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Analyzing Road Accidents and Prevention: Engineering Solutions and Geopolitical Implications for National Security

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Abstract | **Original Research Article**

Road accidents, even with construction of the best possible roads and intersections cannot be fully avoided. But the effects of these accidents on road users and vehicles can be minimized with proper measures. The purpose of this study is to examine the main causes of road accidents in Bangladesh and to come up with preventive measures for the improvement of road safety. Data from the Bangladesh Road Transport Authority (BRTA), the Roads and Highways Department (RHD), the Welfare Association of Bangladesh, and the Accident Reports Forms (ARF) were used for this research, applying GIS tools. During the period from 2020 to 2024, 30,514 accidents took place in Bangladesh. In Bangladesh, road safety is a major concern, with a high level of fatalities and injuries resulting from road accidents. Worldwide, road accidents claim about 1.35 million lives each year, and young people, particularly pedestrians, cyclists, and motorcyclists, are the most affected. In Bangladesh, a disproportionately high number of road accidents take place, and human behavior and vehicle condition are major factors. The traffic department and the Government have a significant role to play in identifying reckless driving speeding, and overloading of vehicles, and government and citizens alike have a key role to play in ensuring road safety as well. Further, road accidents have significant geopolitical and national security implications, as they disrupt transportation systems, compromise emergency response, and introduce weaknesses in critical infrastructure. During a time of national emergency or geopolitical crisis, poorly performing road systems compounded by accidents could compromise military readiness, border security, and the nation's overall resilience. Thus, enhancing road safety measures is not only crucial to protecting lives but also to protecting national security and regional stability.

Keywords: Road accident, Accident prevention strategy, Engineering Solutions, Geopolitical Implications for National Security.

INTRODUCTION

1. Road safety is a major issue in Bangladesh, as a large number of individuals lose their lives or are severely injured in road accidents every day. Road accidents are one of the most wanted and unpredictable dangerous incidents that road users can experience. Worldwide, road accidents have become a major societal problem, increasing at a high rate.

2. Annually, an estimated 1.35 million individuals lose their lives as a consequence of road accidents, with the highest death rates being among the 15 to 29 years age group. Pedestrians, cyclists, and motorcyclists are at most risk of these deaths, particularly in developing countries, as noted by the World Health Organization (WHO, 2018b). According to Odgen (1996), road accidents result in half a million fatalities every year, and a further 10 to 15 million people are injured. The severity of accidents resulting from road traffic injury has been well documented in the literature (Odero *et al.,* 1997; Ratanavaraha & Saungka, 2014; Shankar *et al.,* 1996). A study by Biswas *et al.,* (2022) shows that nearly 90% of road accident take place in developing countries, reflecting a disproportionately high rate of accidents in these nations. One of the aims of the Sustainable Development Goals (SDGs) has been to compare the loss of lives and injuries resulting from road accidents between 2015 and 2020, as suggested by WHO (2015), following the increasing trend of road accidents globally. Zafri *et al.,* (2020) point out that, as a developing nation, Bangladesh is one of the most unsafe countries in the world as far as road crashes are concerned. The nation has faced a troubling increase in road accidents in recent years. WHO (2022) shows that pedestrians are the most vulnerable group of road users,

making up approximately 23% of all road deaths. In Addition, Hasib *et al.,* (2020) noted that the death rate due to motor vehicles in Bangladesh ranged between 30 and 60 fatalities per 10,000 vehicles. Nonetheless, the real number of deaths is likely to exceed officially documented statistics. Some research has examined the fatality rate of road traffic crashes in Bangladesh. For example, Islam and Dinar (2021) determined the major causes and geographical distribution of road crashes through qualitative and semi quantitative approaches. Rahman *et al.,* (2021) applies a binary logistic regression model in identifying key factors that significantly contribute to fatal motorcycle crashes in Bangladesh. Hossain and Zaman (2021) investigated the factors that affect the severity of road accidents in Khulna city based on a binomial logistic regression model, whereas Hossain *et al.,* (2023) applied text data mining methods in identifying crash contribution factors and patterns of fatal truck crashes in Bangladesh.

3. Although completely eliminating road accidents is unrealistic, their impact can be mitigated through appropriate measures. Therefore, policymakers must analyze the underlying causes of road accidents to formulate effective interventions. While human, physical, and environmental factors contribute to road accidents, not all are equally significant. Thus, identifying the most critical causes of accidents is essential to developing targeted preventive strategies. This study aims to investigate the key factors responsible for road accidents in Bangladesh and propose preventive measures to reduce their occurrence.

4. Beyond public health and economic losses, road accidents also pose indirect yet serious threats to national security and regional stability. Repeated disruptions in road networks can obstruct the transportation of essential goods, medical supplies, and emergency personnel, thereby weakening national disaster preparedness and civil defense mechanisms. Moreover, insecure road systems jeopardize the smooth implementation of regional connectivity projects like the Belt and Road Initiative (BRI) and the BBIN Motor Vehicles Agreement, which are crucial for economic integration and strategic positioning in South Asia. In fragile geopolitical contexts, road safety failures can erode trust, strain military logistics, and expose vulnerabilities in national infrastructure, ultimately undermining Bangladesh's security posture (Haq et al; 2019; Rahman & Siddique, 2021). Hence, improving road safety is not only a public safety imperative but also a strategic necessity for maintaining national resilience and geopolitical leverage.

LITERATURE REVIEW

5. A review of the literature was carried out before starting the accident investigation. Bangladesh has a particularly high road fatality rate relative to other countries. To understand this phenomenon, it necessary to examine three major contributing factors: environment conditions, driver behavior, and vehicle condition (Rahman *et al.,* 2017). Road accidents in 2022 killed 9,652 people, according to official statistics from the Bangladesh Road Transport Authority (BRTA) (Bangladesh Road Transport Authority, 2022). Poor maintenance of roads, such as potholes, uneven surfaces, and a lack of proper lighting, results in hazardous conditions that affect visibility and control, making accidents more likely. Furthermore, the large number of roadworthy vehicles with defective brakes, malfunctioning steering, and worn-out tires constitutes a critical risk to road safety (World Health Organization, 2018).

6. In response to traffic related deaths, BRTA has initiated a multi-pronged approach, including the development of road infrastructure by building, repairing, and adding essential safety elements like traffic signals. More stringent enforcement of traffic laws has also been put in place through increased police deployment on roads (Bangladesh Road Transport Authority, 2022). Bangladesh, in 2022, has witnessed more than 7,600 road accidents, 606 railway accidents, and 262 waterway accidents, which resulted in the deaths over 11,000 people and many injuries, according to the Passenger Welfare Association (Kabir & Nurul, 2023).

7. The road accident effect in 2022 was dire, with 10,858 deaths, comprising 2,804 transport workers, 666 students, and 114 police officers, among others from different professional and political backgrounds. Motorcycle were responsible for almost 29% of accidents, followed by trucks, pickups, and vans at 24%. Buses were responsible for 14% of accidents, while battery powered rickshaws and easy bikes constituted 11%. Tractors were responsible for 8%, CNG auto rickshaws for 6%, and cars, jeeps and microbuses altogether accounted for 7% of accidents (Kabir & Nurul, 2023).

OBJECTIVE

8. The main objective was to identify road accidents and accident prevention strategies in Bangladesh, with attention to their implications for geopolitics and national security.

METHODOLOGY & MATERIALS

9. MATERIALS

This study is based on secondary data sources, with information collected from various newspaper and annual reports from the transportation authority. The data were obtained from the Bangladesh Road Transport Authority (BRTA), Roads and High ways Department (RHD), Welfare Association and of Bangladesh and the Accident Report Forms (ARF) and followed by the creation of maps using Geographic information System (GIS) in Bangladesh. It is important to note that many accidents go unreported, meaning the actual number of incidents is likely higher than the registered figure.

10. STUDY AREA

Bangladesh, a developing country in South Asia, covers a total area of 1,47,570 sq. km and has a population of approximately 174.6 million, ranking 8th in the world (Worldometer, 2025). Road accidents are one of the leading causes of death in the country (Khatun *et al.,* 2024) (Figure-1). The total length of the road in Bangladesh is approximately 3,75,000 km, including National Highways, Regional Highways, and Zilla Roads (World Highways, 2022).

11. METHOD

Data from the last 5 years (2020-2024) were collected from various secondary sources. Both qualitative and semi quantitative methods were employed to interpret the statistical data. The study focused on road categories and accident-related factors as key variables for analysis. Trends in road accidents were examined to identify the primary causes and safety concerns. The study employs a theoretical framework aimed at improving road safety and reducing accidents rates in Bangladesh.

Major causes of road accidents:

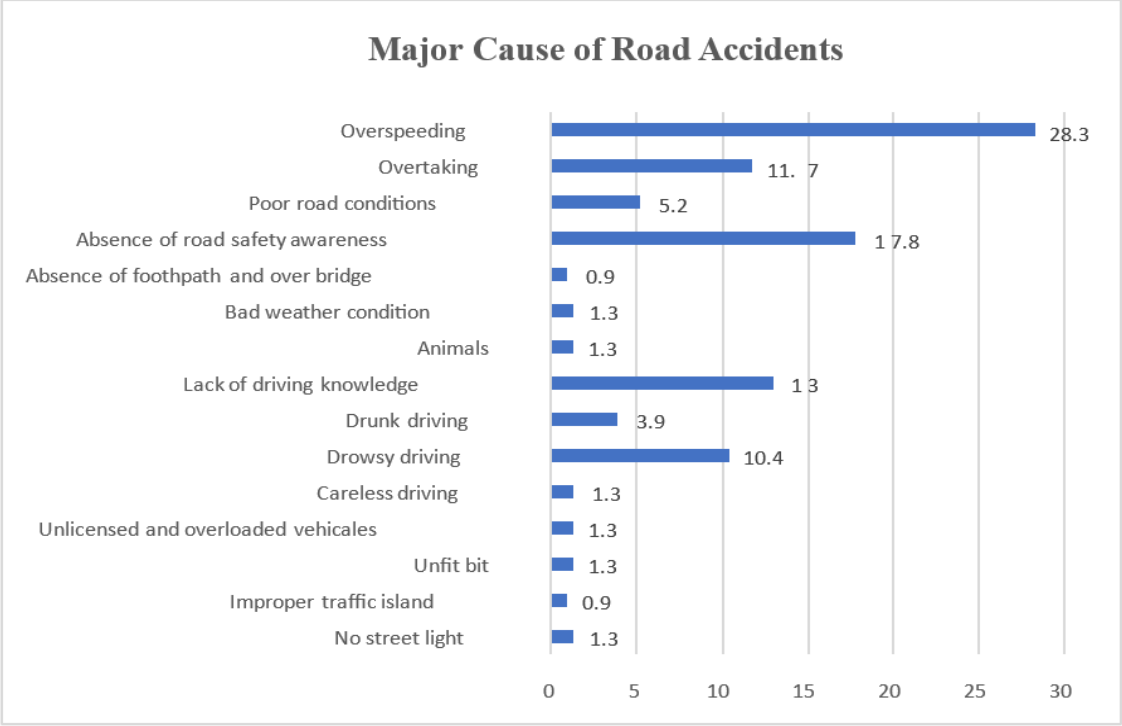


Figure-1

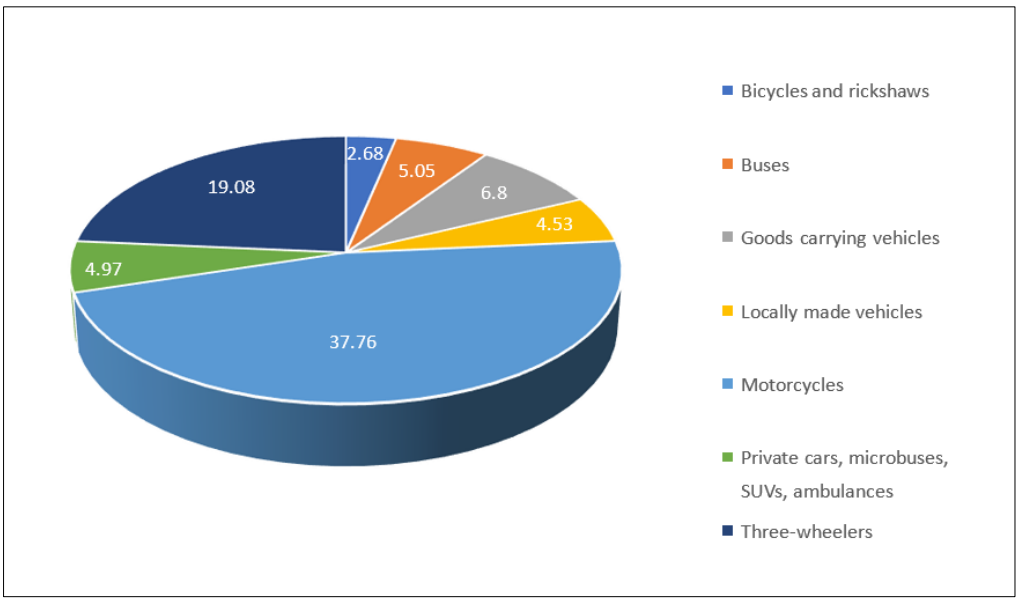
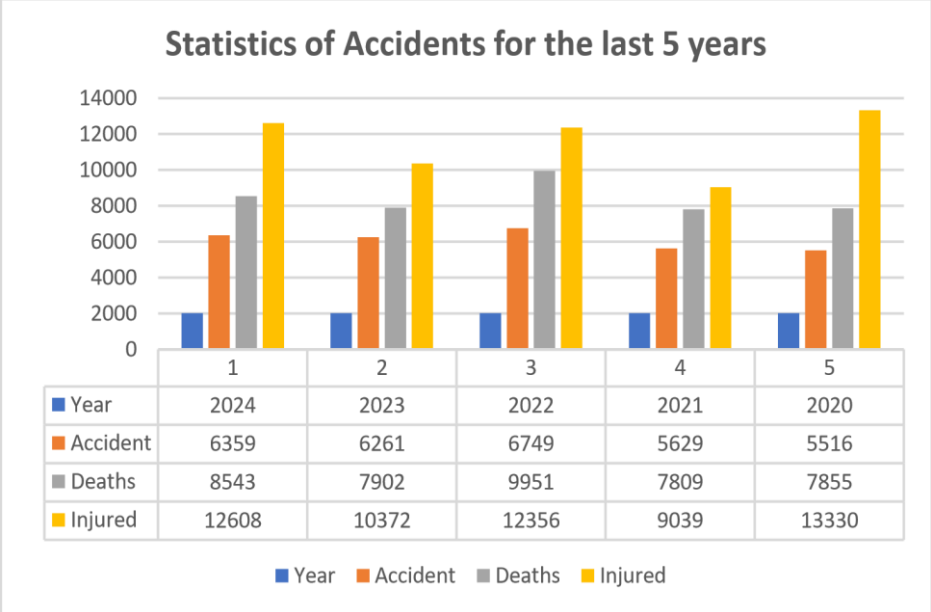


Figure-2

Type of vehicle contributing in accident:

Statistics of Accidents for the last 5 years:



	1	2	3	4	5
Year	2024	2023	2022	2021	2020
Accident	6359	6261	6749	5629	5516
Deaths	8543	7902	9951	7809	7855
Injured	12608	10372	12356	9039	13330

Figure-3

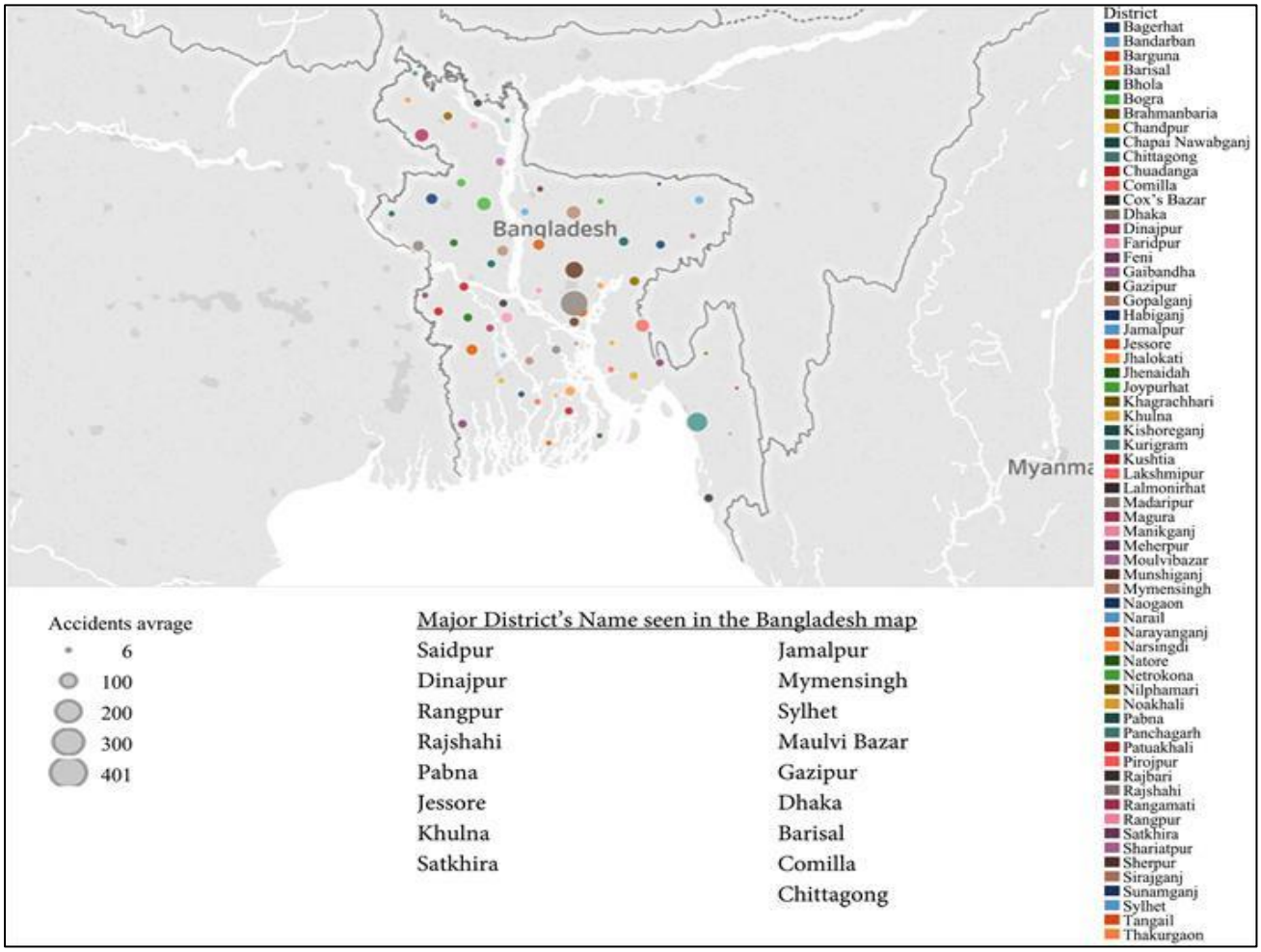


Figure-4

Mapping of average number of road accidents in Bangladesh:

Geopolitical implications for National Security:

12. Bangladesh's road safety is not just and issue of public health and infrastructure but one with extensive geopolitical ramifications. Being a strategically placed nation in South Asia, the transport infrastructure of Bangladesh is pivotal to regional connectivity schemes like the BBIN Motor Vehicle Agreement, the BIMSTEC Transport Connectivity program, and the Belt and Road Initiative (BRI). The frequent of road accidents, especially on national and regional highways, derails trade corridors, discourages foreign investor confidence, and undermines the nation's strategic positioning in cross-border economic in collaboration (Siddiqui et al 2019).

13. Moreover, in the context of national security, inadequate road infrastructure can hinder military mobility, emergency disaster response, and law enforcement operations, particularly in border and coastal areas. Poor surveillance and unsafe roads in rural border zones can also be exploited for illegal trafficking and smuggling, posing additional risks to internal security (Rahman & Haque, 2022). By investing in smart traffic systems, improving rural connectivity, and strengthening road monitoring technologies, Bangladesh can enhance both its transportation safety and its national defense readiness.

Prevention Strategies for Road Accidents in Bangladesh

14. **Integration of Advanced Road Design Techniques**

The network in Bangladesh requires significant improvements in design to enhance safety. Authorities must ensure proper planning that includes safe curves, well designed banking on slopes, and elevated pedestrian crossing. Divided highways and express lanes should be implemented in accident prone areas to prevent head on collisions. The construction of strong median barriers and guardrails can also help reduce severe crashes.

15. **Upgrading Road Signage and Visibility**

Currently, many roads lack proper traffic signs, making navigation difficult, especially at night. High visibility, glow in the dark signage and retro reflective road markings should be introduced in accident prone zones. Additionally, digital electronic sign boards displaying real time traffic updates, speed limits, and hazard warnings should be installed on highways and urban roads to improve driver awareness.

16. **Implementation of Smart Traffic Management Systems**

The majority of the intersections in Bangladesh are controlled manually by police personnel, which causes jam and confusion. For the sake of efficiency, there should be an adaptive traffic signal system installed that has the capability to change signal timings in accordance with the real time density of vehicles. Red light cameras should also be installed at key intersections to discourage violations and enhance adherence to traffic regulations.

17. **Enhancing Highway Safety measures.**

In order to counter the dangers that come with traveling on highways, the authorities should provide weigh stations at strategic locations of check overloaded trucks, which are usually responsible for damaging roads and causing brake failures. Overpasses for pedestrians should also be built at high traffic areas to avert accidents that occur when pedestrians try to cross busy highways.

18. **Rural Road and Bridge Infrastructure Development**

Many rural roads in Bangladesh are unpaved or poorly maintained, increasing the risk of accidents due to skidding and potholes. The government should invest in asphalt or concrete pavement for rural roads, along with proper drainage systems to prevent waterlogging. In flood prone areas, elevated bridges should be constructed to ensure uninterrupted connectivity.

19. **Public Awareness and Community Based Education**

Raising awareness is crucial in improving road safety. A community based road safety program should be introduced at the municipal level, where people are educated about traffic rules, pedestrian safety, and the consequences of reckless driving. Workshop in schools should also be initiated to familiarize children with traffic rules from an early age, ensuring better safety habits as they grow.

20. **Alternative Transport Solutions and Traffic Reduction Measures**

In order to minimize congestion and accident, exclusive bike lanes and public transportation priority roads must be created. Metro and railway network expansion may also effectively minimize the use of private vehicles, thereby reducing traffic volume and accident susceptibility.

21. **Strict Enforcement of Speed Control Measures**

Speeding is a major cause of road accidents in Bangladesh. To address this issue speed breakers and rumble strips should be placed in school zones, hospitals, and residential areas to slow down vehicles. Moreover, GPS based speed limiters should be installed in public buses and trucks to ensure compliance with speed limits, reducing reckless driving.

CONCLUSION

22. Road traffic accidents have been a major concern, with the number of fatalities growing at an alarming level. The trend is getting worse, especially in developing nations, and Bangladesh has been one of the worst-hit countries over the past few years. Reckless driving, speeding, and overloading of vehicles account

for up to 90% of all road accidents. Most occur within city centers and along highways, where traffic jams and bad road conditions further worsen the situation. Aside from the direct loss of life, road accidents have a large economic impact, especially on low- and middle-income households, who find it difficult to manage medical bills and loss of income. The victims are usually responsible earning members of their households, impacting directly not just household stability but also the economy of the country. Furthermore, the deteriorating road safety scenario has broader implications for geopolitics and national security, as critical transportation infrastructure becomes vulnerable to disruptions that can affect trade routes, emergency responses, and cross-border mobility. To ensure sustainable road safety, a multi-stakeholder effort, which includes government agencies, engineers, law enforcement agencies, and members of the community, is needed. By incorporating modern technologies and stringent regulation measures, Bangladesh can transition towards a more efficient transportation system that is safe, eventually lowering fatalities and enhancing overall road safety.

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