

I. INTRODUCTION

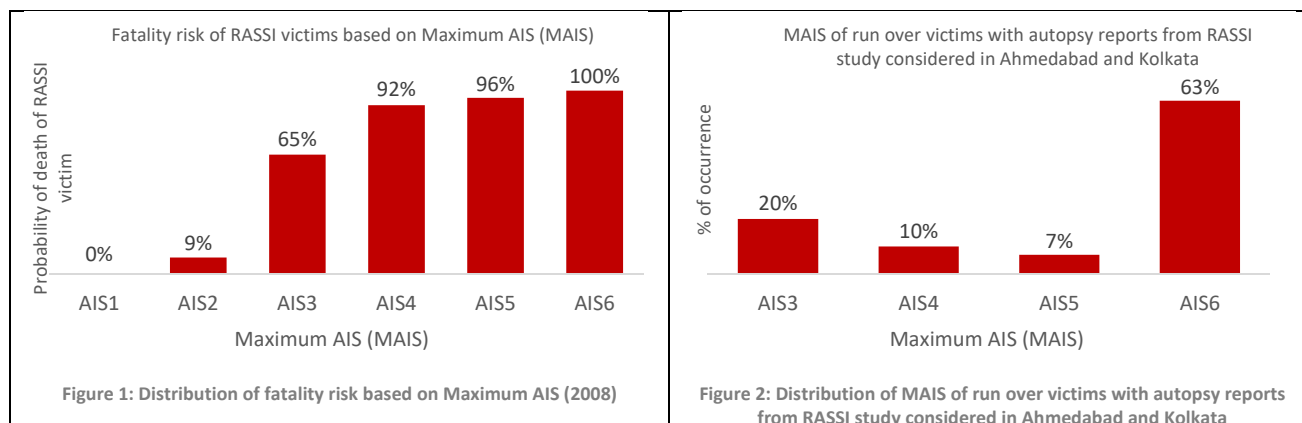
As per the most recently published statistics on road traffic crashes in India [1], the year 2016 witnessed a total of 480,652 road crashes resulting in 150,785 fatalities. In this, nearly 48% of fatalities were to Motorised Two-Wheeler (M2W) riders (35%), pedestrians (11%) and cyclists (2%). In an urban Indian scenario, the roads are densely populated with Vulnerable Road Users (VRUs) and interaction with heavy commercial vehicles is high, so is the crash risk involved and related injury burden. This paper is aimed to project the fatality risk of VRUs (of the cities Ahmedabad and Kolkata) being run over by trucks and buses based on injury severity derived from the Abbreviated Injury Scale (AIS) 2008.

II. METHODS

To understand the scenario, police data [2] of two Indian cities such as Ahmedabad and Kolkata were analysed. A total of 692 fatal crashes (crashes involving at least one fatality) had occurred between January 2016 and December 2016 and in 84% (580) of those crashes at least one VRU died. In that, a collision between a VRU and a truck/ bus was seen in 37% (214) of the fatal crashes. Hence it can be seen that the crash related interaction between VRUs and trucks/ buses is high, but the police data lacks in-depth information regarding these crashes. Hence In-depth road traffic crash data of Ahmedabad and Kolkata collected under the Road Accident Sampling System – India (RASSI) methodology [3] was chosen for the purpose of this study. A total of 470 crashes from RASSI study investigated over a period of three years (April 2014 – March 2017) from the cities Ahmedabad and Kolkata were considered. From that, crashes involving VRUs being run-over (wheels of a vehicle passing over a victim) by trucks/ buses were selected and analysed. For the purpose of this study, “trucks” and “buses” include all types of trucks/ buses exceeding a minimum Gross Vehicle Weight (GVW) of 3.5 tonnes. For the purpose of this study, VRUs include M2W riders, pedestrians and bus occupants who fell down from a moving bus. M2W occupants account for 35% of fatality in India [1] and hence they are categorised as VRU. By design, majority of city buses in India does not have doors fitted at passenger ingress/ egress points and hence the risk of bus occupants falling off the bus through these openings and subsequently getting run over by the same or other vehicles is substantially high. Of the 470 crashes investigated, 294 (63%) crashes involved at least one fatality of which 127 (43%) crashes resulted in run over of a VRU by a truck/ bus. In total 318 fatalities were registered of which 136 (43%) fatalities were a result of run over. Autopsy reports of 98 run over victims were available and hence these 98 fatalities and the corresponding 94 fatal crashes were considered for this study.

III. INITIAL FINDINGS

The RASSI data between April 2011 and March 2017 (6 years) consists of 2,336 crashes. A total of 4,784 crash victims (vehicle occupants and pedestrians) either suffered fatal or non-fatal injuries as a result of the crash. Out of which injury data was available for 1,952 (41%) crash victims. The injuries of these victims were coded using AIS 2008. Figure 1 (Below) shows the probability of death of crash victims from the RASSI database derived based on the Maximum AIS (MAIS). It is important to note that Figure 1 does not consider the age or the MAIS body region of the victims.



The 98 run over victims include 55 vehicle occupants (49 M2W occupants and 6 bus occupants who fell down from a moving bus) and 43 pedestrians. The MAIS based on AIS 2008 of these 98 run over victims with autopsy reports from RASSI study were analysed and the distribution is provided in Figure 2 (Above). Figure 2 shows that MAIS 6 injuries are more prevalent (63%) in run over victims followed by MAIS 3 (20%), MAIS 4 (10%) and MAIS 5 (7%), respectively.

The formula used for developing the fatality risk chart (Figure 1) based on MAIS from RASSI database is,

$$\text{Probability of death} = \frac{\text{MAIS}_{if}}{\text{MAIS}_{ia}} \times 100$$

Eq.1 where, i = Specific AIS severity, f = Count of total fatalities at MAISI and a = Count of total victims at MAISI.

The probability of death estimated out of RASSI data in Figure 1 differs a lot from the global trend except for MAIS 6, and the main reason for such a difference is poor/ inadequate documentation of injuries in the Indian medical records.

IV. DISCUSSION

A comparison between Figure 1 and Figure 2 suggests that 63% of the run over victims sustained MAIS 6 injuries which are currently untreatable, and the fatality risk involved is 100%. There were 17% victims who had suffered MAIS 4 or 5 injuries which corresponds to severe and critical injuries respectively and the probability of death is above 90%. The remaining 20% of the run over victims suffered injuries of MAIS 3 and had a 35% chance to have survived the crash. Hence, this study was aimed to establish a relationship between the fatality risk calculated for RASSI crash victims based on MAIS and relating the respective findings to estimate the probability of death of VRUs getting run over by trucks/ buses in Ahmedabad and Kolkata. The mathematical relationship between Figure 1 and 2 suggests that the fatality risk of VRUs being run over by trucks/ buses is high and the chances of the victims surviving the run overs without getting killed per 100 run over victims is only 8 in Ahmedabad and Kolkata. Although the above estimation holds true to an extent, all 98 (100%) victims considered in this study died as a consequence of resulting injuries. Caution is advised as the analysis is based on a small sample size of fatal run over victims from particular cities and hence it is likely that the fatality risks estimated here is quite high and may not be an accurate representative value. Literature review suggests that there are not many studies conducted to particularly identify the fatality risk involved in run over by trucks and buses. As per the study conducted by [4] the fatality risk involved in run overs is just 11%, this may again be because of the small sample size considered (71 victims) and the study is based on run over by vehicles of all body types, and in most occasions (28%) the run overs were caused by cars, in 14% by trucks and in 6% by buses. It is important to understand that the type of road users in India and Europe are very different. In India, M2Ws are the predominant road users and they are the most affected VRUs as well [1]. But the work of [4] supports this study in a way that all the fatal victims in their study died of injuries with an AIS \geq 4 and the minimum fatality risk estimated as per this research for injuries with AIS \geq 4 is 92%.

In conclusion, this study projects that the severity of the injuries caused by trucks and buses to VRUs in an event of a run over in the cities of Ahmedabad and Kolkata is high and the fatality risk involved is also substantially high. In case of M2W occupants considered in this study, 43% (21 occupants) of them had a self-fall and were subsequently run-over by a truck/ bus, 40% (20 occupants) of M2W occupants either had a side impact (20%) or a sideswipe (20%) with a vehicle and were subsequently run-over by a truck/ bus, 14% (7 occupants) encountered a rear end impact and were subsequently run-over by a truck/ bus, and 1 M2W occupant had an impact with a pedestrian and was subsequently run-over by a truck/ bus. All bus occupants considered in this study fell down from a moving bus and were subsequently run-over by the same vehicle they were traveling. In case of pedestrians, 79% (34 pedestrians) of them were knock down and got subsequently run-over by a truck/ bus and 21% (9 pedestrians) got directly run-over by a truck/ bus. In all these cases, the fatal injuries were as a result of the wheels of the vehicle passing over the victim's body. Nearly 82% of the run over victims considered in this study died on the spot. It is perceived from this study that the chances of VRUs surviving a run over by truck/ bus in Ahmedabad and Kolkata is low and hence the only way to improve the scenario is to prevent run-overs from happening. To prevent or minimise run overs from happening, one or more of the following systems such as a run over protection device or danger zone deflectors, Blind spot mirrors and detection system, Autonomous braking system, should be incorporated. Certain design related changes or enhancements to the vehicles such as large windshield area, nose cone design on the front of the vehicle, properly designed side underrun protection device, automatic doors in buses can also prevent run overs from happening. Although the above mentioned system and design changes can make a difference to the current scenario it is important to analyse its effectiveness individually and in combination in order to incorporate the most effective solution against run overs.

V. REFERENCES

- [1] Transport Research Wing (Ministry of Road Transport and Highways, Government of India), Road Accidents in India, 2016.
- [2] Road traffic crash data of police department of Ahmedabad and Kolkata cities from January 2016 to December 2016.
- [3] Rameshkrishnan N et al, IRCOB, 2011.
- [4] Liener U C et al, Online published: Springer-Verlag Berlin Heidelberg, 2011.