A REVIEW ON SELECTED ASPECTS OF ROAD TRAFFIC ACCIDENTS UNDER THE JURISDICTION OF WEST BENGAL POLICE AREA WITH SPECIAL EMPHASIS ON NORTH TWENTY FOUR PARGANAS DISTRICT

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Abstract: Road traffic accidents occupy a significant place in the management practices of road transport system. The present study primarily focuses on intensity of road traffic accidents, accident fatality rate, their spatial and temporal variation, impact of road manoeuvering, age-sex composition of drivers and passengers died and road user category experiencing death in West Bengal police area and several other perspectives of road traffic accidents with respect to different police commissionerate and police district area of North Twenty Four Parganas district. Field surveys have been conducted upon 500 eyewitnesses and with personnel in-charge of various police stations under different police commissionerates and police districts of North Twenty Four Parganas district to identify outcome of different aspects of road traffic accidents. Accident Severity Index (ASI) and Accidental Fatality Risk (AFR) provide scenario of intensity of road accidents over the years. Spearman's rank correlation coefficient (R_s) comprises relation between death (fatality) and injury of road accidents at different manoeuverings. Bi-variate correlation analysis has been performed to determine whether fatality and injury of road crashes are independent of different types of places of crash occurrence in North Twenty Four Parganas district. Map has been constructed to identify accident black spots detected in different types of roads across North Twenty Four Parganas district. The study emphatically reveals that fault of drivers of motor vehicles is most serious cause of road accidents and economically active age group of drivers specially males are subject to more fatality. These accidents can be controlled by enforcing speed regulations and adopting other mitigatory measures.

Index Terms- Road accident, Manoeuvring, ASI, AFR, Fatality

I. INTRODUCTION

Road traffic crashes are being widely recognized as a research area of transportation planning since it affects mortality and morbidity of the population and involves economic consideration all over the globe. Road traffic injuries rank as the eighth leading cause of death globally and the present situation implies that by 2030 road traffic deaths will be identified as fifth principal cause of death unless suitable safety measures are adopted (Biswas et al., 2015).

Traffic accident studies in India and more specifically under the jurisdiction of West Bengal police area is important because both the region experience tremendous pressure of population in association with great deal of economic activities and the direct relation between economic development and motorization has made the discussion more relevant. Road accident fatalities in India have soared up at the rate of 5% per annum with respect to annual population growth rate of 1.4% (Singh, 2017). During the year 2015, top 13 states of India accounted for 86.7% of total number of road accidents and 83.6% of total accident fatalities of which West Bengal occupies a significant population with a share of 2.6% and 4.3% respectively. Among the metropolitan cities of India Kolkata ranks fifth in terms of occurrence of road crashes and eighth in terms of injuries with a gross figure of 4104 and 3182 respectively [Ministry of Road Transport and Highways (MoRTH), 2015].

Road traffic accidents are responsible for traffic congestion in streets (Retallack and Ostendorf, 2019). Different types of factors responsible for occurrence of road crashes are broadly classified into four categories such as human behavioural parameters, condition of road inhibiting free flow of traffic, environmental parameters such as incessant rain, mist, fog etc., and vehicular fault such broken tyre, overloading etc. (Subramanian, 2012). Despite improvement in road infrastructure throughout India over the years, road safety is still met without proper attention. With travel for work, education, health care and leisure activities becoming priority for people, India has witnessed unprecedented vehicular growth over the last two decades. Vehicular density has increased from 2.8 vehicles per Km to 31 vehicles per Km between 2000 and 2011 (Gururaj and Gautham, 2017). Incentivizing private vehicles at the cost of public transport segment has made the situation worse.

The study aims to highlight intensity of road traffic accidents, temporal variation of occurrence of road accidents, types of vehicles affected by road accidents, causes of accidents, impact of road manoeuvering, share of persons died by sexual composition and driver-passenger segment in West Bengal police area. Accident black spots identified in different National Highways, State Highways and other roads, and human casualties in relation to road crashes occurred at different types of places are also highlighted with respect to different police commissionerate and police district zone of North Twenty Four Parganas district.

II. METHODOLOGY

The methodology section describes the approach by which the study is conducted, and therefore it incorporates sample size of the study, sources of data, statistical techniques applied and else other.

2.1. Sample Size of the Study

Field surveys have been conducted by interacting with on-duty officers at five police stations under Barrackpore police commissionerate, three police stations under Bidhannagar police commissionerate, and four police stations each under Barasat police district and Basirhat police district respectively to find out the vehicles/objects involved in road accidents and consequent fatalities and injuries recorded. 100 inhabitants or frequent road users under each of the four police commissionerate and police district of North Twenty Four Parganas district who have sometimes witnessed or experienced road accidents and family members of another 100 affected persons from different places of the study area have been interviewed to determine impact of road manoeuvring in fatalities and injuries, sexual composition of persons died with respect to road user category, and share of drivers and passengers death on account of road crashes.

2.2. Data and Source of Data

Secondary database has been collected mainly from the publications and reports prepared by Ministry of Road Transport and Highways [MoRTH], Government of India (2018, 2019); Ministry of Statistics and Programme Implementation [MoSPI] (2018, 2019); West Bengal Traffic Police (2019); Transport Department, Government of West Bengal (2020) to collect information about frequency of road accidents and accidental deaths over the years, temporal variation of road accidents, causes of road accidents in West Bengal police area, accident black spots detected, types of road crashes and occurrence of road accidents in different types of places in North Twenty Four Parganas district respectively.

2.3. Statistical Techniques and Map Construction

Accident Severity Index (ASI) and Accidental Fatality Risk (AFR) for the years 2015 to 2019 [World Health Organization (WHO), 2012] has been calculated as under:

$$Accident\ Severity\ Index\ (ASI) = Persons\ Died \div 100\ Accident \qquad (1)$$
$$Accidental\ Fatality\ Risk\ (AFR) = Number\ of\ Accidental\ Deaths \div 100000\ Population \qquad (2)$$

Spearman's rank correlation coefficient (R_s) (Fisher, 1958) has been evaluated to examine the relationship between death and injury figure on account of road traffic accidents at different manoeuverings as under:
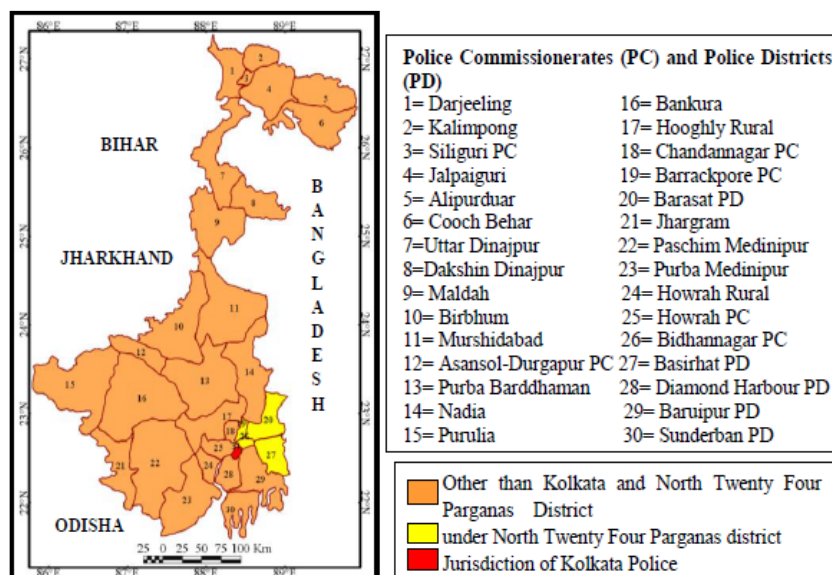
$$R_s = 1 - [6 \times \sum d^2 \div (n^3 - n)] \qquad (3)$$

where, d = difference between rank of variable x and variable y, x = died, y = injured, n = frequency of observation

Bi-variate correlation determines the impact of road accidents occurring in different types of places upon road accidental death and injury (Croxton et al., 1975) using SPSS software 25.0. Maps have been constructed to represent the spatial extension of different police districts and police commissionerate zones under the domain of West Bengal police area, and also to characterize the frequency of accident black spots in National Highways, State Highways and other roads across North Twenty Four Parganas district. The results of field survey and data recorded from other documents are also represented with the help of requisite tables and diagrams.

III. STUDY AREA

The West Bengal police area was constituted under the Police Act, 1861. The region consists of 22 districts having an areal coverage of 88647 sq Km (excluding metropolitan city of Kolkata) that belongs to the domain of Kolkata Metropolitan Area (KMA) and beyond the boundary of KMA (Census of India, 2011). The region extends between 85°50´E. and 89°50´E., and 21°38´N. and 27°10´N. (Ghosh, 2013).

Police Commissionerates (PC) and Police Districts (PD)

1= Darjeeling	16= Bankura
2= Kalimpong	17= Hooghly Rural
3= Siliguri PC	18= Chandannagar PC
4= Jalpaiguri	19= Barrackpore PC
5= Alipurduar	20= Barasat PD
6= Cooch Behar	21= Jhargram
7=Uttar Dinajpur	22= Paschim Medinipur
8=Dakshin Dinajpur	23= Purba Medinipur
9= Maldah	24= Howrah Rural
10= Birbhum	25= Howrah PC
11= Murshidabad	26= Bidhannagar PC
12= Asansol-Durgapur PC	27= Basirhat PD
13= Purba Barddhaman	28= Diamond Harbour PD
14= Nadia	29= Baruipur PD
15= Purulia	30= Sunderban PD

Other than Kolkata and North Twenty Four Parganas District
under North Twenty Four Parganas district
Jurisdiction of Kolkata Police

Source: www.mapsofindia.com (accessed on 17.06.2021)

Figure 1: Spatial extension of police commissionerate and police district zones under West Bengal police area

The region serves population strength of about 86779421 (Bureau of Applied Economics and Statistics, 2015). It has nine police ranges in three zones namely South Bengal zone, Western zone and North Bengal zone (West Bengal Police, 2018). It also comprises six police commissionerate area namely Barrackpore Police Commissionerate, Asansol-Durgapur Police Commissionerate, Howrah Police Commissionerate, Bidhannagar Police Commissionerate, Siliguri Police Commissionerate and Chandannagar Police Commissionerate and 24 other police districts including women and cyber crime branch in total. It is designed to work for the gendarmerie, local civilian police and secret police.

North Twenty Four Parganas district, located in the south-eastern part of West Bengal, is survied by two police commissionerate zones namely Bidhannagar and Barrackpore police commissionerate (combined area of both the zones is 415.84 sq Km) and two police districts namely Barasat and Basirhat police district (combined area of both jurisdiction is 3678.16 sq Km) [www.wbp.gov.in, accessed on 28.04.2021]. The district is characterized by triaxial development of road network, such that National Highway (NH) 34 extending towards North, NH 35 extending towards East and State Highway (SH) 2 extending towards East respectively (Datta and Sahu, 2021) connected by numerous arterial and sub-arterial avenues, and these facilitate huge pressure of traffic daily. Total number of public transport and goods transport vehicles plying across the district reaches the level of 157508 (NABARD, 2018).

IV. RESULTS AND DISCUSSION

4.1. Intensity of Road Traffic Accidents

Intensity of road traffic accidents examines density of accidental death with respect to population coverage or accident cases registered. In the present situation, Accident Severity Index (ASI) and Accidental Fatality Risk (AFR) in West Bengal police area for different years has been evaluated and presented in table 1 as under.

Table 1: Temporal Variation of Accident Severity Index and Accidental Fatality Risk in West Bengal Police Area

Year	Total Number of Accidents	Persons Died	ASI	AFR
2015	13208	6234	47.2	14.2
2016	13580	6544	48.19	14.5
2017	11631	5769	49.6	12.3
2018	12705	5711	44.95	6.0
2019	10158	5500	54.15	5.7

Based on: MoRTH (2019)

Table 1 represents that ASI is gradually rising upto the year of 2017 whereas AFR has experienced sharp decrease after 2016. This implies that although frequency of accidents and death of persons have declined after 2016 following the success of 'Safe Drive, Save Life' campaign initiated by Government of West Bengal, death rate has not diminished in due proportion of occurrence of accidents. Total population in West Bengal police area has recorded great increase which leads to a fall in AFR.

### 4.2. Temporal Variation in Occurrence of Road Traffic Accidents

Table 2 and figure 2 highlight daily occurrence pattern of road traffic accidents on average throughout the year and monthly occurrence pattern of road traffic accidents in different places of West Bengal police area.

Table 2: Monthly Variation of Total Number of Accidents, Persons Died and Injured in West Bengal Police Area in 2017

Months	Total Number of Accidents	Total Number of Persons Affected	
		Died	Injured
January	1083	581	913
February	993	479	827
March	1088	578	811
April	1010	489	919
May	1037	532	836
June	1036	485	888
July	892	406	964
August	819	391	806
September	922	453	847
October	920	466	764
November	942	472	709
December	889	446	817
Total	**11631**	**5778**	**10101**

Based on: MoRTH (2018)

Table 2 describes that maximum number of accidents happen in the month of January possibly due to frequent incidents of fog, mist and hailstorm which reduce visibility of the driver to as much as below 20 metre (Theofilatos and Yannis, 2014). Again, the period of March to June experiences another high accident regime which is mainly for emotional fatigue offered by sultry weather in high temperature of summer season. Higher occurrence of accidents is generally followed by higher human casualty level but exceptionally July demonstrates maximum number of people injured in road accidents because roads become slippery in rainy season and breaking system of vehicles becomes dilated which otherwise causes minor or grievous injury to people rather than fatal accidents.
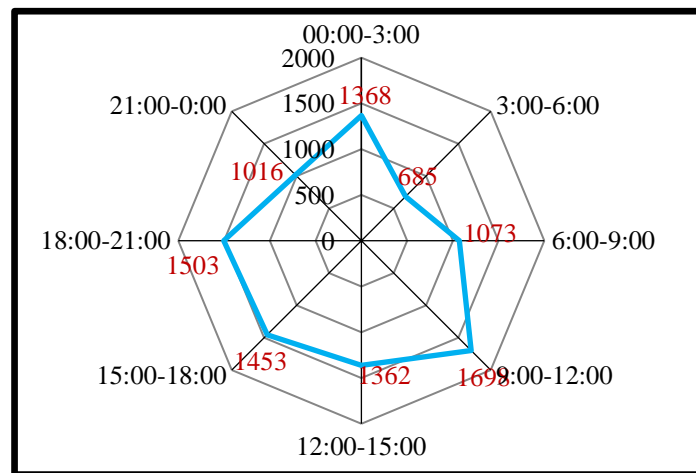
Note: Figures 0-2000 in the radar axis indicate hourly occurrence of road traffic accidents in an average day in West Bengal police area

Based on: MoSPI (2018)

Figure 2: Daily variation of occurrence in road traffic accidents in West Bengal police area in 2018

Figure 2 illustrates that maximum accidents take place during morning office hours (9:00-12:00) slightly diminished by next off-peak hours and again peaked in afternoon office hours (15:00-18:00) but substantially less in late night, mid-night and early morning hours. This happens because pressure of traffic in day hours and office periods on roads is extremely high which marginalizes option for safe driving and journey (Yuan et al., 2018). This figure has not reflected the recent trends of late night accidents which happens due to rash driving, bike race which is particularly of serious concern in different parts of Saltlake, Rajarhat and Bidhannagar Police Commissionerate area.

4.3. Vehicles Involved in Road Traffic Accidents

Traffic accidents are, in general, outcome of the exceedence of the capacity a corridor can sustain compared to the rate and volume of traffic movement which is promoted by unconscious and anomalous mobility of pedestrians and vehicles (Shim et al., 2015). Therefore, damage of private and public vehicles is of quite concern since it affects transport service apart from consideration of demographic casualty and frequency of road traffic accidents. Table 3 represents involvement of different types of vehicles in different accident cases and consequent human fatality and injury in accidents.

Table 3: Vehicles/Objects Affected in Relation to Frequency of Accidents and Human Casualties Involved in West Bengal Police Area in 2018

Impacting Vehicles	Total Accident	Persons Died	Persons Grievously Injured	Persons Minor Injured
Pedestrian	4153	2782	2305	222
Bicycle	621	338	395	13
Two-wheelers	1197	972	1129	183
Autorickshaws	2	45	126	8
Cars, Taxis, Vans and Light Motor Vehicle (LMV)	430	249	877	202
Trucks/Lorries	593	306	705	163
Buses	49	22	386	178
Other Non-motorized Vehicles	172	78	230	3
Others	441	441	1005	104

Based on: Field survey (2019)

Damage of tyres, brakes, chassis and other vehicular equipments primarily account for high occurrence of road accidents. Table 3 explains that accidents involving pedestrians characterizes dominant share along with accidental death and injury, followed immediately by two-wheelers' involvement in accidents, accidental fatality and grievous injury of persons. The reason behind high occurrence of accidents committed by pedestrians and two-wheeler owners may be attributed to attention deficit hyperactivity disorder, use of mobile phone while walking or driving, violation of traffic signal, road markings and else other (Caird et al., 2008). Trucks are highly susceptible to road crashes probably due to overloading (Kumar and Toshniwal, 2015), whereas accidents by cars, taxis, vans and LMVs are seen mostly injurious. Tate and Turner (2007) have examined the difference between the negotiation speed and design speed of road curves significantly influence injury crash rate. This figure is particular because data has been collected mostly from the vicinity of principal arterial roads passing through the urban areas, national and state highways where interference of rural transport is nominal.

4.4. Causes of Road Traffic Accidents

Causes of road traffic accidents in the present study area are diverse, and these are graded according to the degree of casualties realized, ranging from fatal to non-injury which is illustrated in figure 3 as under.
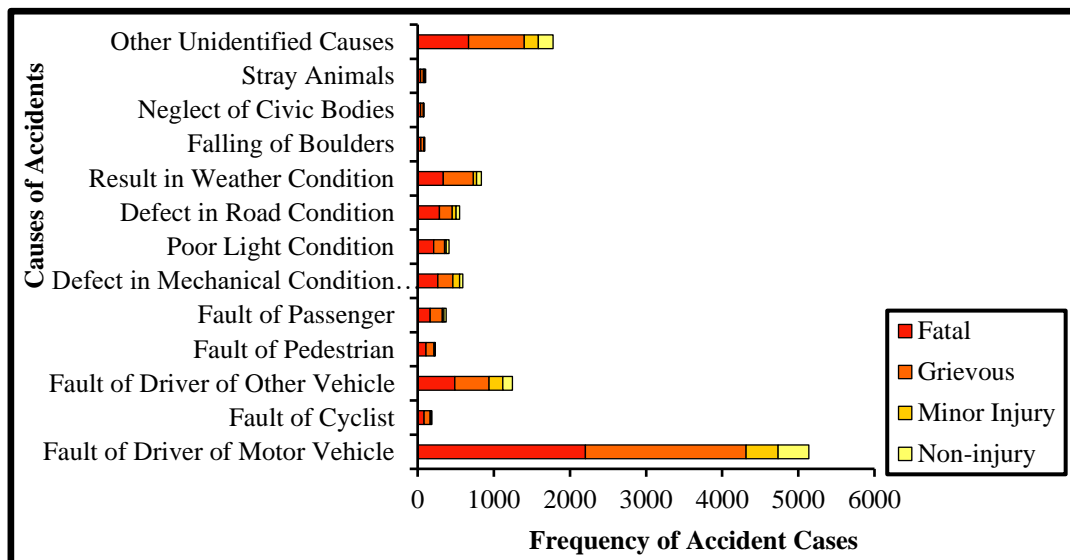
Based on: MoSPI (2019)

Figure 3: Human fatality and injury differentiated by causes of road traffic accidents involved in West Bengal police area in 2018

Figure 3 identifies that fault of drivers of motor vehicles is responsible for 44.18% of total number of accidents followed immediately by other unidentified causes and fault of drivers of other vehicles and most of the accidents identified deadly with exceptions in case of consequence of weather condition and other unidentified causes where grievous injury cases surpass fatal cases. Fault of drivers of motor vehicles incorporates a number of issues such as violating speed norms, signal breaching, intake of alcohol, lane diversion, use of mobile phones while driving that causes distracted attention, fatigue and elseother (Muhlrad and Lassarre, 2005). Fault of pedestrians mainly count for use of mobile phones while walking. Most of the Indian vehicles found to qualify desirable safety standards such as airbags, electronic steering and advanced braking system. WHO (2015) states that present enforcement level pertaining to helmet usage in India marks only 40%. Among the natural barriers, mist, flooding of corridors, road slope, road curvature obstructing considerable frontal sight etc. create obstacles inhibiting the practice of smooth traffic flow and accelerates chances for road traffic accident.

4.5. Impact of Road Manoeuvring on Human Casualty

Manoeuvring includes passage of roadways experiencing roadside turns other than at intersections or parking. Vehicles enter or leave the roadway for gaining access to roadside property or other roadside markets, informal pedestrian drop-off or pick-up points (Anowar et al., 2013). Table 4 characterizes different road manoeuverings that are more or less responsible for road accidents in West Bengal police area and relation between death and injury statistics at these manoeuverings.

Table 4: Evaluation of Spearman's Rank Correlation Coefficient between Death and Injury on Account of Road Traffic Accident at Different Manoeuvrings in West Bengal Police Area

Type of Manoeuvre	Number of Persons Affected		Rank for x (R_X) and y (R_y)		$d = R_x \sim R_y$	d^2
	Died (x)	Injured (y)	R_x	R_y		
Diverging	527	1099	4	3	1	1
Merging	255	673	8	8	0	0
Crossing	1042	1451	2	2	0	0
Stationary	132	339	13	11	2	4
Temporarily Held Up	83	257	15	15	0	0
Parked	122	334	14	13	1	1
Stopping	164	317	11	14	-3	9
Starting from Near Side	134	349	12	10	2	4
Starting from Off Side	224	526	9	9	0	0
Turning Right	602	1043	3	4	-1	1
Turning Left	475	836	5	6	-1	1
Making U-turn	401	801	7	7	0	0
Going Ahead Overtaking	1427	2385	1	1	0	0
Going ahead Not Overtaking	423	918	6	5	1	1
Using Private Entrance	30	128	16	16	0	0
Reversing	193	338	10	12	-2	4
n= 16						**∑d²= 26**

Based on: Field survey (2019)

Therefore, Spearman's Rank Correlation Coefficient (R_s):

$$1- [6 \times 26 \div (16^3-16)]$$
$$= 0.96$$

Table 4 describes that among different types of manoeuvers identified, overtaking is mostly fatal because it reduces braking distance to avert accident, followed immediately by crossing and right turning. Lack of proper road markings, unassigned speed breakers and other shortcomings in road geometry accelerate the probability of road accidents (Sawalha and Sayed, 2001) by reducing stopping sight distance (SSD). The problem of manoeuvering crashes is more specific at urban fringe areas where traffic speed is high but interrupted by considerable pedestrian movement. Spearman's rank correlation coefficient of 0.96 demonstrates that there is very strong positive relationship between death and injury figure on account of road traffic accidents at different manoeuvrings.

4.6. Sexual Composition of Persons Died with Respect to Road User Category

The earlier discussions have focused on gross death of persons with respect to accident cases taking place but these are unable to reflect the share of male and female population among persons died on account of road traffic accidents. Evaluation of sexual composition is significant from the viewpoint of population participating in economic workforce and maintenance of social harmony (Alotaibi, 2018). There is also obvious difference in death of persons for various road users. Table 5 recognizes sexual composition of persons died with respect to road user categories as follows.

Table 5: Sexual Composition of Persons Died with Respect to Road User Category in West Bengal Police Area in 2018

Road User Category	Male	Female
Pedestrians	2450	483
Bicycles	324	28
Two-wheelers	973	57
Autorickshaws	51	21
Cars, Taxis, Vans and Light Motor Vehicles	230	27
Trucks	593	77
Buses	145	21
Other Non-motorized Vehicles	0	0
Others	18	2

Based on: Field survey (2019)

Table 5 interprets males dominate death statistics over females subject to road accidents for each specified category because males are preferred in professions which involve trips by roadways besides commuting. Maximum number of males is notified dead in pedestrian category followed immediately by two-wheelers and trucks. Two-wheelers and other motor vehicles are more prone to road accidents compared to private cars because the earlier can skid easily if control is lost (Kusselson, 2013) and therefore accident situation is obvious in the statistical analysis.

4.7. Age-sex Composition of Drivers and Passengers in Road Traffic Accidental Death

Passengers constitute a significant proportion of road traffic space. However, passengers' safety almost depends on the calibre and efficiency of driver (Monash University, 2016). Figure 4 represents death toll of passengers and drivers in different age-sex group in West Bengal police area as under.
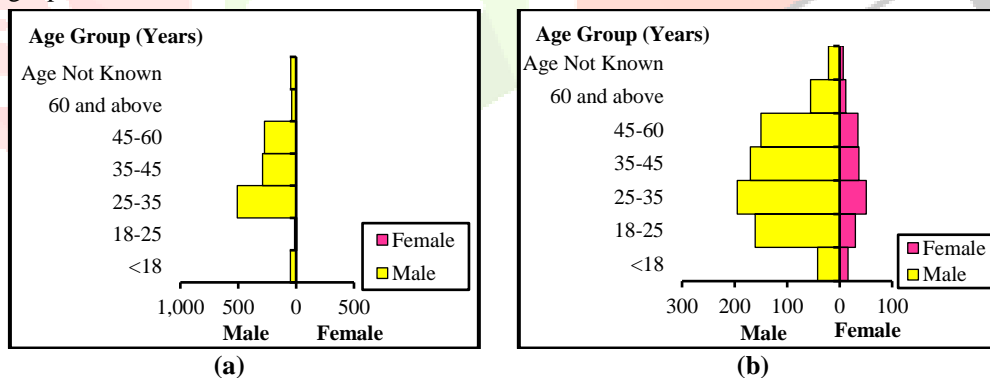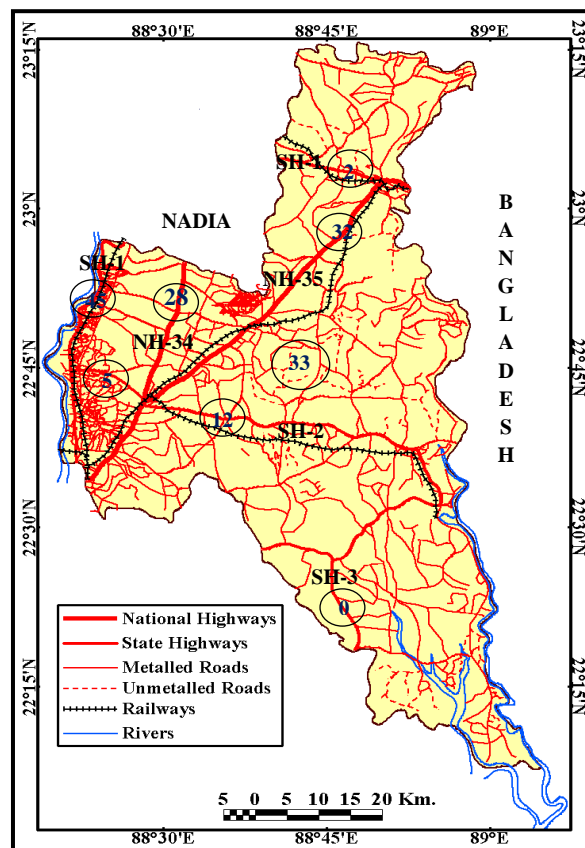

Based on: Field survey (2019)

Figure 4: Age-sex composition of drivers and passengers in road traffic accidental death in West Bengal police area in 2018 – (a) drivers (b) passengers

Figure 4 explains that number of passengers died in different age groups varies from 1.13 times to 35 times approximately with respect to number of drivers succumbed to death, which may be attributed to exceedence of passenger carrying capacity of vehicular fleet. Epidemiological studies indicate that the risk of drivers being involved in a casualty crash is influenced by direction and magnitude of the effect of passenger presence (Vingilis et al., 2014). Maximum frequency of drivers and passengers identified death has been recorded in the age group of 25-35 which comprises principal workforce in economic sectors. Drivers below 15 years and beyond 60 years are found rare because of unsuitability owing to lack of experience and physical fatigue respectively, which is implicit in the death statistics of drivers (Vassalo et al., 2016).

4.8. Accident Black Spots in North Twenty Four Parganas District

MoRTH, Government of India (2015) has defined road accident black spots a stretch of corridor about 500 m in length in which either five road accidents or ten fatalities (including grievous injuries) took place during the last three calendar years. Indian roads experience death of 0.15 million people per annum (Vashisth, 2018) and these are mainly caused by human errors such as fatigue, inattentiveness, distraction etc. which leads to accidental lane departure. North Twenty Four Parganas district, despite being second urbanized district of West Bengal after Kolkata total road length throughout the district is met inadequate to accommodate the tremendous pressure of vehicular population and pedestrians. In this context, figure 5 and table 6 highlight road accident black spots identified along National Highways, State Highways and other roads and their impact on road crash fatality and injury.

Note: Figures inside ◯ indicate frequency of black spots along specific national highways, state highways and other roads, NH= National Highways SH= State Highways

Based on: www.mapsofindia.com (accessed on 04.05.2021); Field survey (2019)

Figure 5: Accident black spots identified along different national highways, state highways and other roads across North Twenty Four Parganas district

Table 6: Accident Black Spots, Frequency of Road Crashes, Fatality and Injury Observed in Different Police Commissionerate and Police District Zones of North Twenty Four Parganas District in 2018

Police Commissionerate (PC)/Police District (PD) Zones	Total Accident Black Spot	Frequency of Road Crashes	Fatality	Injury
Bidhannagar PC	32	227	38	273
Barrackpore PC	57	448	158	322
Barasat PD	63	542	196	542
Basirhat PD	17	166	96	122

Based on: West Bengal Traffic Police (2019)

   Figure 5 represents accident black spots are mostly concentrated along state highways of North Twenty Four Parganas district followed immediately by national highways and other category roads. Fault in geometric structure, violation of traffic rules, older fleet of vehicles survived by mismanaged vehicular equipment, indistinct road markings, unspecified speedbreakers and other associated factors are responsible for high occurrence of crashes in these roads. Table 6 describes frequency of road accidents per accident black spot is maximum in Basirhat police district and this is least in Bidhannagar police commissionerate, road accident to injury rate also follows the same trend but road accident to fatality ratio is least in Basirhat region and it is highest in Bidhannagar zone. This variation in different attributes of road crashes of the district is the outcome of sensitiveness in adapting traffic safety norms.

4.9. Road Traffic Accidents in Different Places of Occurrence and Their Impact on Injury and Death of People in North Twenty Four Parganas District

   Road accidents in association with road traffic crashes generally consider factors such as accidents taking place in a particular geographical area, type of road features such as straight, curved, steep and else other, types of road junction and traffic control and weather condition. Out of these parameters, location is considered most crucial since it close relies on the categorization of traffic and geometric conditions that are related to road accidents (Bako and Musa, 2014).

   It has been observed that there exists considerable spatial variation with respect to road crashes and consequent human casualty in different police commissionerate and police district zones of North Twenty Four Parganas district. The relation between these accidents occurring in different types of places and human death and injury has been represented in table 7 as follows.

Table 7: Results of Bi-variate Correlation between Road Accidents in Different Types of Places and Consequent Human Fatality and Injury in North Twenty Four Parganas District

Place of Occurrence of Road Accidents	Statistical Particulars	Human Casualty	
		Fatality	Injury
Residential Area	Pearson Correlation	0.946*	0.897
	Significance (One-tailed)	0.027	0.051
	N	4	4
Institutional Area	Pearson Correlation	0.372	0.379
	Significance (One-tailed)	0.314	0.311
	N	4	4
Market/Commercial Area	Pearson Correlation	0.865	0.934*
	Significance (One-tailed)	0.067	0.033
	N	4	4
Open Area	Pearson Correlation	0.885	0.734
	Significance (One-tailed)	0.057	0.133
	N	4	4
Bus Stop	Pearson Correlation	-0.054	0.498
	Significance (One-tailed)	0.473	0.251
	N	4	4
Petrol Pump	Pearson Correlation	0.913*	0.779
	Significance (One-tailed)	0.043	0.112
	N	4	4
Hospital	Pearson Correlation	0.589	0.951*
	Significance (One-tailed)	0.205	0.024
	N	4	4
Others	Pearson Correlation	0.416	0.368
	Significance (One-tailed)	0.292	0.316
	N	4	4

Note: Correlation is significant at the 0.05 level ($\rho<0.05$) or 95% significance (one-tailed)

Based on: Appendix I

Data for the bi-variate analysis has been collected from publication of Transport Department, Government of West Bengal for four police commissionerate and police district areas of North Twenty Four Parganas district. Table 7 interprets that pearson correlations between fatality and road crashes occurred at residential areas and petrol pumps, and between injury and road crashes occurred at market/commercial area and hospital comprise very high positive relation and these are significant at $\rho<0.05$. Types of road accident places are the outcome of differential landuse pattern (Berthod, 2016), and the unspecified road junctions, improper traffic control practices in these places offer potential force for significant occurrence of road crashes. Out of different places studied above, residential areas and market/commercial areas remain relatively congested by human interference. Analysis of traffic accidents at different places is also essential for adopting road engineering measures, such that proper traffic calming at market areas, better design and location of bus stops, safety at petrol pumps and else other.

V. CONCLUSION

The analysis describes that there exists considerable interdependence between spatio-temporal and demographic aspects, and occurrence of road traffic accidents and human casualties involved. The study interprets that accidents are relatively higher in the month of January and during the period of March to June because of the impact on physiological reflexes due to climatic vagaries, and within different hours of an average day total number of accidents taking place in late night, mid-night and early morning hours constitute only 47.5% of the accidents happening between morning peak hours and afternoon office hours.

Fault of drivers of motor vehicles such as violating speed regulations, alcoholic driving and elseother account for 44.18% of total number of accidents. Economically active age group of drivers and more specifically males are more susceptible to higher fatality and accident risk compared to female counterparts because males avail more roadways besides housing for their profession. The problem of road accidents in any micro-region of India gets complicated due to interruption of motorized and non-motorized vehicles and mixed traffic components sharing same road space at same event of time.

Road safety considers shared responsibility of a number of ministries, therefore implementing road safety programmes demands well-coordinated and integrated approaches. Road safety measures are found inadequate despite recurring incidences of road traffic casualties, but execution of proper safety planning can improve the situation. These include good road design such as improvement of left and right turn channelization, installation of clear sight triangle, routine inspection of vehicular standards, enforcement of speed regulation by installing Red Light Violation Detection (RLVD) cameras and speed cameras, repairing of road potholes with urgency, construction of parallel service roads on both sides of major corridor to facilitate movement of non-motorized vehicles and elseother. Very recently 'World Clock' application has been commissioned for service to determine the exact time period required to cross the length between two signalized crossings at recommended vehicle speed of 40-50 Km/h in motion, and thus to encourage vehicular population reach their destiny in due time. Motor Vehicles (Amendment) Act, 2016 and several other frameworks can aid in raising public awareness about travel behaviour. Strengthening trauma care on a priority basis incorporating all health treatment institutes of the study region and development of road safety information system to avail authentic data for guiding all road safety activities are considered another prime task. Thus to conclude, prevention of traffic accidents is of utmost importance for ensuring environment friendly transport system and achieving economic prosperity.

CONFLICT OF INTEREST

The author declares that he has no known competing financial interests or personal relationships with other entities or researchers that could have appeared to influence the work reported in this paper.

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APPENDIX

Appendix I: Road Accident Statistics in Different Types of Places of Occurrence and Consequent Fatality and Injury in Different Police Commissionerate (PC) and Police District (PD) Zones of North Twenty Four Parganas District

PC/PD	Road Accidents by Place of Occurrence								Fatality	Injury
	1	2	3	4	5	6	7	8		
A	75	11	41	26	50	3	4	17	38	273
B	165	20	75	84	43	11	5	45	158	322
C	231	11	151	77	35	11	7	19	196	542
D	83	5	41	25	6	3	0	3	96	122

Note:

A: Bidhannagar PC   1: Residential Area   5: Bus Stop
B: Barrackpore PC   2: Institutional Area   6: Petrol Pump
C: Barasat PD   3: Market/Commercial Area   7: Hospital
D: Basirhat PD   4: Open Area   8: Others

Based on: Transport Department, Government of West Bengal (2020)