pandemic itself. Bevsinovi'c [19] showed that at most 50% of the pre-covid19 demand can be transported, while most of the trains will be highly utilized reaching their maximum occupation. Alawad [20] stated that the rail industry has been severely affected by the COVID-19 pandemic, as passengers tend to stay away from the trains.

3. Results and Discussions

In this study, the logistic analysis of before-after effects of COVID-19 on the railways accident patterns and severity are presented along with hotspot analysis using ArcGIS. and the overall findings from this study is summarized in table 1.

Table 1: Summary of Railway Accidents Before and After COVID-19

Criteria	Before COVID-19 (May14,19-Mar7,20)	After COVID-19 (Mar8,20-Dec31,20)
No. of Accident	198	99
No. of Fatality	209	120
No. of Injury	442	31
No. of Casualty	651	151

3.1. Logistic and Hotspot Analysis

From fig.2&3, the various types of railway accidents occurred along with number of accidents and fatalities are demonstrated for 299 days period before and after COVID-19 pandemic. Before and after pandemic situation, the primary reason of accident occurrence is hitting pedestrian and the next highest percentage belongs to rear end type of accidents. Collision, head on, derailment, losing control, fire accidents and falling from vehicles are also responsible for significant amounts of accidents. The highest number of accidents and fatalities belongs to hitting pedestrian type of accident and number of accidents occurred because of rear end collision is significantly lower than the other one. It can be said that, the variation of type of accidents and fatalities lowered significantly before and after COVID-19. Before pandemic, the type of accidents is more than 14 but during and after the pandemic the variety reduced to only 6types. But the prevailing accident type remained unchanged before and after the pandemic.

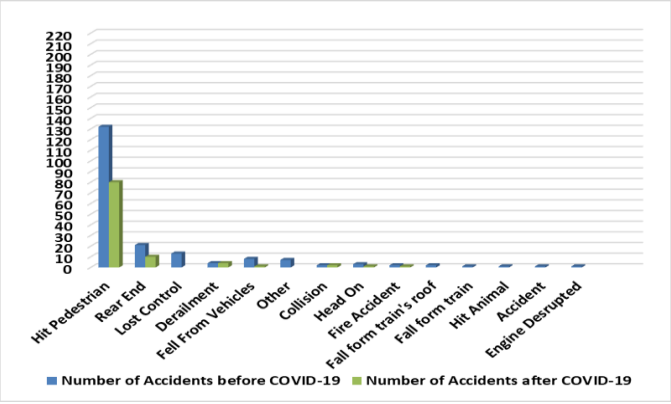

Fig. 2: Number of accidents in relation with different type of railway accident before and after COVID-19.

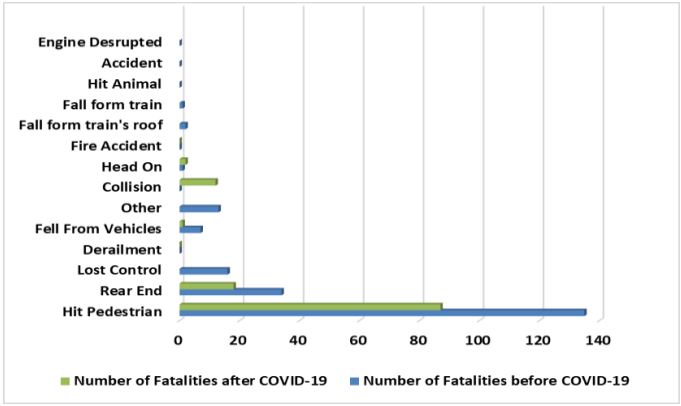

Fig. 3: Number of fatalities in relation with different type of railway accident before and after COVID-19.

Also, during the lockdown period which was from 26 March,20 to 30 May,20, only 4 accidents had been occurred because of rear end collision, hitting pedestrian and fire accidents and 4 were killed and 2 were injured by accident that been occurred at the level crossing zone because of rear end collision involved 2 vehicles, train and auto rickshaw and other 2 were killed involving pedestrian and fire accidents.

Fig.4 represents number of accident and fatality with respect to the time of the day 299 days period before and after COVID-19 pandemic. Before and after the pandemic, the number of accident and fatality both are highest for those type accidents that had been occurred during the day time and the second highest position belongs to the night-time accidents and very little percentage of accidents data are not reported along with their occurrence time along the day but the total number of accidents and fatalities are much lower than before pandemic situation. Also, during the lockdown period which was from 26 March,20 to 30 May,20, 2 accidents had been occurred at the day time in which 4 were killed and 2 were injured.

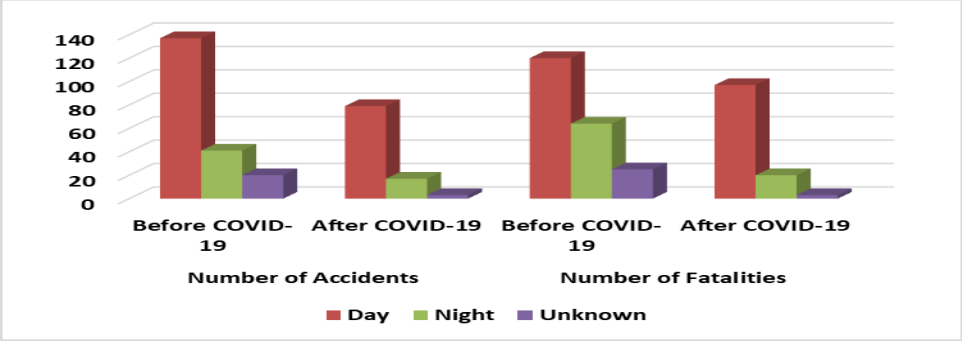

Fig. 4: Number of accidents and fatalities in relation with the time of the day before and after COVID-19.

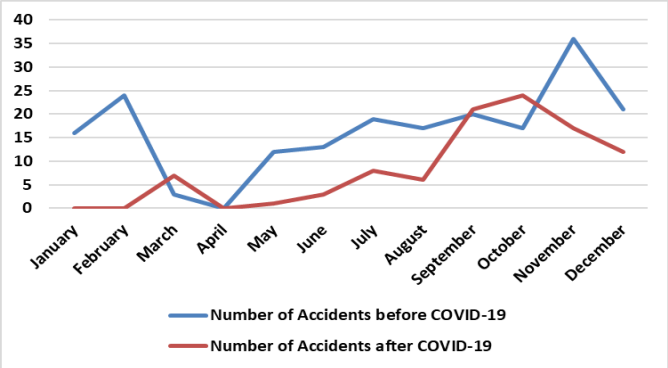

Fig. 5: Number of accidents in relation with different months before and after COVID-19.

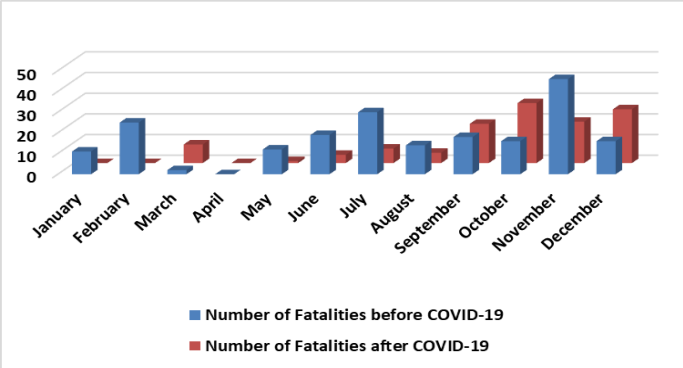

Fig. 6: Number of fatalities in relation with different months before and after COVID-19.

Fig. 5 and Fig. 6 show that the number of accident and fatality with respect to the time of the day 299 days period before and after COVID-19 pandemic. Before pandemic, the number of accident and fatality both are lowest for the month of March and then increased with the following months and found highest for the month of November. It can be also noticed that no data were reported during the month of April. After the pandemic, the number of accidents and fatalities both are highest for the month of October and from March to July the number of accidents and fatalities decreased significantly as the government declared lockdown and the movements of people became restricted. The bar exhibits that the number of fatalities and accidents were pretty high during October, November and December. It can be said that, the number of accidents and fatalities lowered significantly before and after COVID-19 throughout different months. Also, during the lockdown period

which was from 26 March,20 to 30 May,20, only 4 accidents had been occurred in which 6 were killed and 2 were injured and it is also the lowest during the full year of pandemic.

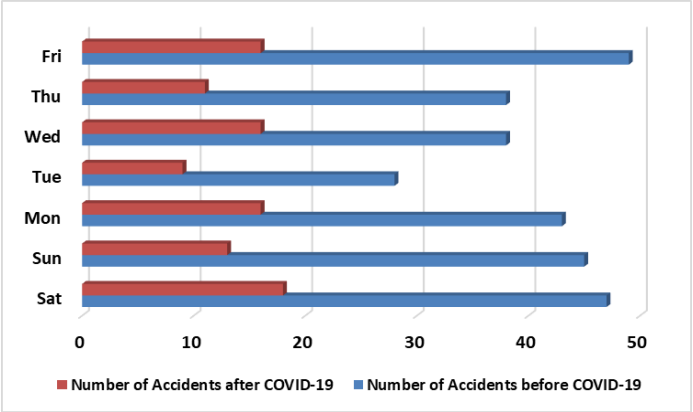

Fig.7: Number of accidents in relation with different days before and after COVID-19.

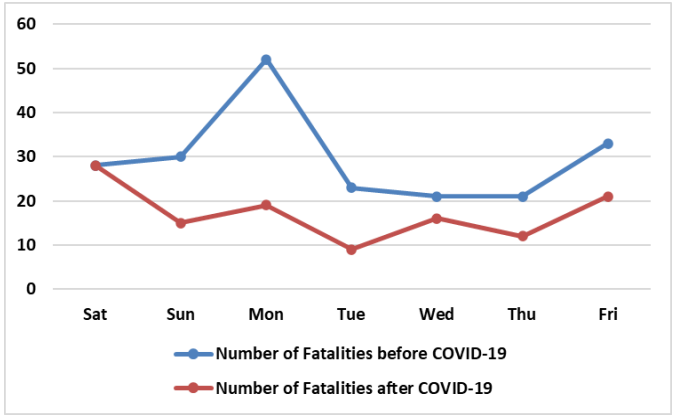

Fig. 8: Number of fatalities in relation with different days before and after COVID-19.

Fig. 7&8 represents the number of accidents and fatalities with respect to different weekdays for 299 days period before and after COVID-19 pandemic. The bar chart shows that the number of accidents is highest on Friday whereas the number of fatalities is highest on Monday. The number of accidents and fatalities both are found lowest on Tuesday before the pandemic. It is noticed that the accidents during the pandemic the number of accidents and fatalities both is highest on Saturday whereas the number of accidents and fatalities both are found lowest on Tuesday. The number of accidents and fatality found much lower before and after COVID-19 throughout different weekdays. Also, during the lockdown period which was from 26 March,20 to 30 May,20, 4 accidents had been occurred which is on Sunday and Monday.

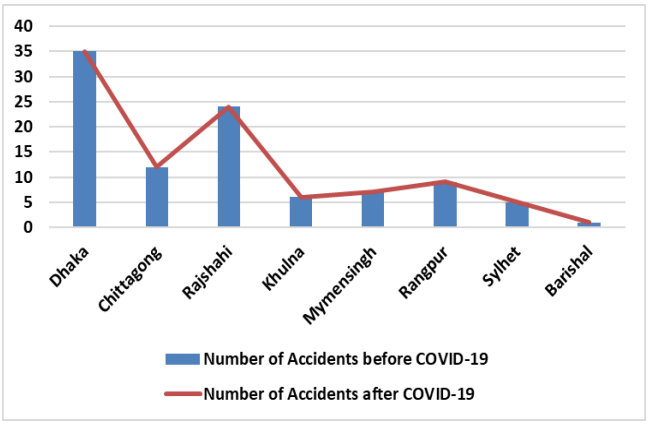

Fig. 9: Number of accidents in relation with different divisions before and after COVID-19.

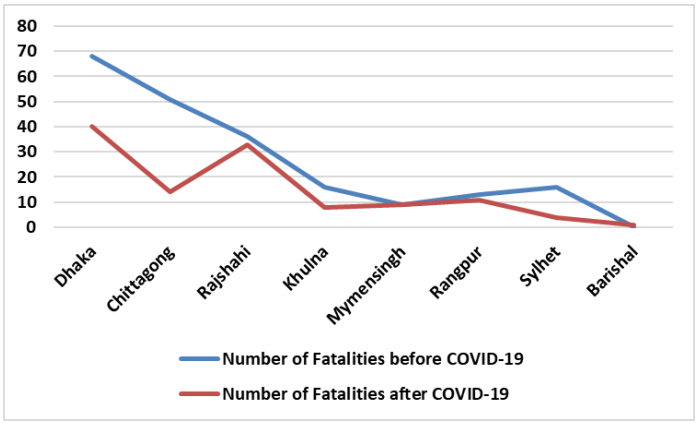

Fig. 10: Number of fatalities in relation with different divisions before and after COVID-19.

Fig. 9&10 represents the railway accident data for all the 8 divisions represents the variation between the number of accidents and fatalities with respect to different districts and divisions for 299 days period before and after COVID-19 pandemic. Before and after pandemic, it is noticed that the highest number of accidents occurred in Dhaka division which is also the same for the highest amounts of fatalities. The lowest number of accidents and fatalities are found in Sylhet division. No accidents had been occurred at Barishal division before pandemic. The lowest number of accidents and fatalities are

found in Barishal division after pandemic. It can be said that, there is a significant drop in the number of accidents and fatalities between different divisions before and after the pandemic as the government declared lockdown and the movements of people became restricted. Also, during the lockdown period which was from 26 March,20 to 30 May,20, 4 accidents had been occurred in 4 different divisions under the districts such as Rangpur, Gopalganj, Comilla, Gazipur.

The hotspot of accidents is shown in fig.11 using ArcGIS with respect to number and severity of accidents occurred in different districts before and after COVID-19. Dhaka is the district in which the highest amounts of accidents had been occurred before and after the pandemic which is 21 and 14. From the plot, it can be seen that the severity of accidents is much lower after the COVID-19 situation.

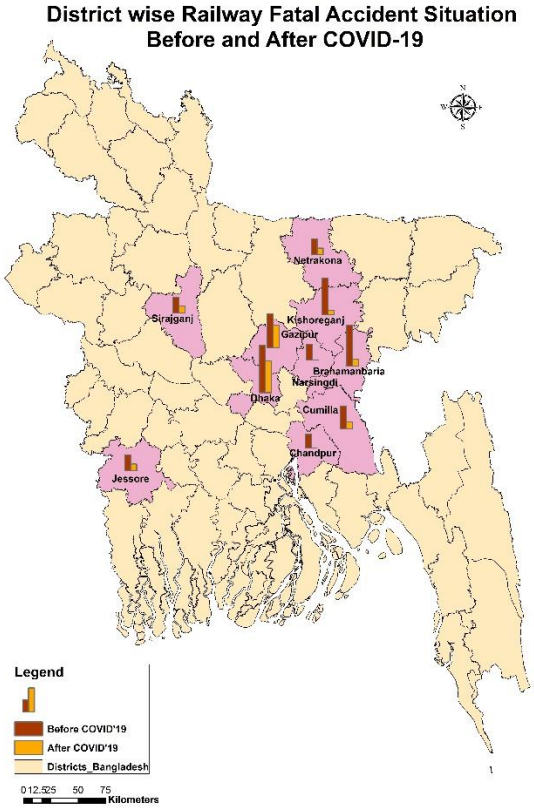

Fig. 11: Number of Accidents in relation with different districts before and after COVID-19.

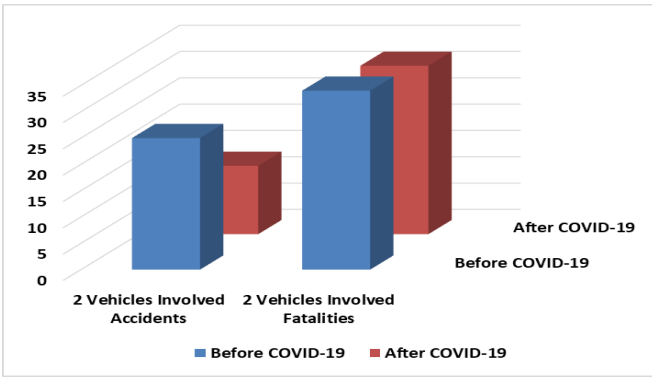

Fig. 12: Number of accidents and fatalities involving 2 vehicles before and after COVID-19.

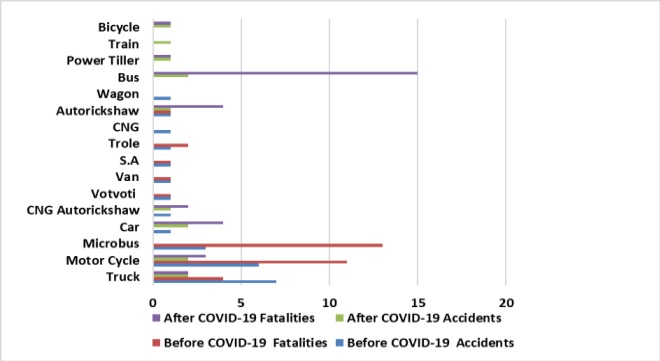

Fig. 13: Number of accidents and fatalities involving 2 vehicles corresponding various type of vehicles before and after COVID-19.

Fig. 12&13 represents the number of accidents and fatalities involving 2 vehicles for 299 days period before and after COVID-19 pandemic. The number of accidents and fatalities both are found pretty high before the pandemic situation. 14 types of vehicles were involved in accidents and Truck is responsible for most of the accidents and motorcycle is responsible for the second highest. Although bus and microbus are not responsible for many accidents but the severity of accidents and the number of fatalities involving microbus is extremely high and the number of fatalities involving motorcycle is second highest in the position. But after pandemic, less types of vehicles involved in accidents. accident involving 2 vehicles and the number of accidents is not very significant in comparison to before pandemic but the number of fatalities involving bus is pretty high. Also, during the lockdown period which was from 26 March,20 to 30 May,20, 4 accidents had been occurred in which 1 accident happened at the level crossing zone involving train and autorickshaw during which 4 people were killed and 2 were injured.

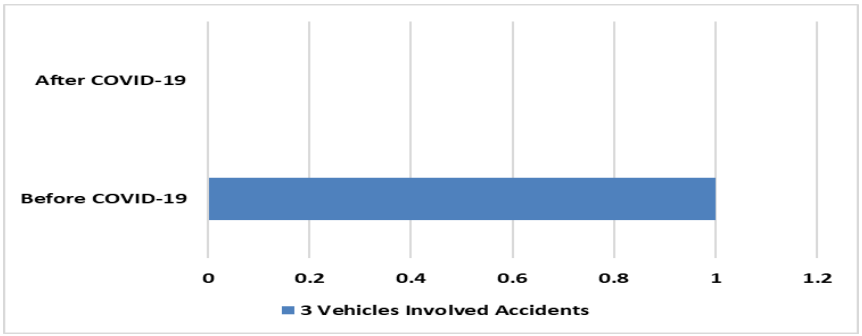

Fig. 14: Number of accidents involving 3 vehicles before and after COVID-19.

Fig. 14 represents the number of accidents and fatalities involving 3 vehicles for 299 days period before and after COVID'19 pandemic. It is noticed that only rickshaw is involved in accident involving 3 vehicles and the number of accidents is only found to be 1 but there were no fatalities occurred before the pandemic involving 3 vehicles. Also, no accidents involving 3 vehicles were occurred after the pandemic situation and during lockdown period.

4. Conclusion

The total scenario of railway accidents before and after the pandemic situation summarized that the total number of accidents, casualties and fatalities reduced significantly after pandemic situation. The descriptive statistics of the data shows that the railway accidents decreased by 50% in after pandemic situation, comparing to before COVID-19 data and casualty subsuming fatalities, injuries of people decreased by 76.8%. The logistic analysis clearly demonstrates the trend of accident patterns before and after the pandemic situation which gives a clear idea about the severity of railway accidents and before-

after effects of COVID-19 on the railway accident patterns which indicates that the number and severity both decreased after the pandemic situation mainly due to restrictive movements.

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