

# Kolkata City Accident Study

***Analysis of 868 Police reported crashes from January 2018 to December 2018***

*Submitted by:*

JP RESEARCH INDIA PVT LTD  
3rd Floor, Kovai Towers,  
44A, Balasundaram Road, P N Palayam,  
Coimbatore – 641037, Tamil Nadu, India.  
Phone: +91-70446 39376

*Submitted to:*

The Deputy Commissioner of Police (Traffic), Kolkata city.  
BB Ganguly Street, Poddar Court, Lal Bazar,  
Kolkata - 700001, West Bengal, India.

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# ACKNOWLEDGEMENTS

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This study is conducted under the Road Accident Sampling System – India (RASSI) initiative, which is financially and technically supported by the following consortium members:



FIGURE 1: RASSI CONSORTIUM MEMBERS

We also thank and acknowledge the RASSI consortium members for their belief in safer road travel for India, which ultimately has made this project possible.

We think this is a pioneering attempt in India towards data-driven road safety strategies that have proven to be highly effective in mitigating fatalities, injuries and crashes around the world. We hope that the data collected and analyzed from this study is useful to all the stake holders of Kolkata city roads (including motorists and pedestrians) for data-driven decision making, which will eventually make our journeys safer.

## Executive Summary

The Traffic Control Room (TCR), Kolkata Traffic Police, sends crash notification email every morning listing the fatal, serious and minor crashes that has occurred the previous day. Based on the notification, crash investigators from JP Research India Pvt. Ltd. (JPRI) proceed for in-depth on-site scientific crash investigation for selective cases based on a selection criteria. The TCR has provided notifications on 868 crashes consisting of fatal, serious, minor and no injury crashes from 01 January 2018 till 31 December 2018. This report provides a preliminary analysis of these 868 police reported crashes and offers a detailed analysis of 125 crashes that were scientifically examined by JPRI to determine the various contributing factors influencing crashes and injuries on the roads of Kolkata City.

The below table summarizes the count of fatal crashes and count of fatalities based on notifications received from TCR and FSTP to JPRI.

TABLE 1: DISTRIBUTION OF ALL CRASHES, FATAL CRASHES AND FATALITIES

Month	All Crashes	Fatal Crashes	Fatalities
Jan	88	28	28
Feb	67	25	29
March	72	18	18
April	60	17	19
May	68	28	29
June	72	29	31
July	73	24	25
Aug	69	30	30
Sept	81	38	38
Oct	83	34	35
Nov	65	28	28
Dec	70	26	27
Total	868	325	337

Below data summarizes the fatal crash and fatality counts between 2015 and 2018. There is a decreasing trend for total fatalities from the year 2015 to 2017, where the counts fall from 412 in 2015 to 329 in 2017. However, the year 2018 showed a slight increase in total fatal crashes and fatalities when compared with the previous year.

TABLE 2: COMPARISON OF FATAL CRASHES AND FATALITIES BETWEEN 2015 AND 2018

	2015		2016		2017		2018	
	Fatal crashes	Fatalities	Fatal crashes	Fatalities	Fatal crashes	Fatalities	Fatal crashes	Fatalities
<b>Total</b>	412	422	388	407	318	329	325	337
<b>Monthly Average</b>	34	35	32	34	27	27	27	28

Below table summarizes the distribution of Injury severity of police reported crashes (868 Crashes) and JPRI's sample (125 Crashes) collected through in-depth scientific crash investigations.

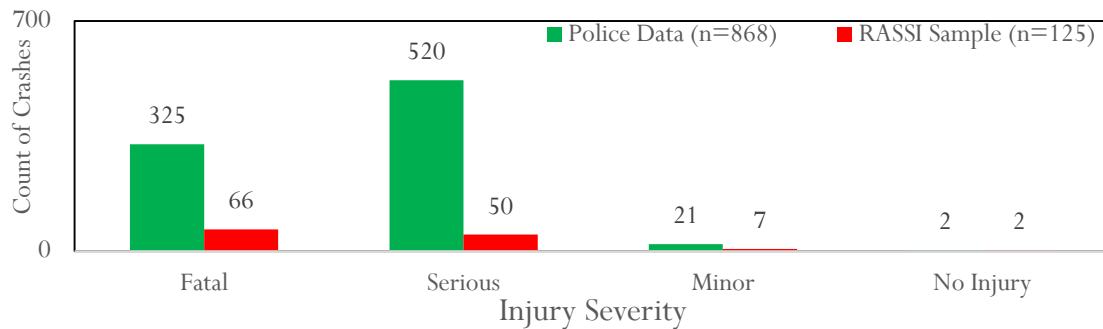


FIGURE 2: DISTRIBUTION OF INJURY SEVERITY

The top contributing factors for JPRI sample 125 crashes are as tabled below:

TABLE 3: HADDON MATRIX FOR 125 CRASHES

	<b>Human (96%)</b>	<b>Vehicle (86%)</b>	<b>Infrastructure (81%)</b>
<b>Pre-Crash</b>	Pedestrian - Dangerous behavior on roadway (24%) Disobeyed traffic signal (18%) Speeding - Excessive speed for conditions (17%) Pedestrian Inattention (13%) Improper lane change/lane usage (12%) Speeding exceeding speed limit (9%)	M2W user knocked down to the ground (32%) Vision obstruction due to vehicle interiors (18%)	Poor pedestrian infrastructure – crossing (18%) Poor road marking and signage (18%) Poor Intersection Design (14%) Undivided Road (12%) Vision Obstruction – Man made structure (6%) & Tree/Plantation (4%) Defective traffic signals (5%) Poor street lighting (4%)
<b>Crash</b>	Helmet not used (24%) Helmet not properly used (8%) Seat belt not used (4%)	Pedestrian knocked down to the ground (29%) Pedestrian run over (17%) Runover of M2W rider/bicyclist (10%)	Object impact – Road side – manmade structure (7%) Object impact – road side – trees/plantation (2%)
<b>Post-Crash</b>	-	Ejection (4%)	-

Countermeasures are listed based on priority ranking and ease of implementation that can have immediate effect on ground in terms of reduction of fatalities on road.

1. Counter measures related to road engineering:

**Table 3 shows that 50% of crashes, there is an involvement of road engineering deficiencies such as poor road marking and signage (18%), poor pedestrian infrastructure – crossing (18%), Poor intersection design (14%).** It is highly recommended that improving the existing pedestrian crossing facility adhering to IRC 103 2012, providing proper road markings (IRC 35 2015) and road signage (IRC 67 2012) will enhance the road users to also counter the contributing human factors such as “Pedestrian – dangerous behaviour on roadway (24%), “Improper lane change/lane usage (12%).

2. Counter measures related to enforcement:

**The data shows that “Helmet not used” contributed to 24% of crashes where head/face is injured and “Helmet not properly used” contributed to another 8%.** It is recommended that enforcement drive on usage of helmets and how to strap it on properly, should be carried out in the city. This can potentially avoid fatal/serious injuries to the motorcycle riders.

**The data shows that “Disobeyed traffic signal” contributed to 18% of crashes.** Enforcement drive on traffic signal violations will help mitigate such fatal/serious crashes.

3. Counter measures related to buses:

**Runover (of M2W rider/bicyclist or pedestrian or bus occupant) contribute to 30% of crashes, most of them resulting in fatalities.** Installation of runover protection devices have the potential to avoid the M2W rider/bicyclist or pedestrian or bus occupant coming under the wheels of Kolkata city buses.

**Data shows that “vision obstruction due to vehicle interiors” contribute to 18% of the crashes.** Installation of mirrors in enhancing the vision of the driver to be able to see pedestrians/motorists standing right in front of the bus will reduce the driver blind in front the bus and avoid such crashes.

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## 1 Introduction

Kolkata is the capital city of the state of West Bengal and largest city of eastern India. It is the third most populous metropolitan city and seventh largest city in India. Being the principal commercial, cultural, and educational center of East India, the city houses 4.5 million densely populated residents. The roads of Kolkata carry a mix of pedestrians, taxi's, cars, buses and goods carriers.

The study area for the road accident study covers 400 kilometers of roads. It includes only urban areas that fall under KMC (Kolkata Municipal Corporation). The areas covered under the study area are: Ballygunge, Alipore, New Alipore, Lansdowne, Bhowanipore, Tollygunge, Jodhpur park, Lake gardens, Golf green, Jadavpur, Santoshpur, Kasba, Garden reach, Behala, Thakurpukur, Kudghat, Ranikuthi, Bansdronei, Baghajatin and Garia. To the west of the city, South port, West port, Garden reach, Khidderpore, Metiabruz, Taratala, Watgunge, Rajabagan, and Nadial. The main corridors of Kolkata are North-South street from Shyambazar to Tollygunge, named Bhupendra Bose Avenue, Jatindra Mohan Avenue road, Chittaranjan Avenue, Jawaharlal Nehru Road, Ashutosh Mukherjee Road, Shyama Prasad Mukherjee Road and Deshpriya Sashmal Road. One of most important roads in the Kolkata city is the Eastern Metropolitan Bypass (E.M. bypass) that runs from north to south along the east edge of the city. The most important east-west corridor is A.J.C. Bose Road and Park Circus Connector, connecting Vidyasagar Setu and Eastern Metropolitan Bypass.



FIGURE 3: MAP SHOWING STUDY AREA IN KOLKATA CITY  
(COURTESY: GOOGLE MAPS)

## 2 Background

### 2.1 How did this study begin?

In July 2014, the Confederation of Indian Industry (CII) in Kolkata and ITC Limited invited JPRI to present the importance of scientific crash investigations at a meeting, attended by CII



representatives and the then Deputy Commissioner of Police (DCP) – Traffic, Kolkata city. During the meeting, the DCP expressed interest in conducting on-site crash investigations to understand the causal and contributing factors of fatal crashes in Kolkata city. Subsequently, in September 2014, JPRI presented the requisites to initiate activities for conducting the research, to the Kolkata Traffic Police and, after the necessary permissions, began on-site crash investigations of fatal crashes from 11<sup>th</sup> November 2014. Currently, JPRI has completed 4 years of Accident Study in Kolkata and continues to do accident research for the year 2019/2020 with the continued support from Kolkata Traffic Police.

## 2.2 How is JPRI conducting this study for free for the government?

This study is being conducted at NO COST TO THE GOVERNMENT. JPRI respects and is grateful for the cooperation provided by the police and other government agencies for conducting these in-depth crash investigation studies. In return, JPRI provides a one-page-per-case report on road engineering countermeasures for all the fatal road crashes and selective non-fatal cases to the Fatal Squad of Traffic Police (FSTP). This report contains scientific, detailed and unbiased insights regarding road safety infrastructural issues in Kolkata and its cost-effective counter measures in-line with the standards issued by Indian Road Congress (IRC).



FIGURE 4: CRASH INVESTIGATIONS BEING CARRIED OUT BY JPRI CRASH RESEARCH TEAM

JPRI research teams spend considerable amount of time examining road crashes. In-depth crash investigations are conducted in a scientific manner involving detailed examination of the crash

scene, crashed vehicles and the injuries sustained by the victims of the crashes. In possible case, researchers also interview the victims to understand the crash sequences better. CCTV footage, if available, is also collected from the Traffic Control Room (TCR) of Kolkata Police, for further analysis. The data collected is stored in a database which allows for detailed analysis of crashes. Numerous measurements, notes and observations are made on scientific crash data forms, which are used to build a scientific database called “Road Accident Sampling System – India”, or “RASSI” in short. This scientific database is shared by a consortium of automotive manufacturers who use it for improving vehicle design and developing India-specific safety technologies. This scientific research consortium provides financial and technical support to JPRI under the RASSI initiative for obtaining this scientific data.

### 2.3 Does this study affect my privacy?

This study is purely scientific, and any personal information such as victim names, contact numbers, vehicle registration numbers, etc. are NOT STORED in the analytical database.

JPRI crash investigation processes are aimed at making unbiased scientific examination of each crash to determine the various contributing factors to better understand effective counter measures. To maintain anonymity, JPRI researchers, after completing a crash examination, de-identify all the personal details before being fed into the analytical database.

### 2.4 Objective of this report

Traffic Control Room (TCR) and Fatal Squad of Traffic Police (FSTP) have provided notifications on 868 crashes consisting of fatal, serious, minor and no injury crashes. This report provides preliminary analysis of these police reported crashes and offers a detailed analysis of the various contributing factors influencing crashes and injuries on the roads of Kolkata City for 125 cases investigated in-depth by JPRI. The report not only identifies these “contributing factors” but also ranks them based on the number of crashes these factors have influenced. This ranking is aimed at helping decision makers and road safety stakeholders in planning cost effective road safety investments using data-driven road safety strategies.

## 2.5 About JP Research India

JP Research India Pvt. Ltd. (JPRI) is a research company in the business of automotive crash data collection and analysis. The company, a fully owned subsidiary of JP Research, Inc., is a forerunner in road safety research and has undertaken pioneering on-scene crash investigation and in-depth data collection projects aimed at scientifically understanding and mitigating road traffic fatalities in India.

Crash research has proven to be the best way to understand the characteristics of real-world road traffic crashes. Countries such as the USA, UK, Germany and Japan have benefited from the use the results of such research in significantly reducing the number of road traffic fatalities in their countries. The fact that India has been losing approximately 1,50,000 lives on its roads every year makes it imperative that such in-depth studies be conducted to aid swift steps in addressing the key factors influencing the high traffic mortality rate in India.

JPRI is experienced and well established in using crash research methodologies developed in other nations and customizing these to suit India's unique traffic conditions. After conducting numerous studies and on-site crash research projects on Indian roads, JP Research India has developed its own India-specific crash data collection forms, a methodology for conducting site and vehicle crash investigations in the inimitable Indian traffic environment, and a searchable database of in-depth crash data. In addition, the company's experts offer training in all of these areas, for those who would prefer to perform their own data collection and analysis.

In other words, at JP Research India, our overriding objective is to understand Indian roads, traffic and road users in ways that can be used to save lives: ours and yours.

### Contact:

E-Mail: [reachus@jpresearchindia.com](mailto:reachus@jpresearchindia.com)

Website: [www.jpresearchindia.com](http://www.jpresearchindia.com)

### Head Office:

JP RESEARCH INDIA PVT. LTD.

3rd Floor, Kovai Towers,

44A, Balasundaram Road, P N Palayam,

Coimbatore – 641 037, Tamil Nadu, India.

Phone: +91-422-4500437/38/39

## 2.6 About Road Accident Sampling System – India (RASSI)

While the economic and social benefits of implementing standardized crash reporting and crash data collection systems to improve road and automotive safety thus reducing fatalities have been demonstrated in Europe and the USA for some time, there has been no comparable system in India. The absence of systematically collected, nationwide in-depth traffic crash data has been seriously impeding scientific research and analysis of road traffic crashes in India. Only real world crash data, properly defined, can reliably identify the key factors that contribute to traffic crashes, both in terms of their frequency and severity. Further, since cultural and socio-economic conditions, as well as the roads themselves, affect driving conditions and crash outcomes, the data must be specific to a particular region. An automotive crash data system, based on US/European model but modified for Indian conditions, has been successfully demonstrated in the state of Tamil Nadu, Maharashtra, Gujarat, West Bengal and Rajasthan by a consortium of private companies. This initiative is called **RASSI**.

The genesis of the RASSI project began with a passenger car crash analysis study undertaken in Chennai, Tamil Nadu. This led to short-term crash studies on National Highways (NH) in the districts of Kanchipuram and Coimbatore, with the cooperation of the Tamil Nadu state police. Based on the experience from these initial studies, a robust methodology was developed to perform in-depth crash data collection and research that applied generically to all Indian roads. A relational database was also developed to record the scientific data obtained from each crash investigated by the researchers. Based on the early success of RASSI, a number of OEMs came forward to provide financial support for the continuation of the study on a yearly basis. In 2011 in JPRI's Coimbatore Data Centre, the RASSI Consortium officially came into being, and members were granted interactive access to the database.

Crashes are investigated continually in detail by JPRI teams in Coimbatore, Pune, Ahmedabad, Kolkata and Jaipur. The program logs a wide array of data including vehicle and crash site photographs. The teams collect and assess detailed evidence such as skid marks, broken glass, impacted objects, and measurements of crash damage to the vehicle and identify interior vehicle locations contacted by occupants during the crash event. The teams then follow up with on-site investigations by linking medical record reviews to document the nature and severity of injury from a crash.

The long-term goal of the RASSI Consortium is to create an integrated network of data centres across India with the support of other automotive and transportation-related companies and of

the Government. This would result in a common set of automotive crash data for research and analysis of root causes for the country.

Contact:

Website	<a href="http://www.rassi.org.in">www.rassi.org.in</a>
RASSI Technical Committee Chairman	Mr. Ravishankar Rajaraman ( <a href="mailto:ravishankar@jpresearchindia.com">ravishankar@jpresearchindia.com</a> )
RASSI Business Committee Chairman	Mr. Ajit Dandapani ( <a href="mailto:ajitd@jpresearch.com">ajitd@jpresearch.com</a> )

### 3 Methodology

#### 3.1 Crash Notification

Every morning, TCR notifies JPRI of all fatal and injury crashes in the study area that occurred on the previous day. On receiving the notification, JPRI researchers evaluate the data provided in the notification and based on a selection criteria, decide on the list of crashes that can be scientifically taken up for investigation. The basic criteria to be met for a crash to be investigated by the JPRI researchers include; 1. Crash must involve at least one motorized vehicle and 2. Crash spot has to be on a public road within the study (with Kolkata city jurisdiction). In addition, other details such as crash spot has to be identifiable by knowing the final rest positions, vehicle trajectories, other evidences. After taking up the case, JPRI researcher will collect the CCTV from TCR, if available, and then reach the crash scene to examine the scene evidence and inspect the involved vehicles. Vehicle inspection is done at crash scene or police station, wherever the vehicles are available.

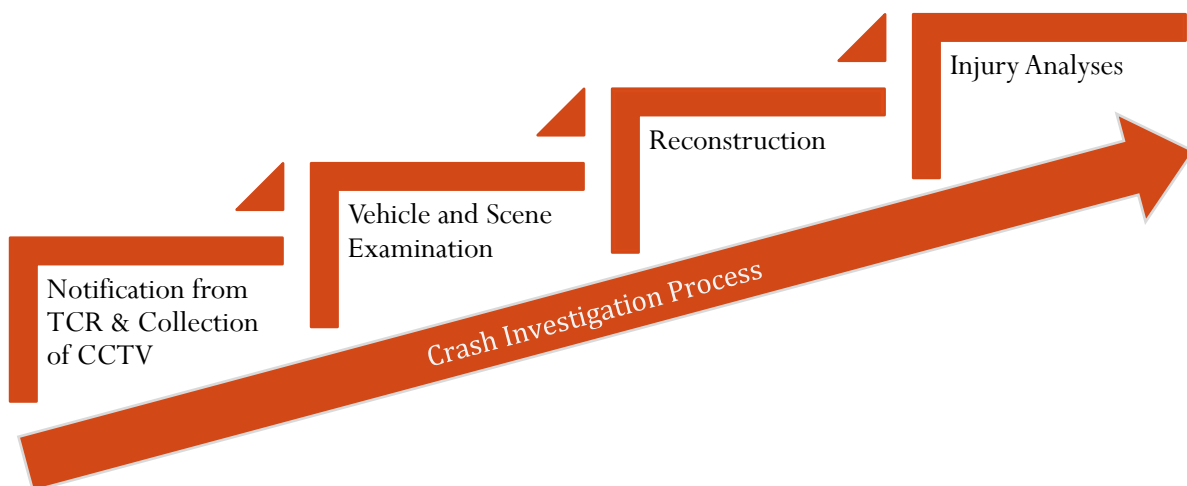


FIGURE 5: JPRI METHODOLOGY OF CRASH INVESTIGATION

The Kolkata Traffic Police has installed CCTV cameras at various locations, and videos of crashes recorded by these CCTV cameras give good information on pre-crash, crash and post-crash. But many crashes still take place in areas not monitored by CCTV cameras, or beyond the viewing range of the installed CCTV cameras.

#### 3.2 Scene Examination

Crash scene inspection includes taking pictures of roads and vehicle paths, as well as final rest positions of the vehicles, if they are still at the scene. Photos are taken of any crash evidence such

as skid marks, debris or gouges on the roadway. A scene sketch of the crash scene is then created, which includes the roadway, vehicle trajectories, scratch marks, debris location, oil pool, blood pool and final rest positions of the involved vehicles. A measuring wheel is used to take scene measurements. Global Positioning System (GPS) logs are also taken for every crash, in order to plot the crash locations spatially and to identify the scene at a later time, if required. Finally, infrastructure parameters including road and roadside configuration, traffic control information, road and weather conditions and other pertinent information are collected.

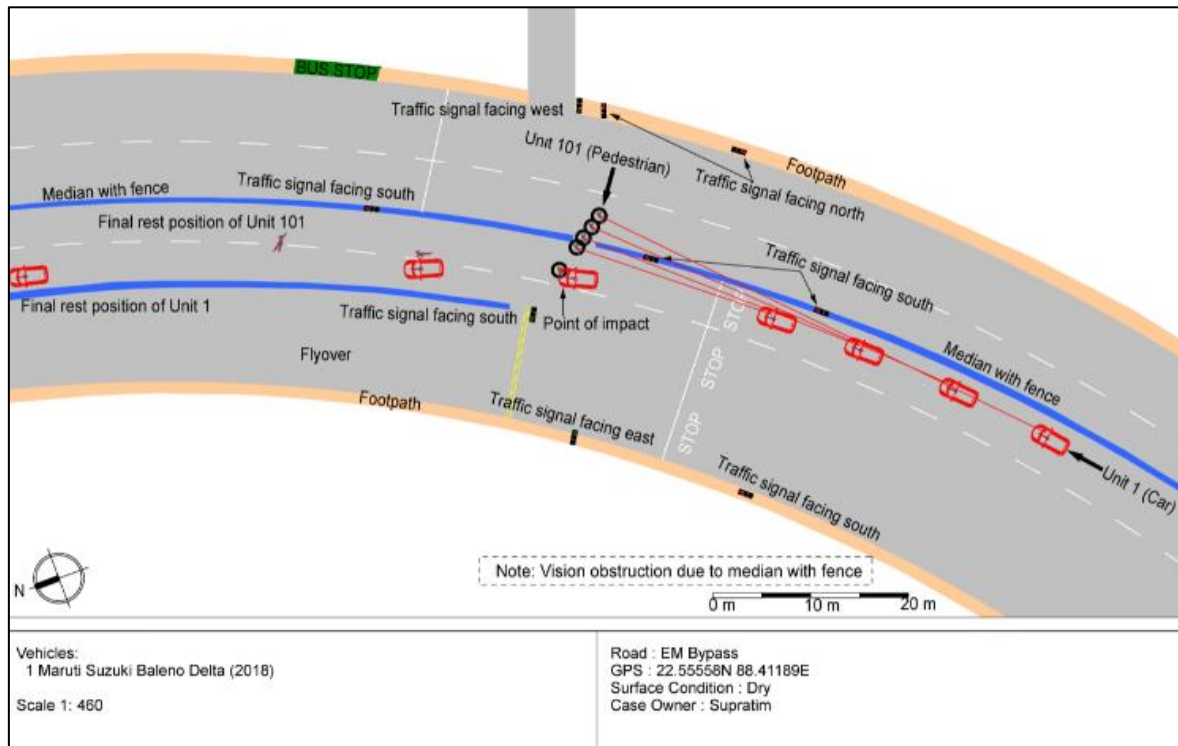


FIGURE 6: SCALED SCENE DIAGRAM

### 3.3 Vehicle Examination

Crash vehicles are examined at the crash scene, if available on spot, or at the police station if the vehicles are towed away. The exterior parts of the vehicle are examined to ascertain the impact and damage profile (direct and indirect). These values are required for determining other properties of impact such as collision severity (e.g., delta-V, EES). Finally, where possible, each impact is correlated to the impacts on the collision partner. The impacts are examined for evidence, such as paint transfer or deposited debris (e.g., metal, tree bark, graze from contact with a solid object), that can confirm such correlations. Road user contacts (e.g., motorcycle riders, pedestrians) on the exterior surface of the vehicle are recorded on a vehicle outline sketch.

The interior of the vehicle is examined to identify any intrusion into the passenger compartment, any occupant contacts with the interior components and structures, any use of and deployment of safety systems such as seat belts, pre-tensioners and airbags. The intruding component is identified and the reduction in occupant space in any of the 3 axes (longitudinal, lateral or vertical) is determined. Deformation of structures due to loading from occupants and interior occupant contacts are used in identifying the occupant kinematics during the crash. Airbags and seat belt components (webbing, pre-tensioners, etc.) are also examined using well-established methods to ascertain whether they have been deployed or used by the occupant. Finally all views of the vehicle, the damage locations, occupant contact evidence and any salient points on the vehicles and collision partners are photographed.



FIGURE 7: VEHICLE EXAMINATION AT POLICE STATION

### 3.4 Crash Reconstruction

Based on the obtained evidence and information, Newtonian laws are employed to obtain the speed of the vehicle at the point of impact. In the absence of reliable evidence on the scene or vehicles, CCTV footage is used to calculate the speed. For complex cases, reconstruction is done using a software named 'PC Crash'. A snapshot of 3D reconstruction is shown in Figure 8.



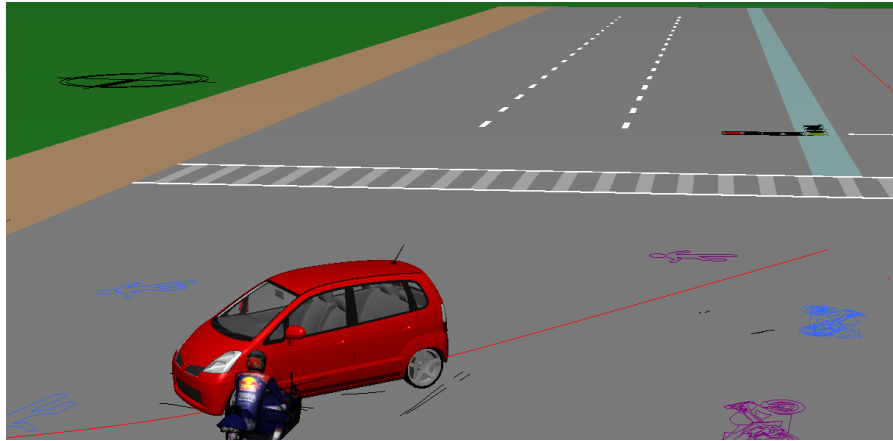


FIGURE 8: 3D VIEW OF CRASH RECONSTRUCTION

### 3.5 Injury Analyses

For all the crashes investigated in-depth, injury reports are collected to analyze the injury details of the affected road user.

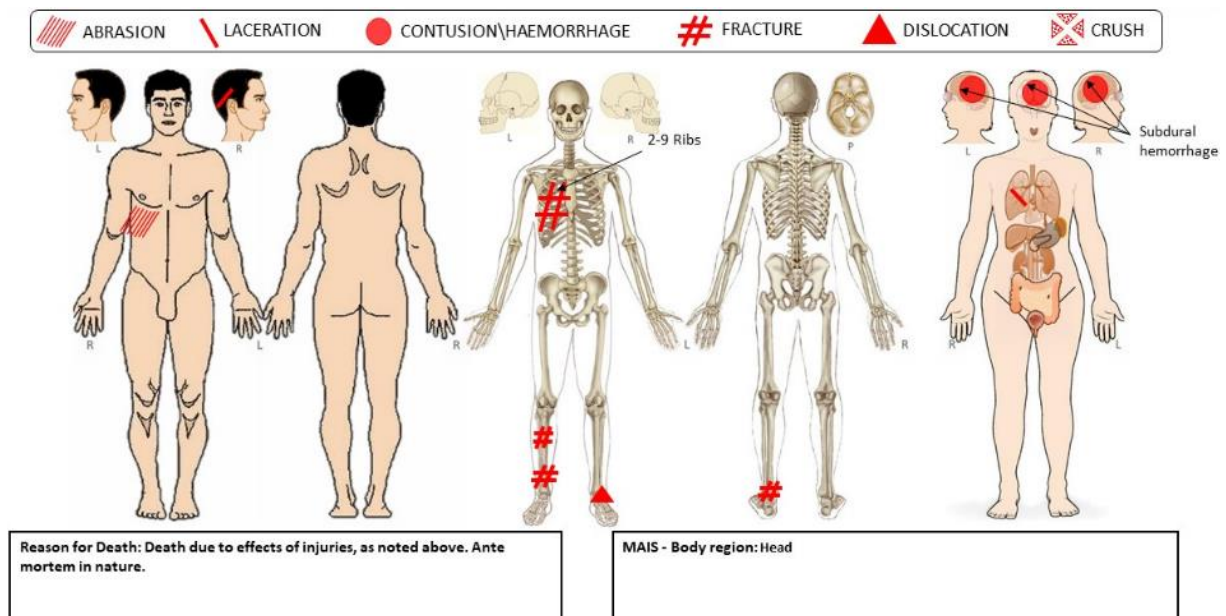


FIGURE 9: INJURY SKETCH SHOWING DETAILS OF OCCUPANT'S INJURIES

### 3.6 Contributing Factors – A Primer

Road traffic crashes are primarily influenced by three main factors:

- Human (Drivers, Motorcycle/Bicycle Riders, Passengers and Pedestrians)
- Vehicle (Vehicle structure, Design)
- Infrastructure (Roadway and the Environment)

Typically, crashes are analyzed for each of the above factors, and the crash is finalized as a result of a problem with only *one* of these factors. This type of analysis results in an overrepresentation of human failures and tend to identify driver errors as the main contributor to road traffic crashes.

Thus, the commonly repeated wisdom – “Driver error is the cause of over 90% of crashes”. The problem with this type of analysis is the assumption that the driver initiated the crash and hence all responsibility lies with the driver. Influencing factors which are vehicle-related and infrastructure-related are often not accounted for, even though they are an inseparable part of the whole crash situation.

### 3.7 JPRI Approach to Studying a Crash

When JPRI researchers examine a crash, efforts are made to determine all the possible failures with each of the above three factors (human, vehicle and infrastructure) leading to the occurrence of that crash. This is because each of these factors can influence crashes independently or as a combination. This kind of analysis gives a broader perspective and can help identify vehicle and infrastructure related solutions that can prevent crashes and mitigate injuries in spite of human errors.

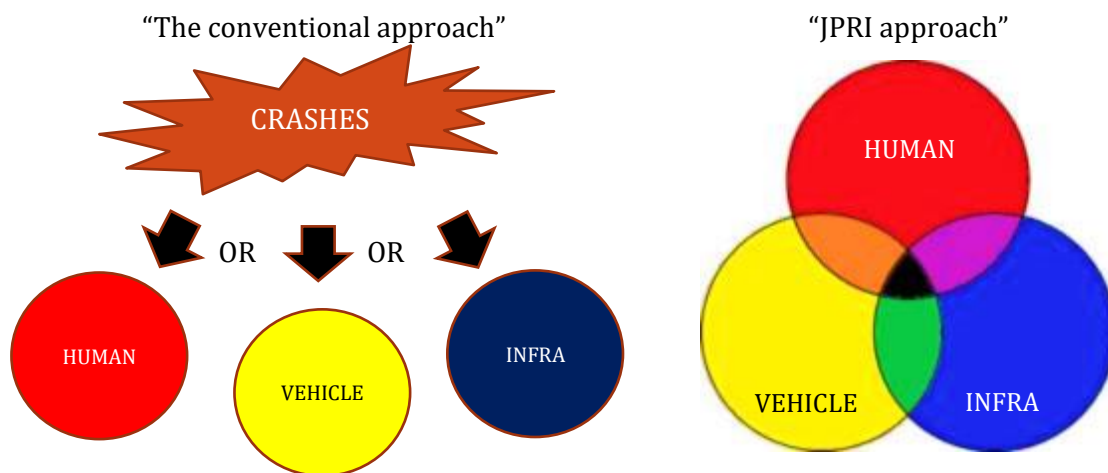


FIGURE 10: APPROACHES FOR ANALYZING ACCIDENT CAUSES

## 4 Data Analysis

The following sections include analysis at two levels

- i) Preliminary level based on the 868 crashes notified by the police; to highlight the basic crash characteristics
- ii) In-depth level based on the 125 crashes investigated in-depth by JPRI; to list the contributing factors leading to the occurrence of crashes.

### 4.1 Crash Data Sample

Over the period of one year from 01<sup>st</sup> January 2018 to 31<sup>st</sup> December 2018, 868 crashes were notified by the TCR to JPRI. Of these 325 were fatal crashes resulting in 337 fatalities and 51 serious injuries, 520 serious injury crashes resulting in about 596 seriously injured victims. Of

these 868 crashes, 125 crashes (66-Fatal, 50-Serious, 7-Minor, 2-No Injury) were studied through on-site scientific crash investigations for an in-depth understanding of these crashes.

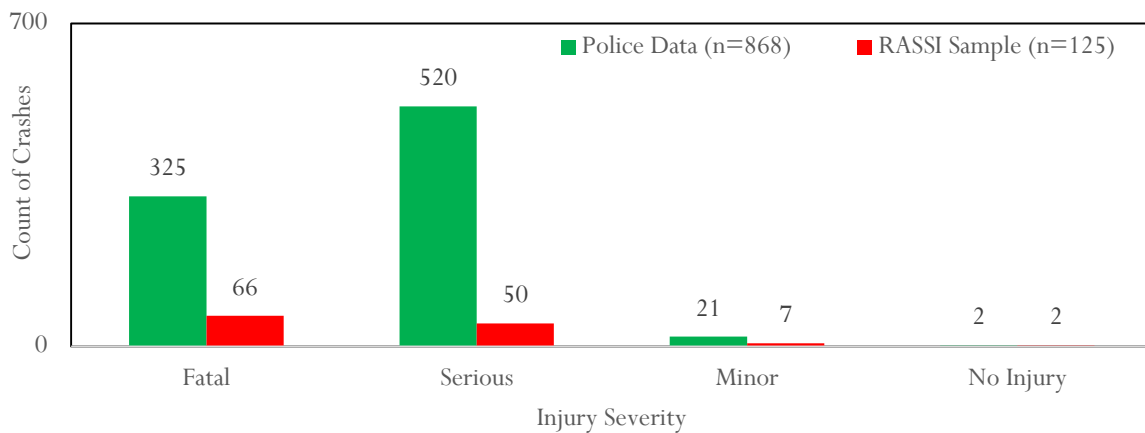


FIGURE 11: DISTRIBUTION OF INJURY SEVERITY FOR POLICE DATA AND RASSI SAMPLE

## 4.2 Preliminary Data Analysis

The 868 crashes notified to JPRI contained preliminary information related to time of accident, location, road user type and severity of the crash. Out of the 70 police stations in the study area, the top 15 police stations account for 42% of all fatal crashes across the city (Figure 12). Kasba and burtolla entered the top 15 list this year (2018) ranking 1<sup>st</sup> and 2<sup>nd</sup> place, while it was not in the top 15 police stations last year (2017) contributing to fatal crashes. Hastings went down to 3<sup>rd</sup> place after a decrease of fatal crashes from 19 in 2017 to 11 in 2018.

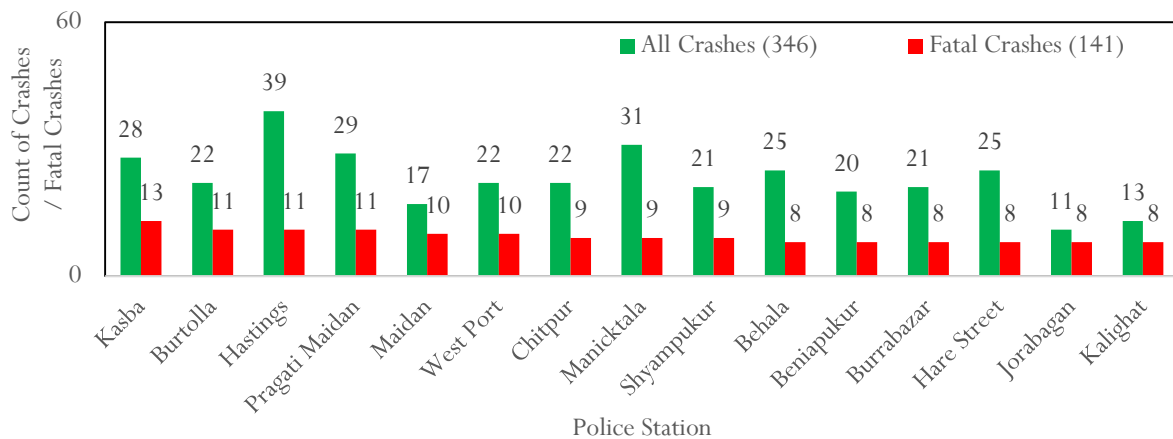


FIGURE 12 DISTRIBUTION OF CRASHES FOR TOP 15 POLICE STATION

### 4.2.1 Distribution of Crashes by Month of occurrence

Plotting the 868 crashes against the month of occurrence highlights that the most vulnerable months are January (10%), October (10%) and May (9%). The peak during October could be

attributed to the long holidays for Durga puja but no further information available for deeper analysis.

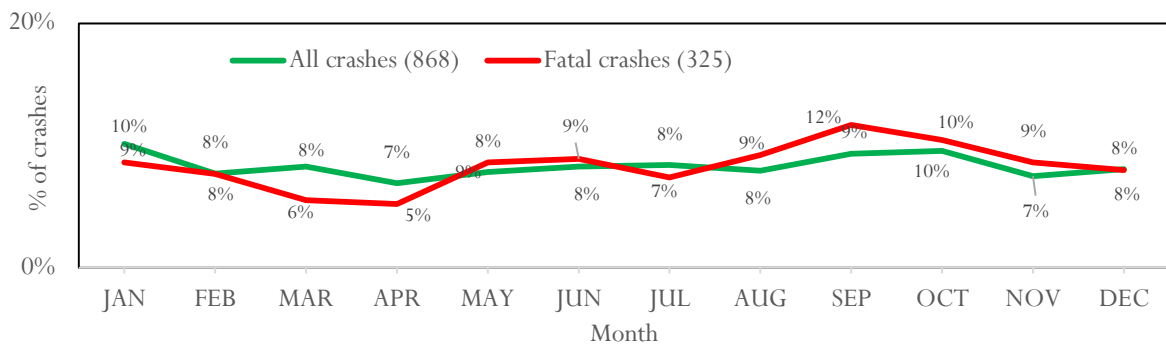


FIGURE 13: DISTRIBUTION OF ACCIDENTS BY MONTH

#### 4.2.2 Distribution of Crashes by Day of occurrence

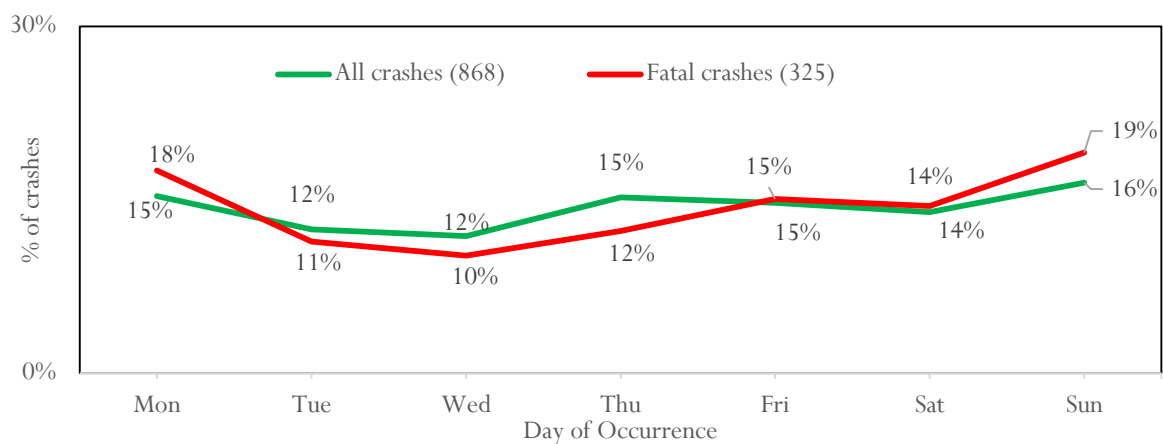


FIGURE 14: DISTRIBUTION OF 868 CRASHES BY DAY OF WEEK

The 868 crashes were plotted against day of week to highlight the trends of crash occurrence through a week. Sunday and Monday show a spike in fatal crashes (19% & 18% respectively).

#### 4.2.3 Distribution of Crashes by Time of Occurrence

The 868 crashes were plotted in time intervals of 3 hours to identify the trend of time of crash occurrence (Figure 15). About one third of a fatal crash occurs between 21:00 and 02:59.

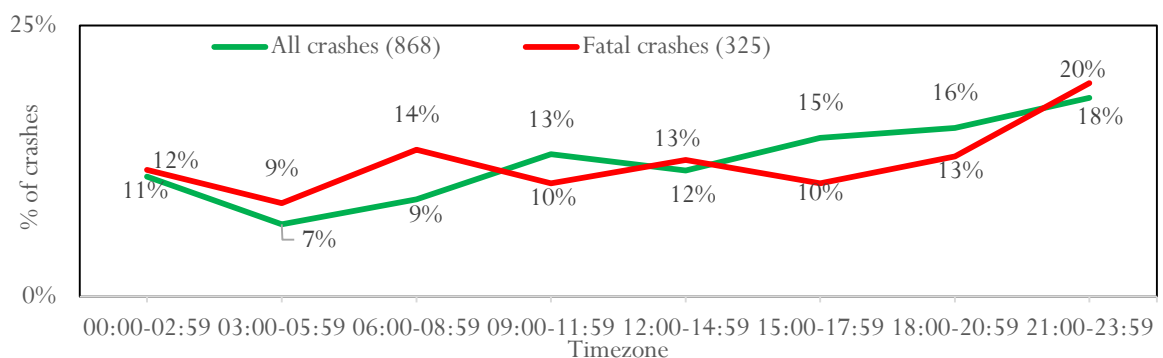


FIGURE 15: DISTRIBUTION OF 868 CRASHES BY TIME OF OCCURRENCE

#### 4.2.4 Distribution by Road user types involved

A total of 1448 road users (1074 vehicle occupants and 384 pedestrians) were involved in the 868 crashes, of which, the vulnerable road users (pedestrians, cyclists and motorcyclists) contribute to 49% of total road users involved in 868 crashes (Figure 16). Unknown vehicles (6%) are a result of Hit and Run cases, where one of the vehicles involved had fled the scene and could not be identified.

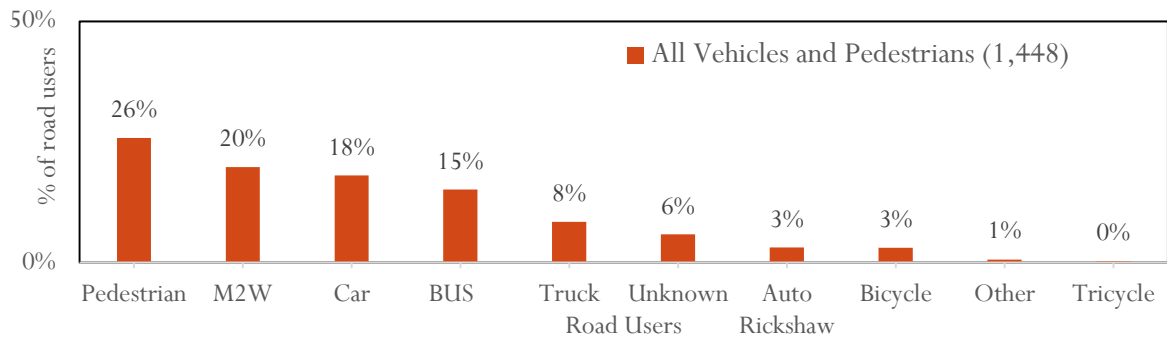


FIGURE 16: PERCENTAGE DISTRIBUTION OF VEHICLES AND PEDESTRIANS INVOLVED IN THE 868 CRASHES.

Please note that the figure is based on a count of the vehicles and pedestrians involved in the analysis and not the number of occupants or crashes. In the case of pedestrians, each pedestrian is a single count.

#### 4.2.5 Affected road users in fatal crashes

The 868 crashes resulted in 325 fatal road users and 635 seriously injured road users. While pedestrians contribute the highest share of fatal road user, M2W contribute the highest as motorized fatal road user. Apart from M2W and Pedestrians, it is also seen that 6% of the road crash fatalities are Bus passengers (Figure 17).

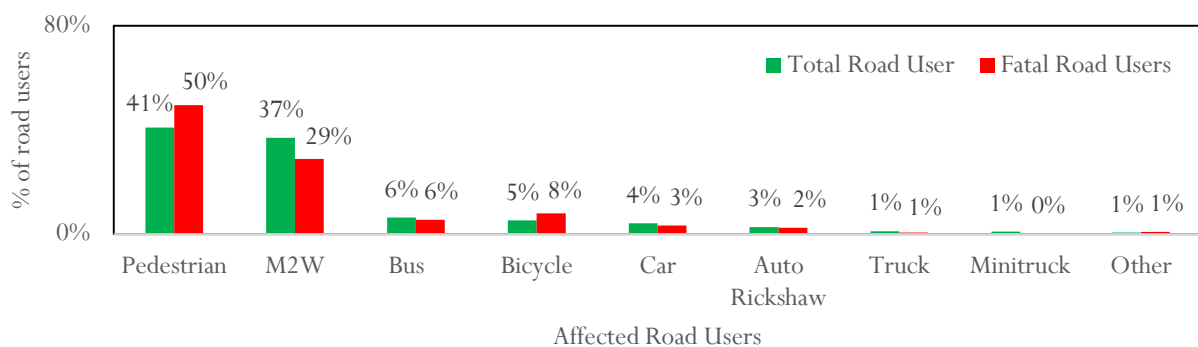


FIGURE 17: DISTRIBUTION OF AFFECTED ROAD USERS FOR FATAL AND ALL CRASHES

Please note that percentages given for pedestrians and vehicles reflect a count of road users with at least one fatal or seriously injured victim in a crash.

Given the high incidence and vulnerability, the following sections of the report will focus mainly on the following road users.

- Pedestrian (165 fatalities)
- Motorized 2-wheeler (100 M2W fatalities)
- Bus Passenger (18 fatalities)

#### 4.2.6 Fatal Pedestrian Crashes (161 crashes, 165 fatalities)

##### 4.2.6.1 Collision Partner analysis

A collision partner analysis for pedestrian crashes plots the frequency of pedestrian crashes against the road user type that impacted these pedestrians. 42% of fatal pedestrian accidents are with either a Bus or a Truck. In these crashes, Buses or Trucks either knocked down the pedestrian or knocked down and ran-over the pedestrian. 21% of fatal pedestrians are impacted by passenger cars followed by M2Ws at 12%.

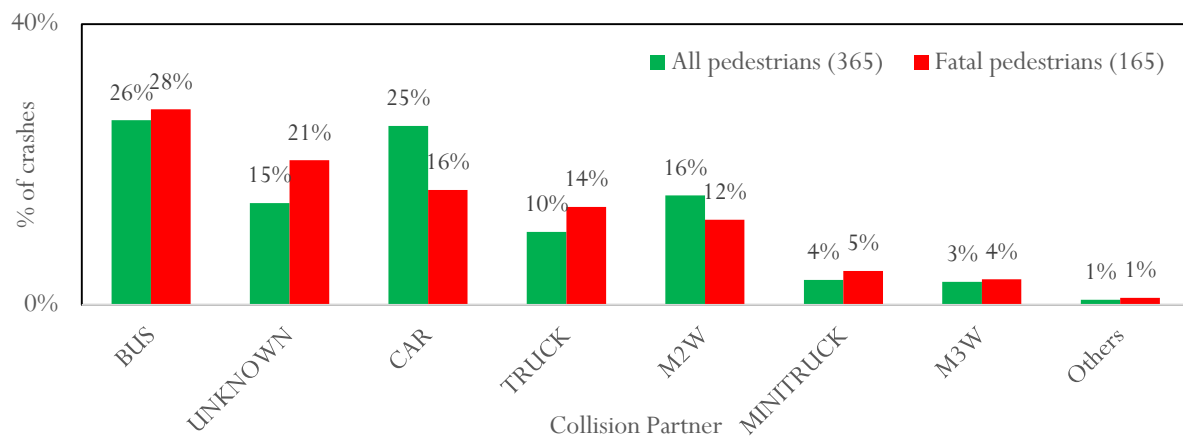


FIGURE 18: DISTRIBUTION OF COLLISION PARTNER FOR FATAL PEDESTRIAN CRASHES

21% of fatal pedestrians are as a result of impact by unknown vehicles (Figure 18). These are hit and run crashes, where, the collision partner (could be Bus, Car, Truck or M2W) fled the scene after the impact with pedestrian. The collision partner for these crashes could not be identified due to unavailability of CCTV at these location.

## 4.2.7 Fatal M2W crashes (94 crashes, 100 fatalities)

### 4.2.7.1 Collision partner analysis

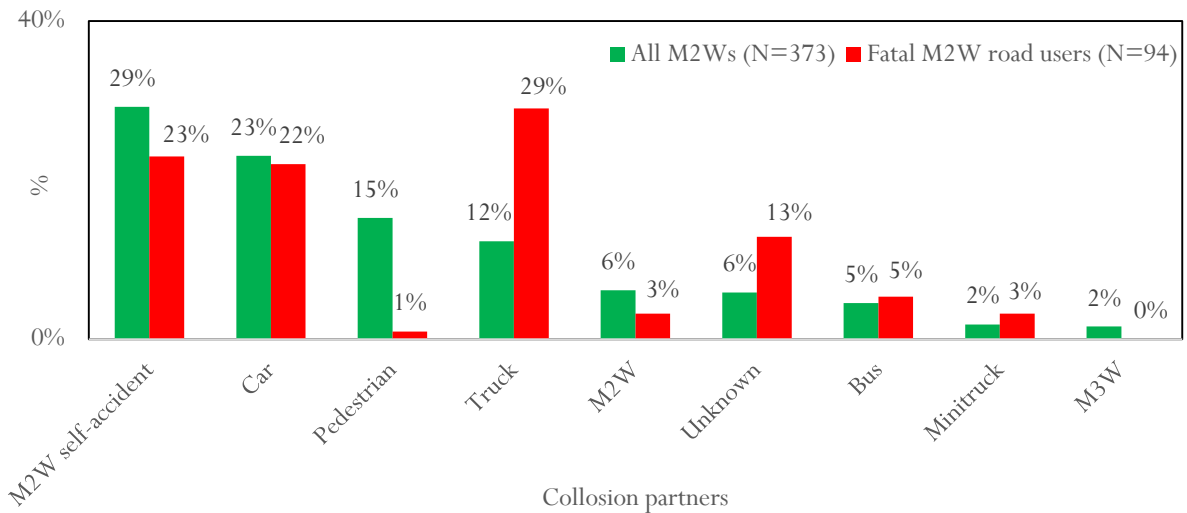


FIGURE 19: DISTRIBUTION BY COLLISION PARTNER FOR FATAL M2W CRASHES

29% of fatal motorcycle road users are a result of the motorcycle rider self-fall or object impact. These are crashes where the rider had lost balance and fell off the motorcycle without any external impact or force acting on them. Next to Car (23%), Heavy vehicles are the most frequented collision partner for M2Ws at 17% (12% trucks and 5% Bus).

## 4.3 Distribution of involved road user for JPRI Sample

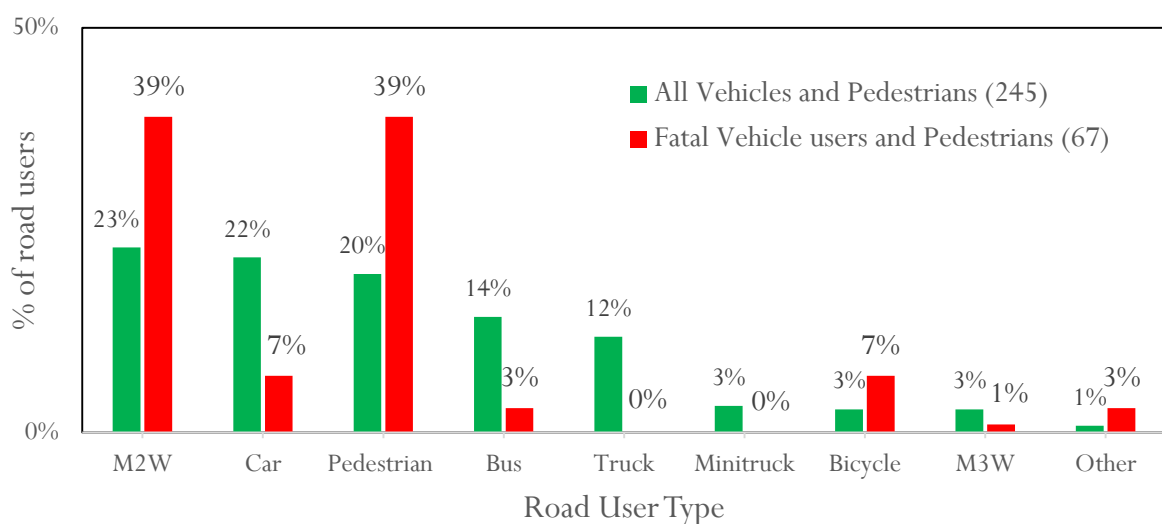


FIGURE 20: DISTRIBUTION OF INVOLVED ROAD USERS

Figure 20 shows that vulnerable road users such as pedestrians and motorized two wheelers share about 85% fatal crashes in JPRI sample.

#### 4.4 Distribution of First Crash configuration for RASSI Sample

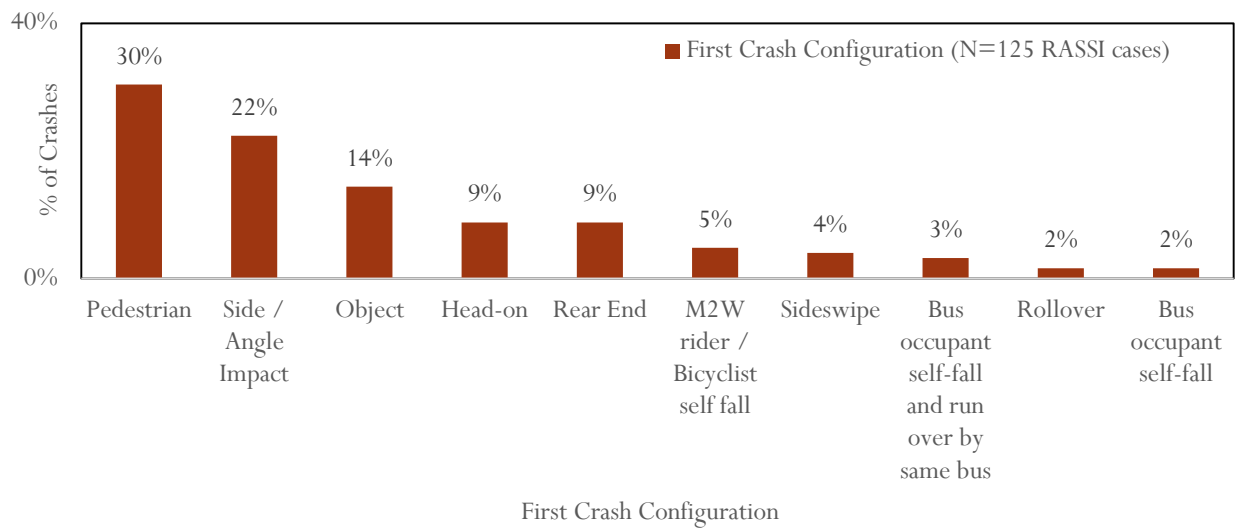


FIGURE 21: DISTRIBUTION OF FIRST CRASH CONFIGURATION

#### 4.5 Detailed Analysis – Contributing Factor Analysis for RASSI sample

A distribution by contributing factors (Human/Vehicle/Infrastructure) for the 125 crashes analyzed is shown in the Venn diagram Figure 22. All three factors together had contributed to 47% of crashes. Followed by the Vehicle and Human factors (27%).

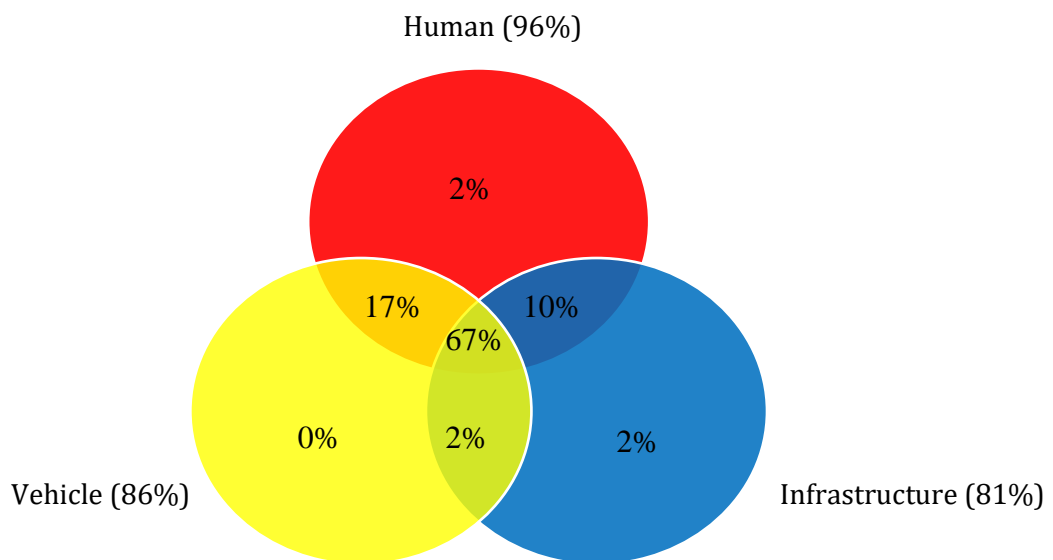


FIGURE 22: VENN DIAGRAM ANALYSIS FOR 125 CRASHES IN KOLKATA CITY



The influence of each factor in the occurrence of 125 crashes are shown in Table 4.

TABLE 4: DISTRIBUTION OF PERCENTAGE OF CF FACTORS

Factor	All Combinations	Alone
Human	96%	2%
Vehicle	86%	2%
Infrastructure	81%	0%

The following sections detail the quantifications of each of the three factors. More than one factor can influence a crashes; hence, the sum of percentage influence may not be equal to 100%.

#### 4.5.1 Infrastructure Factors

TABLE 5: DISTRIBUTION OF INFRASTRUCTURE CONTRIBUTING FACTORS FOR 125 CRASHES

Phases	Infrastructure factors	No. Of crashes	% influenced
Pre-crash	Poor pedestrian infrastructure - Crossing	23	18%
	Poor road marking/signage	22	18%
	Intersection	17	14%
	Undivided	15	12%
	Vision Obstruction – Manmade structure	10	8%
	Vision Obstruction - Trees/Plantation	5	4%
	Vision Obstruction - Others	5	4%
	Poor street lighting	5	4%
	Road Design – Others	4	3%
	Defective traffic signals	4	3%
	Vision Obstruction - Parked vehicles	3	2%
	Poor pedestrian infrastructure - Crossing	2	2%
Crash	Object impact - road side - manmade structures	9	7%
	Object impact - road side - trees/plantation	2	2%
Post-crash	-	-	-

## 4.5.2 Vehicle factors

TABLE 6: DISTRIBUTION OF CONTRIBUTING VEHICLE FACTORS FOR 125 CRASHES

Phases	Vehicle factors	No. Of crashes	% influenced
Pre-Crash	Vision obstruction -due to vehicle interiors	23	18%
Crash	Knock-down of m2w/bicyclist	40	32%
	Knock-down of pedestrian	36	29%
	Runover of pedestrian	21	17%
	Runover of m2w rider/bicyclist	12	10%
	Fall-down	8	6%
	Seatbelts not available/usable	7	6%
	Passenger compartment intrusion - other	5	4%
	Runover of bus occupant	4	3%
	Crash protection – others	4	3%
Post-Crash	Ejection	5	4%
	Entrapment	4	3%

## 4.5.3 Human factors

TABLE 7: DISTRIBUTION OF CONTRIBUTING HUMAN FACTORS FOR 125 CRASHES

PHASES	HUMAN FACTORS	NO. OF CRASHES	% INFLUENCED
PRE-CRASH	Pedestrian - Dangerous behavior on roadway	30	24%
	Disobeyed traffic signal	22	18%
	Speeding - Excessive speed for conditions	21	17%
	Pedestrian Inattention	16	13%
	Improper lane change/lane usage	15	12%
	Speeding - Exceeding speed limit	11	9%
	Driver Inattention	11	9%
	Overtaking in undivided road	7	6%
	Violation of Right of Way	7	6%
	Illegal road usage (includes travelling in the wrong direction)	6	5%
	Driver alcohol	5	4%
CRASH	Helmet not used	30	24%
	Helmet not used properly	10	8%
	Seat belt not used	5	4%
	Overloading of occupants	4	3%
POST-CRASH	-	-	-

## 5 Countermeasures

### 5.1 Countering Infrastructure Factors (81%)

As a general principle in designing pedestrian infrastructure, IRC 103 2012 observes the following points:

***“4.2 The basic aim should be to reduce pedestrian conflicts with vehicular traffic to the minimum, efforts should be made to create such conditions that pedestrians are not forced to walk in unsafe circumstances and that the motorists respect the position of pedestrian.***

***4.3 While planning, the convenience of pedestrian should be a paramount consideration to ensure full utilization of the facilities.***

***4.6 Above all, regular maintenance of all facilities and design elements should be undertaken to maintain accessibility reliability, usability, safety and continuity.”***

Pedestrian facilities in Kolkata suffers from not meeting some of these critical guiding general principles despite the availability of a good base road infrastructure. The top three contributing factors are i) Poor pedestrian infrastructure ii) Poor road marking and signage and iii) Safety at intersections. Counter measures to the top three concerns are listed below keeping in mind the general principles laid out in IRC 103 2012.

#### 5.1.1 Poor pedestrian infrastructure (20%)

##### 5.1.1.1 Poor pedestrian infrastructure - crossing (18%)

There are more than a few impediments in making the well-planned base infrastructure effective/friendly to use and reduce crashes. The most common concern noticed in the city is access to the pedestrian crossings. Example, Figure 23 shows a typical junction where the access leading to pedestrian crossing is completely closed. Over a period of time, such unusable access points affect the pedestrian behavior and encourages jay-walking exposing pedestrians to traffic.



Obstructed pedestrian access points rendering the pedestrian crossing useless.  
(Rabindra Sarobar North side crossing)

FIGURE 23: OBSTRUCTED PEDESTRIAN CROSSING ACCESS POINTS

Lack of pedestrian refuge spaces compound the dysfunctionality of pedestrian facilities. One of the primary user characteristics that the IRC 103 2012 observes, *“The feeling of being secure is the most important governing factor. A pedestrian should feel safe during the day as well as the night while using a footpath / cross walk.”* The standard also mandates the usage of refuge islands on roads with more than 4 lanes or lanes with opposing traffic movements. Most important roads in Kolkata are 4 lanes or more but with no refuge islands.



A pedestrian who follows the traffic situations by using the zebra crossing is pushed to wait unsafely against the traffic (Rabindra sarobar North side junction)

FIGURE 24: LACK OF PEDESTRIAN REFUGE SPACES

Adding to the dysfunctionality is the unavailability of drop kerbs. IRC 103 2012 mandates a maximum kerb height of 150mm with drop kerbs wherever a pedestrian crossing is to be facilitated. But almost all footpaths in Kolkata are more than 150mm with no drop kerbs in place. The aim of the drop kerbs is to be disabled-friendly and streamline the pedestrian flow in urban areas. The drop kerbs, despite providing easy passage by all users, also aids in encouraging proper usage of pedestrian facilities thereby reducing jay-walking.

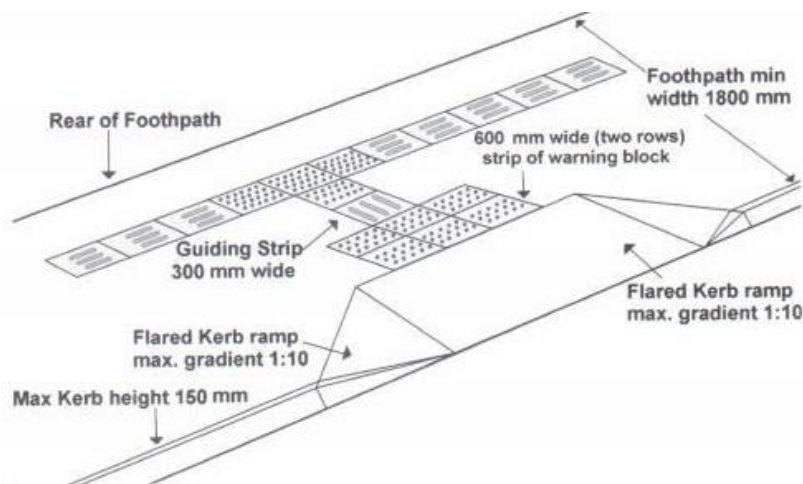


FIGURE 25: FOOTPATH DESIGN AS MANDATED BY IRC 103 2012

Another important aspect of pedestrian facilities with respect to intersections is the traffic lights. The available traffic signals are not useful either because they are not functional or because they are not properly timed in tune with other signals in the junction and showing timing of 2 seconds

green for pedestrians in many important junctions. IRC 93 1985 mandates a minimum of 7 seconds of green time for pedestrians. Traffic signal timings need to be mapped to reflect the actual traffic scenario and installed properly.



**Thus, the following needs to be improved to better the infrastructure, improve usability and reduce jay-walking:**

1. Clear all obstructions to the pedestrian crossing access points.
2. Provide refuge islands on roads with more than 14m total width.
3. Provide working traffic signal for pedestrians with reasonable and exclusive green time.

#### *5.1.1.2 Poor pedestrian infrastructure - Walking alongside (2%)*

Besides the availability of pedestrian facilities in most places, there are still quite a few places lacking dedicated pedestrian footpath. A few of the many locations, having inadequate pedestrian crossing infrastructure in Kolkata city, is shown below:



FIGURE 26: POOR PEDESTRIAN INFRASTRUCTURE - WALKING ALONGSIDE

The IRC 103 2012 highlights certain design elements essential to a pedestrian infrastructure as shown in Figure 27.

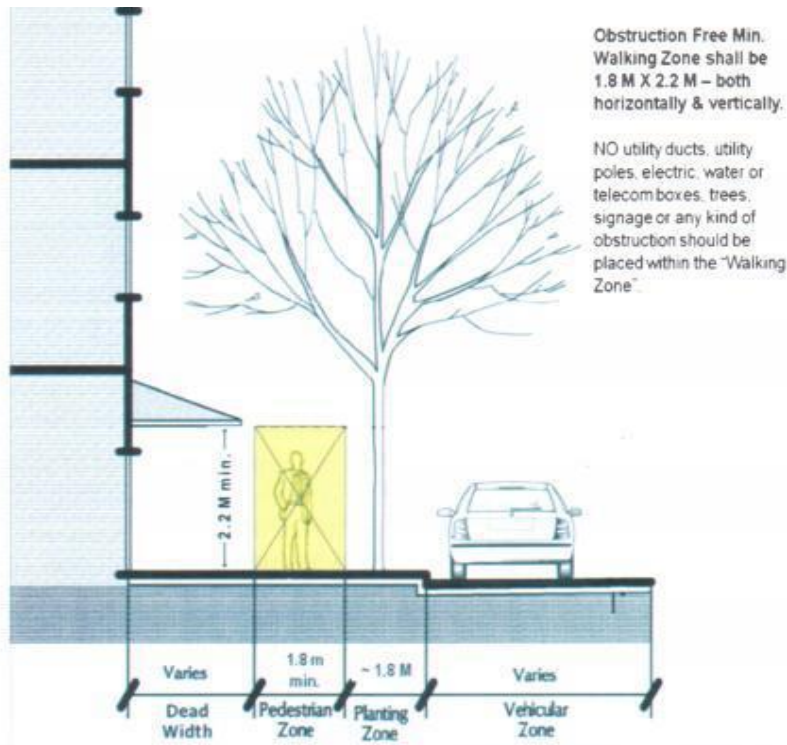


FIGURE 27: PEDESTRIAN FOOTPATH DESIGN AS MANDATED BY IRC 103 2012



Recommendations

**GUIDES FOR GOOD PEDESTRIAN AND ROAD INFRASTRUCTURE:**



The above two guides provided by the Institute for Transportation and Development Policy (ITDP) are good resources for road engineers and traffic planners with examples of successful implementation in some Indian cities.

Better streets, better cities: A guide to street design in urban India.

<https://www.itdp.org/wp-content/uploads/2011/12/Better-Streets-Better-Cities-ITDP-2011.pdf>

Footpath design: A guide to creating footpaths that are safe, comfortable, and easy to use.

<https://www.itdp.org/wp-content/uploads/2014/07/Footpath-design-131030.pdf>

FIGURE 28: BEST PRACTICES DEVELOPED IN INDIA

### 5.1.2 Poor road markings/signage (18%)

The purpose of road marking and signage is to direct and guide the road users, helping them to quickly decide what to do and where to go. If proper road signs and markings are missing, the driving environment becomes dangerous. The ability of a driver/rider to see, read, comprehend and make decisions are largely dictated by the placement, size, visibility and illumination of the signboards, which is a huge subject and a detailed discussion of which is beyond the scope of this document. However, the problems are often so obvious that most frequent road users are aware of them, and solutions to improve such problems of missing or misleading information are not difficult.

The most noted concern with regards to road marking is the design and materials used. The road marking designs are mandated by IRC 35 1997 including the materials and the colour. Road markings in Kolkata are done using non-standard paints that wear out easily. Also the length and the continuity needs attention. Lane markings are by far the most underestimated safety feature of a road. The markings influence the behaviour of the driver in a significant way and hence need to be properly invested and maintained.



FIGURE 29: IMPROPER ROAD MARKINGS – KOLKATA SAMPLE



Recommendations

**The following needs to be taken care of with respect to road markings in the city:**

1. Usage of proper materials that makes the marking visible during day and night.
2. Proper layout and guiding lines at requisite places to influence good user behaviour.

### 5.1.3 Intersection (14%)

An intersection is most vulnerable because of the confluence of vehicle with heterogeneity in travel direction. The major concerns with respect to intersection in Kolkata city are the layout of the intersection, signal positioning and signal timings.

#### 5.1.3.1 Layout of the intersection (14%)

Wide and open intersections provide no directional assistance to the drivers and encourage random traffic flow resulting in an inefficient traffic system. Intersections are the most vulnerable locations they demand high levels of user guidance. A typical intersection in a main locality of the city is over 60m wide. This allows driver to speed up within the intersection which results in a crash.

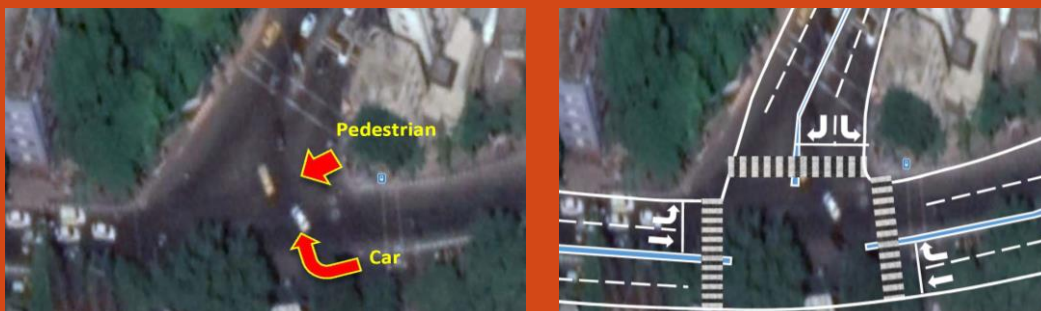


FIGURE 30: WIDE AND OPEN INTERSECTIONS IN KOLKATA

Reduce the gaps within the intersections by extending the centre medians further into the intersection. This helps in the following:



1. Provide for sufficient refuge island with a capped refuse island to protect the pedestrians from vehicle traffic.
2. Slows down the traffic speeds at the intersection thereby improving uniform vehicle throughput and user safety.





### 5.1.3.2 Signal positions

Almost all intersections have the traffic signals positioned. But the position of the traffic signals differ from junction to junction and are not consistent in their locations with respect to a junction. This inconsistency makes the driver ill-informed and is can be counter-productive. IRC 93 1985 mandates two signal poles; one primary on the left side if travel direction just by the STOP line and a secondary post at about 12m to 36m from the primary but on the right side of travel direction.



Provide signals wherever unavailable and realign where available the traffic signals to be conforming to IRC standards to be consistent and informative to the road users.

### 5.1.4 Undivided roads - (12%)

Crashes involving overtaking, during which a vehicle enters the oncoming traffic lane to overtake the vehicle travelling/parked in-front of it, are common on undivided roads simply because there is no barrier/division in place to prevent them. Such crashes often involve head-on collision, a crash type that frequently results in serious or fatal injuries. An example is shown in Figure 31 where, a motorcycle has encroached into the oncoming lane during the overtaking maneuver exposing itself to the head-on collision with oncoming vehicles.



FIGURE 31: EXAMPLE OF AN UNDIVIDED ROAD IN KOLKATA CITY

*please turn over...*



On open undivided roads inside the city, it is always preferable to have some sort of median in place for additional safety. Various median designs are available as shown below:



Central Hatching



Median barriers



Passing lanes



Dualling

- **Central hatching** in city areas can be used with rumble strips or pavement markers to alert drivers when they are leaving their lane. Central hatching can be installed over a continuous length of road or at specific points - for example, curves in the road.
- **Median barriers** physically separate opposing traffic streams and help stop vehicles travelling into opposing traffic lanes.
- **Passing lane** or double yellow solid lines with road studs technically refers to “No overtaking”. Passing lane can be created near curves, hillcrests and places where pedestrian and two wheeler populations are more. A single yellow line with road studs technically refers to “Overtaking allowed when safe”.
- **Road duplication or ‘dualling’** involves changing a single carriageway road to a dual carriageway road by building a second separate carriageway, usually alongside the first. Road duplication provides a safety benefit through provision of a central median barrier or strip of land (median or central reservation), thereby reducing the chances of head-on crashes. This is costly and requires a large amount of space. Duplication is typically only economically viable at higher traffic flow levels.

## 5.2 Countering Vehicle Factors (86%)

Most of these are a result of a deficiency or a setback in the vehicle design. However, after-market alterations are available in the market to circumvent such design setbacks. The following sections detail the concerns and their recommendations.

### 5.2.1 Vision obstruction due to vehicle interiors (18%)

Vision obstruction due to vehicle interior is a vehicle design limitation that restricts the driver’s vision. These vision obstructions create blind spots that usually occur in the front of the driver due to the A-pillar and inadequate coverage of side and rear by the vehicle mirrors.

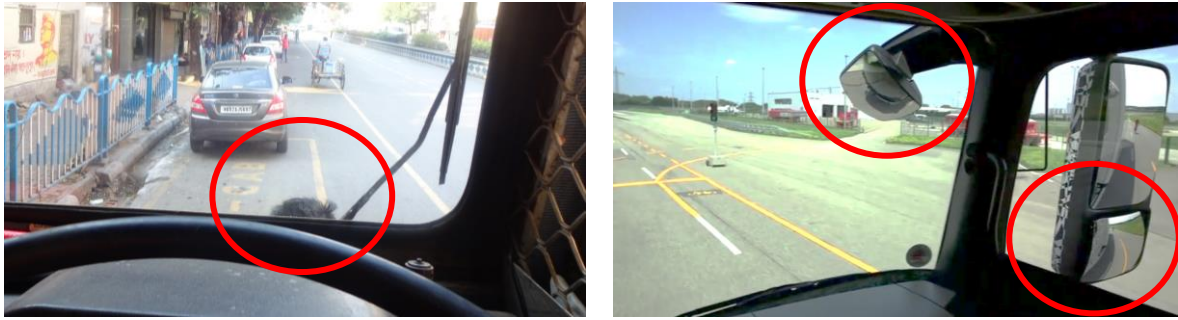


FIGURE 32: ADDITIONAL MIRRORS PROVIDED TO REDUCE DRIVER VISION OBSTRUCTION IN HEAVY VEHICLES

### 5.2.2 M2W -Knock-Down (32%) and Self-fall (6%)

The explanation for knock down is the same for M2W riders as explained earlier in the Vehicle Factors section for fatal pedestrian crashes. The factor “self-fall” involves a M2W rider losing control over his vehicle due to tire slipping, speeding, etc. and falling down to the ground without any preceding collision with another vehicle. While there are technologies like Anti-lock Braking Systems (ABS) available as an option on some motorcycles, the one counter measure that can help mitigate injuries would be wearing safety equipment. Figure 33 shows an illustrative example showing the injury benefits of using a good motorcycle safety gear.



FIGURE 33: INJURY BENEFITS OF GOOD MOTORCYCLE SAFETY GEAR

### 5.2.3 Pedestrian-Knock down (29%)

Pedestrian crashes involving knock down, where a pedestrian is simply pushed forward or aside after the vehicle impact and finally lands on the ground. Knock down crashes resulting in fatal injuries could be due to the vehicle impact or due to ground impact. Currently technologies exist that reduce the vehicle speeds when the vehicle senses that the pedestrian impact is imminent. In addition, passive safety technologies such as softer front-end design of vehicles and pedestrian airbags are also being incorporated in vehicles to ensure that the severity of the impact to the pedestrian is reduced.

### 5.2.4 Pedestrian-Run over (17%), M2W Rider/Bicyclist –Run over (10%), Runover of Bus occupant (3%)

In many pedestrian fatality cases, pedestrians get run over by the wheels of impacting vehicle after being knocked down. Such an occurrence is coded as a run over. This stands good for M2W riders/bicyclist as well. Usually vehicles with high ground clearance (buses and trucks) result in a run over of M2W rider/bicyclist or pedestrian. However, in some cases bus occupants fall out of the bus and getting ran over by the wheels as shown in Figure 34.



FIGURE 34: RUNOVER OF BUS OCCUPANT  
(PICTURE SOURCE: KOLKATA TRAFFIC POLICE)

Runover protection devices are globally tested and in practice which have the potential to avoid the runover situation. An example of S1 Gard in practice for city buses in USA is provided below;



Recommendations

### S1 GARD – RUN OVER PREVENTION DEVICE



S1 Gard is a device installed in public transport buses in many cities in USA to deflect the road users from coming under the wheels of a bus. These devices are claimed to be highly effective for public transportation, to save bus occupants, pedestrians, bicyclists, M2W riders from coming under the wheels. The device consists of a curved polyurethane guard, mounted in front of the right rear wheels of transit buses, designed to deflect a person out of the path of the wheels in order to prevent injury or death.

For further information and demonstration videos of the device, please check the link:

<http://www.s1gard.com/videos.html>

#### 5.2.5 Bus Occupant Self fall – Vehicle factors:

This factor can be countered by provision of doors for all the city bus. This facilitates controlled access of passengers only at designated Bus stops or during an emergency situation.

### 5.3 Countering Human Factors (96%)

The important human factors, influencing occurrence of crashes, identified in Table 4 are described in brief in the following paragraphs, and information is provided on existing solutions to counter these human errors. Please note that the solutions identified here are merely suggestions and need revised planning before implementation.

#### 5.3.1 Pedestrian - dangerous behaviour on roadway (24%)

Education campaign focusing on pedestrian behaviour on road will help in mitigating crashes related to this factor. In pedestrian crossing accidents, pedestrians attempts to cross in front of slow moving heavy vehicles. Due to vehicle interiors, the drivers vision are obstructed and couldn't able to see the pedestrians and act accordingly. Thus, impacting the pedestrian and further running over them causing fatal injuries. This awareness needs to be raised among various categories of pedestrians such as old aged people, students going to school/college, parents taking their children to schools, women going for shopping and other pedestrians. Figure

35 shows an adult holding the hands of a child, crossing the road in front of a heavy vehicle. Due to vehicle interiors, driver's vision is obstructed.



FIGURE 35: PEDESTRIAN DANGEROUS BEHAVIOUR  
(PICTURE SOURCE: KOLKATA TRAFFIC POLICE)

### 5.3.2 Speeding – excessive speed for conditions (17%) & driver inattention/ distraction (9%)

Speeding and driver inattention related crashes can be mitigated only through proper education, awareness and enforcement. It is important to educate road users and make them aware of the problem through targeted campaigns and awareness drives. The campaigns should be data-driven and offer clear instructions on what drivers/road users must do to prevent crashes.



FIGURE 36: CAMPAIGN CONDUCTED BY THE SAN-FRANCISCO MUNICIPAL TRANSPORTATION AGENCY  
(Source: <https://www.sfmta.com/getting-around/walk/pedestrian-safety/safe-streets-sf>)

After a period of education and awareness drives, enforcement needs to be carried out to discipline unruly drivers and send a strong message that violations will not be tolerated. An alternating series of awareness campaigns and enforcement drives over a long period of time will help shape driver attitudes and, eventually, result in mitigating crashes and injuries.

### 5.3.3 Violation of Traffic Signals (18%)

Figure 37 shows a motorcycle rider violating the traffic signal exposing to the moving traffic on the other arms of the intersection. Stricter enforcement on violation of signals will help in reducing these crashes.



FIGURE 37: VIOLATION OF TRAFFIC SIGNALS  
(PICTURE SOURCE: KOLKATA TRAFFIC POLICE)

### 5.3.4 Helmets not used (24%), helmets not properly used (8%) & seatbelt not used (4%)

All the above human factors can be addressed only through education, awareness and enforcement of helmet and seat belt laws. The methods of campaigning and enforcement are similar to the earlier discussion in the section “How to curb crashes influenced by speeding and driver distraction?”



FIGURE 38: HELMET SEPARATED FROM RIDER'S HEAD AS IT WAS NOT STRAPED  
(PICTURE SOURCE: KOLKATA TRAFFIC POLICE)

## 6 Conclusion

The analysis of 868 police reported crashes and 125 in-depth crashes highlights the following concerns with respect to safety of road users in the city of Kolkata.

1. On an average, about 27 fatal crashes occur every month.
2. Motorized 2-Wheelers and Pedestrians are the most affected road users constituting about 78% of the total road crashes fatalities.
  - a. 23% of fatal M2W crashes are self-fall/object impact while M2W collision with truck/bus constitutes 34%.
  - b. 42% of fatal pedestrian collisions are with bus/truck, 16% with car and 12% with M2W.
  - c. Fatal collision with unknown vehicle (Hit and Run - not captured by CCTV) contributes to 21% of all fatal pedestrian fatalities and 13% of all fatal M2W fatalities.
3. The fatal crashes are distributed over all days of the week, However, Mondays and Sundays shows slightly higher percentage.

*Please turn over*



4. The main contributing factors are as tabled below: (125 crashes)

TABLE 8: HADDON MATRIX FOR 125 CRASHES

	Human (96%)	Vehicle (86%)	Infrastructure (81%)
Pre-Crash	Pedestrian - Dangerous behavior on roadway (24%) Disobeyed traffic signal (18%) Speeding - Excessive speed for conditions (17%) Pedestrian Inattention (13%) Improper lane change/lane usage (12%) Speeding exceeding speed limit (9%)	M2W user knocked down to the ground (32%) Vision obstruction due to vehicle interiors (18%)	Poor pedestrian infrastructure – crossing (18%) Poor road marking and signage (18%) Poor Intersection Design (14%) Undivided Road (12%) Vision Obstruction – Man made structure (6%) & Tree/Plantation (4%) Defective traffic signals (5%) Poor street lighting (4%)
Crash	Helmet not used (24%) Helmet not properly used (8%) Seat belt not used (4%)	Pedestrian knocked down to the ground (29%) Pedestrian run over (17%) Runover of M2W rider/bicyclist (10%)	Object impact – Road side – manmade structure (7%) Object impact – road side – trees/plantation (2%)
Post-Crash	-	Ejection (4%)	-

5. Countermeasures are listed based on priority ranking and ease of implementation that can have immediate effect on ground in terms of reduction of fatalities on road.

a) Counter measures related to road engineering:

**Table 3 shows that 50% of crashes, there is an involvement of road engineering deficiencies such as poor road marking and signage (18%), poor pedestrian infrastructure – crossing (18%), Poor intersection design (14%).** It is highly recommended that improving the existing pedestrian crossing facility adhering to IRC 103 2012, providing proper road markings (IRC 35 2015) and road signage (IRC 67 2012) will enhance the road users to also counter the contributing human factors such as “Pedestrian – dangerous behaviour on roadway (24%), “Improper lane change/lane usage (12%).

b) Counter measures related to enforcement:

***The data shows that “Helmet not used” contributed to 24% of crashes where head/face is injured and “Helmet not properly used” contributed to another 8%.*** It is recommended that enforcement drive on usage of helmets and how to strap it on properly, should be carried out in the city. This can potentially avoid fatal/serious injuries to the motorcycle riders.

***The data shows that “Disobeyed traffic signal” contributed to 18% of crashes.*** Enforcement drive on traffic signal violations will help mitigate such fatal/serious crashes.

c) Counter measures related to buses:

***Runover (of M2W rider/bicyclist or pedestrian or bus occupant) contribute to 30% of crashes, most of them resulting in fatalities.*** Installation of runover protection devices have the potential to avoid the M2W rider/bicyclist or pedestrian or bus occupant coming under the wheels of Kolkata city buses.

***Data shows that “vision obstruction due to vehicle interiors” contribute to 18% of the crashes.*** Installation of mirrors in enhancing the vision of the driver to be able to see pedestrians/motorists standing right in front of the bus will reduce the driver blind in front the bus and avoid such crashes.

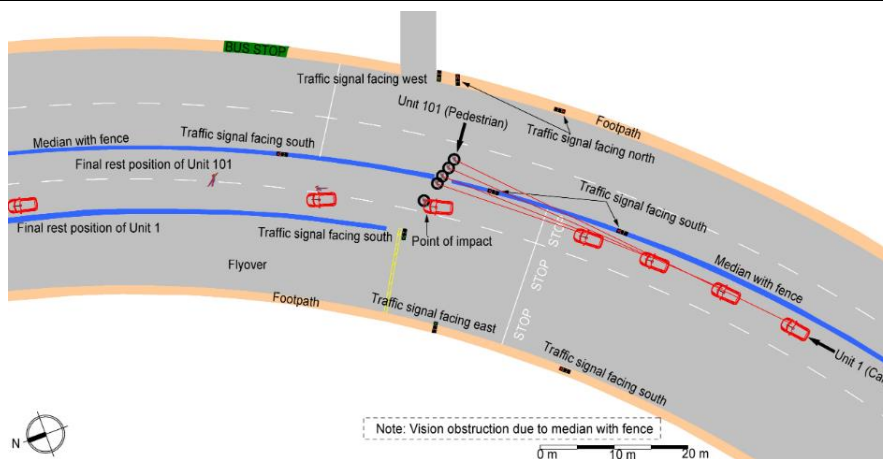
## 7 Appendix

### 7.1 Pedestrian crash – case study

Crash Date: 02 December 2018	Crash Time: 11:05 Hrs
GPS: 22.55558N 88.41189E	Crash Location: EM Bypass near Chingrighata flyover
Injury Severity: Serious	Road Structure: Signalized Intersection

#### Crash Summary:

Unit 1 (Maruti Suzuki Baleno Delta, Car, 1 occupant) was travelling towards north on the right lane of a 9 lane (divided by metal fence) city road. Unit 101 (Pedestrian, Female, 15 years) was travelling towards west through a gap in median. Unit 101 was running and crossing the road straight from right side to left side of Unit 1. Unit 1 violated the traffic signal and impacted Unit 101 (Event - 1). Unit 1's vision was obstructed due to the metal fence on the median. Unit 1 braked and steered left and at the same time Unit 101 used hands to avoid the impact. Post Event 1, Unit 101 rested on the split lines at some distance from the point of impact and Unit 1 moved ahead and stopped at the edge of the road. Unit 101 was seriously injured and was transported to hospital and the driver of Unit 1 was unhurt.



#### Pre-crash Contributing Factors

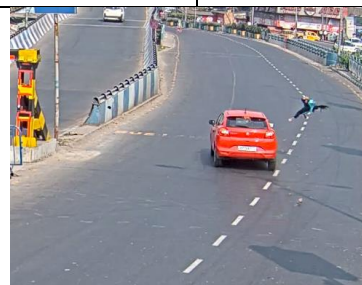
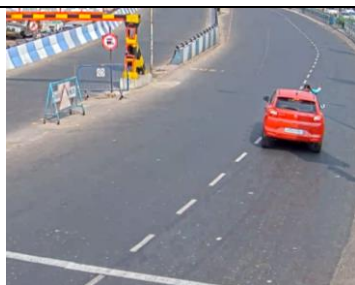
Vision Obstruction – Metal Fence on Median  
 Pedestrian Dangerous Behaviour  
 Poor Pedestrian Infrastructure  
 Disobeyed traffic signal  
 Speeding exceeding speed limit

#### Crash Contributing Factors

Knock down of Pedestrian

#### Post-Crash Contributing Factors

-

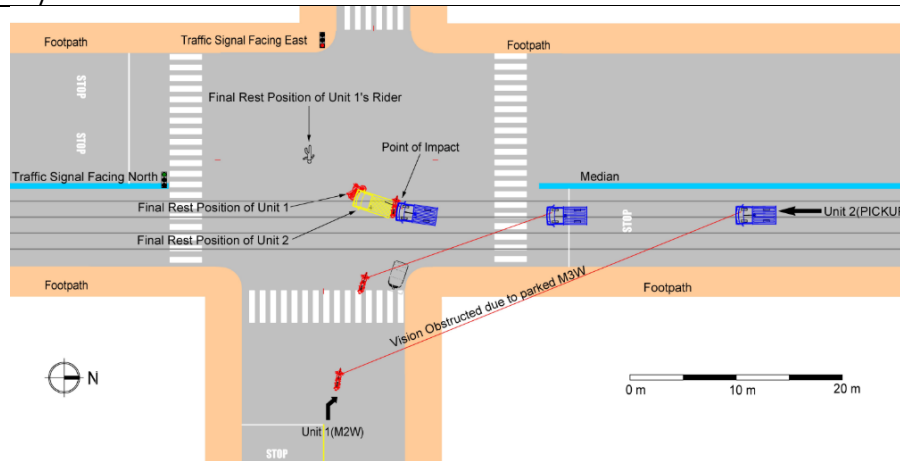


## 7.2 Motorcycle crash – case study

Crash Date: 21 December 2018	Crash Time: 22:25Hrs
GPS: 22.53346N 88.32728E	Crash Location: Ekbalpur crossing
Injury Severity: Serious	Road Structure: Signalized Intersection

### Crash Summary:

Unit 1(Bajaj CT100, M2W, 1 Occupant, With Helmet) was travelling into an intersection from east to turn towards north direction. Unit 2(Tata Ace, PICKUP, 1 Male Occupant) was travelling into the same intersection from north to south to cross the intersection. The road structure was a 4 arm intersection. Unit 1 violated the traffic signal to take a right turn towards north when Unit 2 whose signal was open tried to cross the intersection at the same time. Unit 2 was not able to notice Unit 1 due to a parked M3W. Unit 1 and Unit 2 braked and steered avoid impact. In spite the avoidance maneuver made Unit 1 and Unit 2 had a front side impact. Post impact Unit 1 fell on its left plane and was dragged by unit 2 to a short distance. Rider of Unit 1 suffered right leg injury and rested a few meters from the point of impact. Driver of Unit 2 had no injury. Source: CCTV/Police



### Pre-crash Contributing Factors

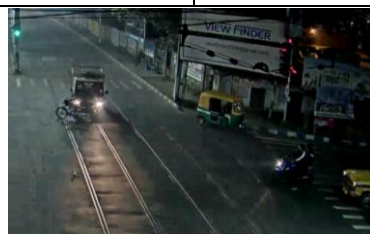
Disobeyed traffic signal  
Vision Obstruction - Parked vehicles  
Poor Intersection Design

### Crash Contributing Factors

Knock-down of M2W  
Helmet not used properly

### Post-Crash Contributing Factors

-

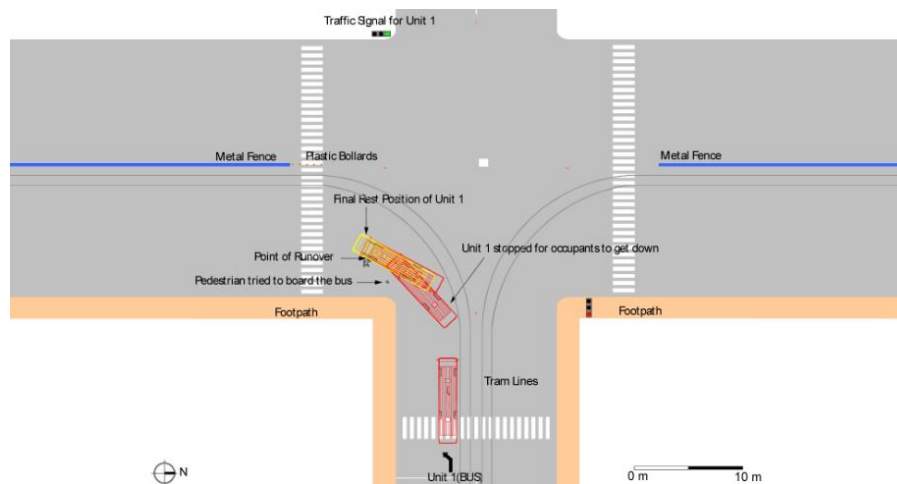


### 7.3 Bus Occupant Self-fall – case study

Crash Date: 19 September 2018	Crash Time: 20:10 Hrs
GPS: 22.51693N 88.34591E	Crash Location: Rashbehari Crossing
Injury Severity: Serious	Road Structure: Signalized Intersection

#### Crash Summary:

Unit 1 (Ashok Leyland Janbus, Bus, 2 occupants) was travelling towards west and intended to take a left turn towards south. Unit 1 was travelling on the 2nd lane from left on a 6 lane divided road. Unit 1 while taking the left turn, stopped at the intersection for its occupants to get down. Then it started to move towards south. One pedestrian (Male, 64 years) tried to board the bus while the bus started to move and he slipped, fell on the ground and went under the left front wheel. The victim's right leg went under the front left wheel (Event 1). Unit 1 stopped after moving about 2 meters ahead. The occupant suffered right leg injury and transported to hospital. Source of the summary is from CCTV footage & police.



Pre-crash Contributing Factors	<ul style="list-style-type: none"> <li>Bus occupant dangerous behaviour on foot board (while trying to board)</li> <li>Public bus stop</li> <li>Driver Inattention</li> </ul>
Crash Contributing Factors	<ul style="list-style-type: none"> <li>Occupant fall on ground</li> <li>Runover of Bus occupant</li> </ul>
Post-Crash Contributing Factors	-



## 7.4 Black Spot Analysis

GPS data for over four years (from Nov 2014 till March 2018) is available for fatal crashes (for 1065 fatal crashes). Black spot analysis was performed using QGIS software to identify the vulnerable crash spots. A grid with each square measuring 100 meter width, is created in the study area (Kolkata City Jurisdiction) as shown in Figure 39.

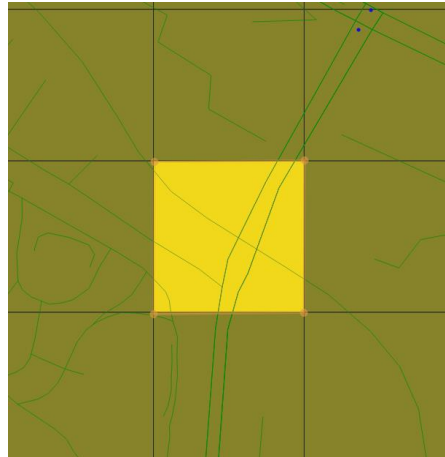


FIGURE 39: CREATION OF GRID IN QGIS SOFTWARE (10000 SQUARE METER AREA FOR EACH SQUARE)

A square with area 10,000 square metre, that has more than 3 fatal crashes inside it, is considered as the black spot. A sample polygon with 4 fatal crash spot inside it is shown in Figure 40. 4 crash fatal spots are indicated by the blue dots.

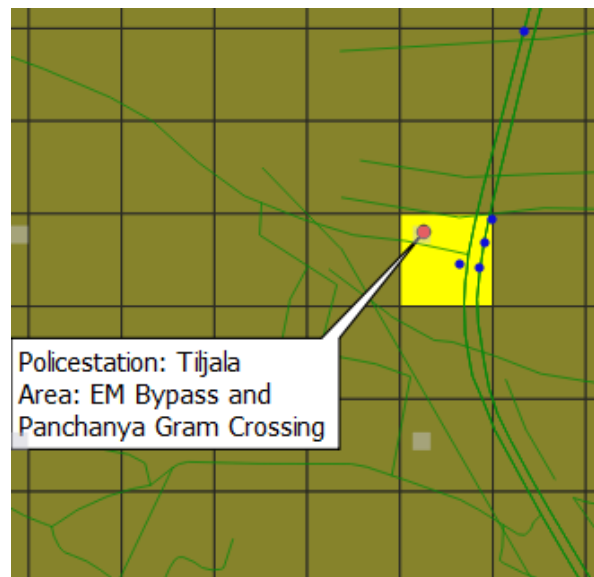
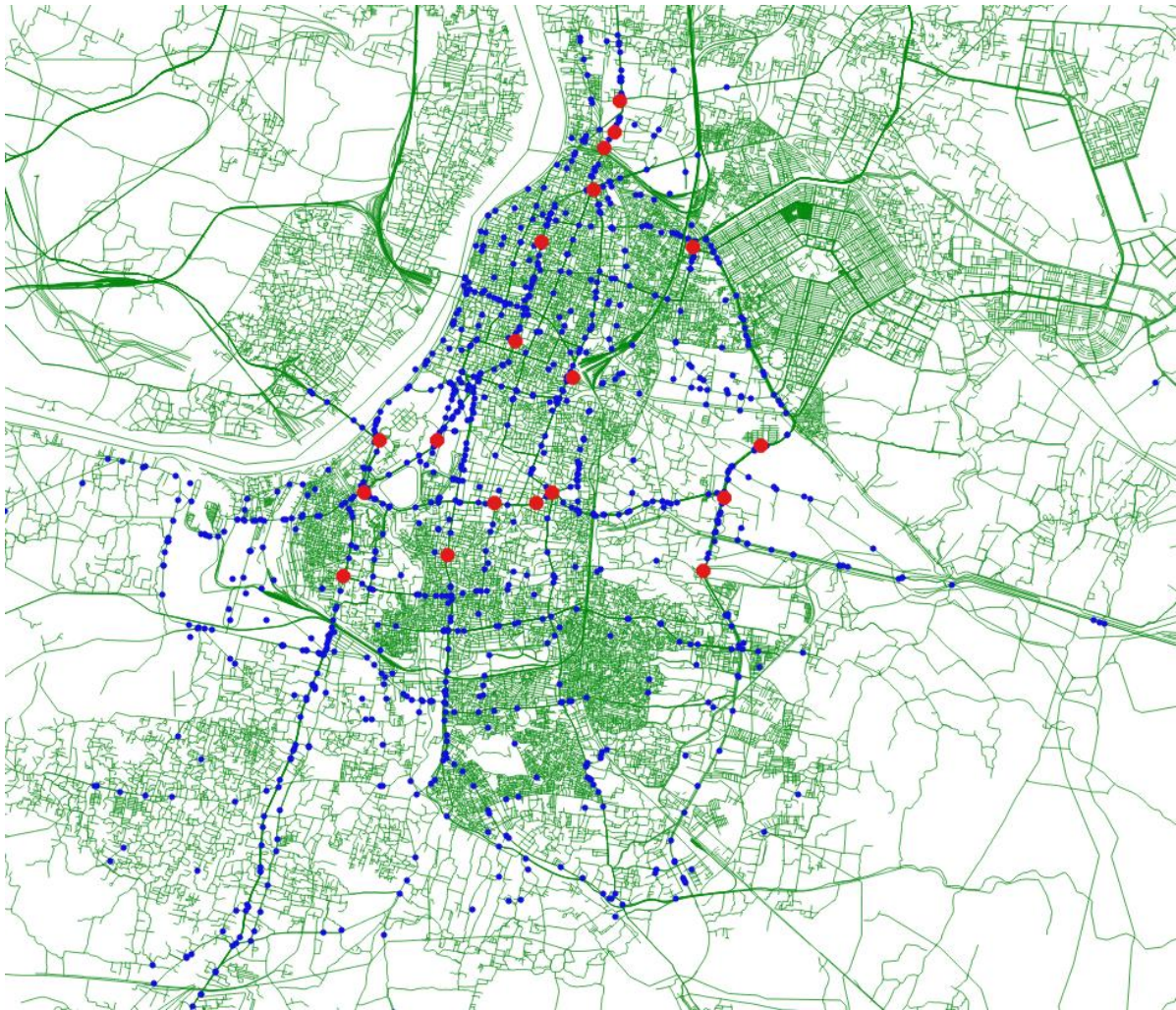


FIGURE 40: SAMPLE GRID WITH HIGHLIGHTED POLYGON THAT CONTAINS 4 FATAL CRASH SPOTS (BLUE DOTS) (IN QGIS SOFTWARE)

1046 fatal crash spots are indicated by the blue dots and 19 identified black spots are indicated by the red dots in Figure 41. This range of 4 or more crashes/10000 m<sup>2</sup> was chosen because, the

crashes are well spread across the city and are not usually clustered at one specific location or area.



**FIGURE 41: FATAL CRASH SPOTS IN BLUE; BLACK SPOTS IN RED. (OUTPUT FROM QGIS SOFTWARE)**  
Details of police station in charge of the crash spot and the area names with landmark is shown for all the 19 identified black spots in the Figure 42.

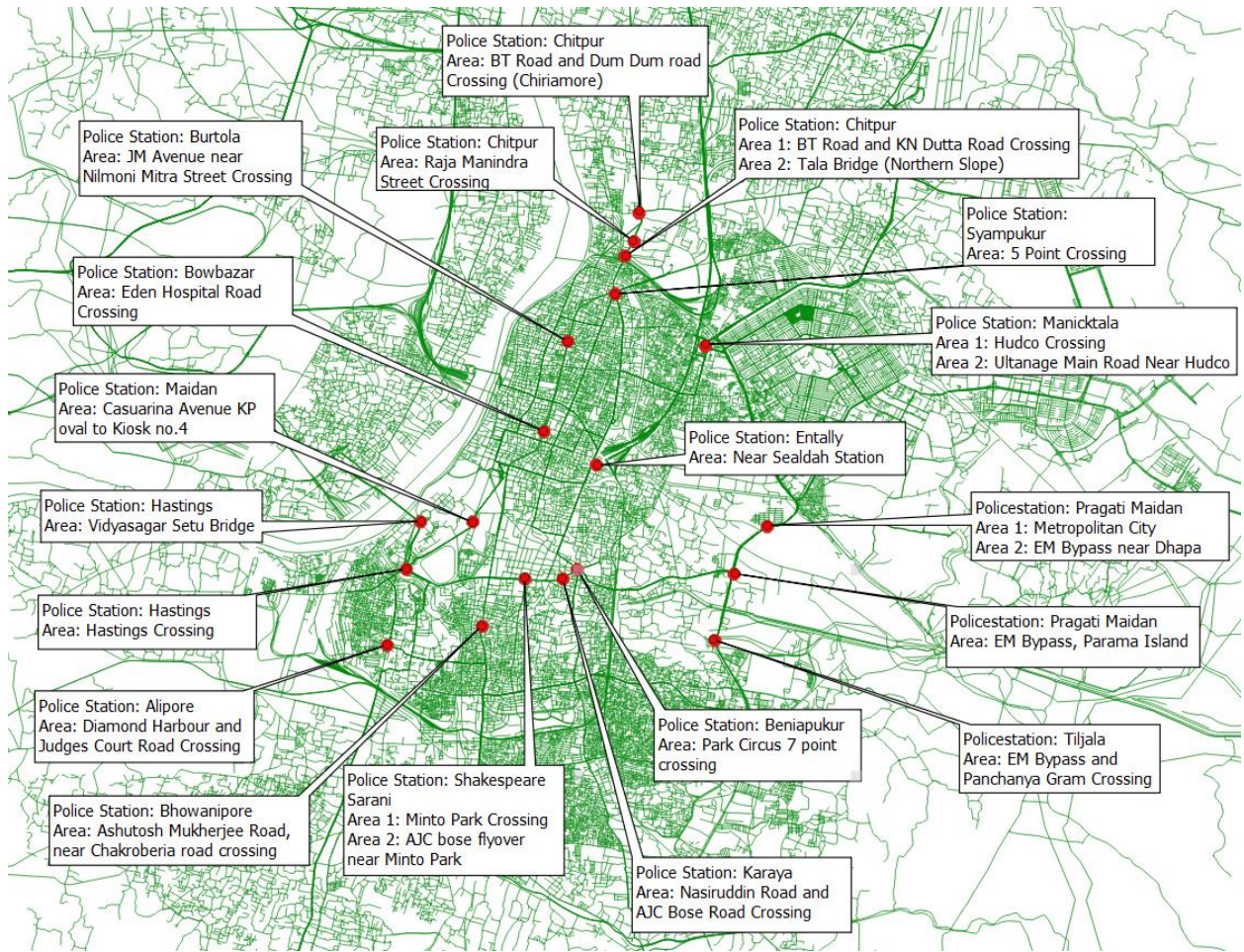


FIGURE 42: DETAILS OF IDENTIFIED BLACK SPOTS. (OUTPUT FROM QGIS SOFTWARE)