# A new methodology for determining accident and injury contributing factors, and its application to road accidents on the Mumbai–Pune Expressway

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**Abstract -** Road accidents are typically analyzed to address influences of human, vehicle, and environmental (primarily infrastructure) factors. A new methodology, based on a "Venn diagram" analysis, gives a broader perspective on the probable factors, and combinations of factors, contributing both to the occurrence of a crash and to sustaining injuries in that crash. The methodology was applied to 214 accidents on the Mumbai–Pune expressway. Factors contributing to accidents and injuries were addressed. The major human factors influencing accidents on this roadway were speeding (30%) and falling asleep (29%), while injuries were primarily due to lack of seat belt use (46%). The leading infrastructure factor for injuries was impact with a roadside manmade structure (28%), and the main vehicle factor for injuries was passenger compartment intrusion (73%). This methodology can help identify effective vehicle and infrastructure-related solutions for preventing accidents and mitigating injuries in India.

## INTRODUCTION

The World Health Organization (WHO), in its *Global Status Report on Road Safety 2013*, observes that road traffic injuries are "the leading cause of death for young people aged 15-29" worldwide, and that, while many countries have taken steps to reduce fatalities from road traffic accidents, the total "remains unacceptably high at 1.24 million per year" [1].

To find effective solutions to this problem, an in-depth understanding of the problem is essential. Given the complexity of crash events and their causes, this is often a case of "easier said than done." The first requirement, of course, is good data on real world crashes. The second is a means of using the data to understand what happens in these crashes and how both the crash events and their injury consequences could best be avoided. The focus of this study was development and application of a methodology to address this second requirement.

## Background

The traditional wisdom regarding road accidents is that driver error is generally the root cause. In a comprehensive review of various approaches for using crash data to create safer road conditions, Stigson et al. [2] point out that, since 1980 the focus has been on the three factors that contribute to an accident: human, vehicle and road infrastructure/environment and their interactions. As that paper succinctly summarizes, early attempts to look at causation tended to link vehicle and environmental factors to the human factor, with the result that drivers and other road users were identified as "the sole or a contributory factor in approximately 95% of all crashes".

Not surprisingly, such a human factors-centered approach fails to address the vehicular and infrastructural problems that are equally significant in contributing to an accident, for an accident is not a singular event but a "dynamic system" [2]. In "Risk Management in a Dynamic Society: A Modelling Problem", Rasmussen examined the causal foundation of hazardous industrial and transport accidents and rejected the idea of looking at separate elements in isolation in favor of considering the dynamic combination of all possible paths to and causes of failures [3]. That paper notes that while "it is often concluded in accident reviews that 'human error' is a determining factor … multiple contributing errors and faults are normally found".

Stigson et al. brings that point back to road accidents by applying one year of real-world fatal crash data to an analysis of the Swedish Road Administration (SRA) model for a safe transport system. The SRA model employs a Venn diagram approach and includes interactions between road users, vehicles and "the road" (that is, the road environment, including infrastructure) — essentially all the factors that together form the road transport system. The Stigson paper found that 93% of the fatal crashes in that study were classifiable using the SRA model, and that, "of the three components, the road was the one that was most often linked to a fatal outcome" [2].

## Approach

For the current study, a Venn diagram approach was applied to a crash investigation of the Mumbai–Pune Expressway, in India, to determine the contributing factors for accidents occurring on the expressway. Implementing the SRA model to Indian conditions posed some difficulties that required a modified approach. For example, there is no set benchmark for ideal conditions (required by the SRA model). This made it impossible to correlate the factors based on their ratings, as had been done by Stigson et al. for the Swedish crash study. The Stigson paper reports correlations based on the European New Car Assessment Program (EuroNCAP) ratings for cars and European Road Assessment Program Road Protection Score (EuroRAP RPS) ratings for roads.

In the absence of such standard rating systems, the SRA model needed to be refined to reflect the Indian conditions. The new method was then tested by application to all accidents occurring on the Mumbai–Pune Expressway over a period of 12 months. Like the SRA model, this method was used to help determine the contributing factors leading to each accident and, separately, to injuries sustained in each accident. This new methodology, developed from the SRA model, has proven to be useful not only for identifying contributing factors but also for ranking them based on the number of accidents these factors have influenced. This ranking is to help policy makers, decision makers and road safety stakeholders in planning cost effective road safety investments using data-driven road safety strategies.

This paper gives details of the contributing factors methodology, its application to crashes, and the results and conclusions from the examination of road accidents on the Mumbai–Pune Expressway.

# METHODOLOGY

The study included 214 accidents that occurred on the Mumbai Pune Expressway from October 2012 to October 2013. The accidents are part of an ongoing in-depth investigation under the RASSI (Road Accident Sampling System–India) initiative, a database development effort supported by a consortium of automobile original equipment manufacturers and JP Research India [4]. Appendices A and B present some of the information captured and coded as part of detailed case investigations on Indian roads.

As illustrated in Table 1, two accidents with the same accident type can have very different injury outcomes. In Case 1, the driver slept and went off-road on his left. The car was lightly damaged and the driver, who was belted, walked away with no major injuries. In Case 2, the driver of a similar car slept and went off-road, but to the right side into the median space. This car impacted a concrete barrier. The car experienced severe intrusions and the unbelted driver was fatal. In both circumstances the causal scenario is the same: a sleepy driver, but the outcomes are drastically different. In order to address this disparity, the accidents were analyzed to determine the contributing factors that led to each accident and, separately, to the resulting injuries. Analyzing the accidents separately for accident causation and injury causation gives a broader understanding of each accident.

## Establishing a baseline

In keeping with the structure set up for the SRA, certain conditions were assumed to be the "ideal conditions", not meeting which would be considered a failure of that specific factor (human, vehicle or infrastructure). These are listed in brief in Table 2. Keeping the ideal as the baseline, each accident was coded for accident causation factors and injury causation factors.

Table 1. Example cases showing different injury outcomes from the same triggering factor

| **Points of comparison** | **Case 1** | **Case 2** |
|---|---|---|
| Scene photos<br>*Taken along the direction of vehicle's travel* |  |  |
| Vehicle photos<br>*Damages sustained by the vehicle* |  |  |
| Injury severity | No injury | Fatal |
| Contributing factors<br>*Leading to an accident* | Sleepy driver | Sleepy driver<br>Narrow shoulder width |
| Contributing factors<br>*Leading to an injury* | Not applicable<br>(No injury) | Manmade concrete barrier<br>Seatbelt not used by occupants<br>Passenger compartment intrusions |

Table 2. Ideal conditions assumed for coding accident and injury causation

| Category | Accident ideals | Injury ideals |
|---|---|---|
| Human | • Sober / vigilant<br>• Adheres to traffic rules<br>• Uses available safety systems (e.g., side/rear mirrors, lights as appropriate to conditions) | • Proper loading and securing of loads<br>• Uses available safety systems (e.g., seat belts and helmets) |
| Vehicle | • Safe-drivable condition (e.g., good tires, brakes, steering)<br>• Not sized/designed to encourage overloading | • No passenger compartment intrusion<br>• Seat belts available in all seating positions |
| Infrastructure | • Good surface condition (e.g., dry, even, unbroken)<br>• Proper signage/warnings (e.g., curves, mergers)<br>• Sufficient shoulder width<br>• Good layout / traffic flow<br>• Visibility not obstructed | • No rigid barrier without proper impact attenuators<br>• "Forgiving" features on roadside and median where needed (e.g., steep slope or drop-off) |

*Accident causation: baseline*

For accident avoidance, an ideal condition as a starting point for examining the "human factor" influences is defined as the occupant/cyclist/pedestrian is sober and alert, obeys road regulations and has properly used the available safety systems (mirrors, etc.), as outlined in Table 2. Any variation from this ideal is noted in the causal analysis. A vehicle is defined as ideal when the vehicle is in a safe, drivable condition, it has not been designed to encourage overloading (e.g., more interior or cargo space than vehicle can safely manage when loaded to actual capacity) and it offers provisions for securely fastening loads. Road conditions are considered ideal when the road section is in good condition and has proper signage, sufficient shoulder widths, intuitive road layout and function (for turns, merging, etc.), and good visibility. If any of these ideal conditions are not met, the failure is recorded.

*Injury causation: baseline*

For injury avoidance, an ideal human condition exists when occupants/cyclists/pedestrians have properly used the available safety systems (seat belts, helmets, etc.), the vehicle is not overloaded (includes passenger loads) and any non-human loads are properly fastened. Ideal vehicle conditions exist when the vehicle has seat belts available for all its seating positions and suffers no passenger compartment intrusion in the accident. Ideal road conditions exist when there are no rigid barriers (including trees) or other dangerous features, such as steep drop offs, rocky outcrops, etc., alongside the roadway or median. If rigid barriers/dangerous conditions do exist, they should be mitigated by impact attenuators or by structures that can afford sufficient protection to keep vehicles safely on the road while still being forgiving enough to avoid creating even more dangerous impact situations than the ones they are protecting against.

*Example: baseline applied*

As an example of how this works, consider Case 2 from Table 1. In this instance, the contributing factors that led to the accident are human factors alone: driver sleepy and not vigilant (just as in Case 1). However, the contributing factors that led to the fatal injuries are more involved:

- Human - Driver not belted
- Vehicle - Passenger compartment intrusion
- Infrastructure - Absence of impact attenuators before a rigid barrier

Each accident in this study was analyzed against the accident and injury baselines in a fashion similar to that shown in Table 1. The factors were then ranked. For accident causation, this ranking is based on the number of accidents a factor has influenced. For injury causation, the ranking is based on the number of injury occurrences that specific factor has influenced.

## Study area

The Mumbai–Pune Expressway is a 94-kilometer, controlled-access highway that connects Mumbai, the commercial capital of India, to the neighboring city of Pune, an educational and information technology hub of India. It is a six-lane roadway with a speed limit of 80 km/h along most of its stretch. Two-wheelers, three-wheelers and pedestrians are not permitted to use most parts of the expressway and non-motorized vehicles are not permitted for the whole stretch. Common vehicle types plying the expressway are cars, trucks and buses.

## Data analysis

The methodology study consisted of analysis of contributing factors for 214 accidents (irrespective of injury) that occurred on the Mumbai–Pune Expressway over 12 consecutive months. A second analysis was conducted for those 68 accidents that resulted in a fatal or serious injury.

### *Injury severity definitions*

Figure 1 shows the distribution of accidents by the highest level of injury (severity) sustained by any involved party. The definitions for each level of severity are as follows:

Fatal Injury: An accident involving at least one fatality. Any victim who dies within 30 days of the accident as a result of the injuries due to the accident is counted as a fatality.

Serious Injury: An accident with no fatalities, but with at least one or more victims hospitalized for more than 24 hours.

Minor Injury: An accident in which victims suffer minor injuries which are treated on-scene (first aid) or in a hospital as an outpatient.

No Injury: An accident in which no injuries are sustained by any of the involved persons. Usually only vehicle damage occurs as a result of the accident.

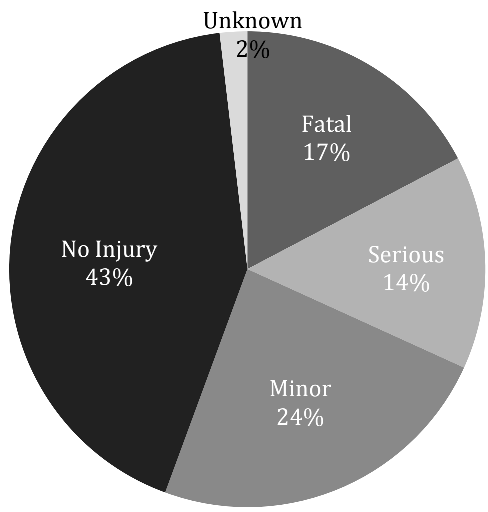


Figure 1. Distribution of accidents by highest injury severity

*Factors influencing occurrence of accidents (214 accidents)*

A distribution by contributing factors (human/vehicle/infrastructure) for the accidents analyzed is shown in the Venn diagram presented as Figure 2. This diagram shows that human factors alone (57%) had the highest influence on the occurrence of accidents, followed by the combination of human and infrastructure factors (22.5%) and vehicle factors alone (16.5%).

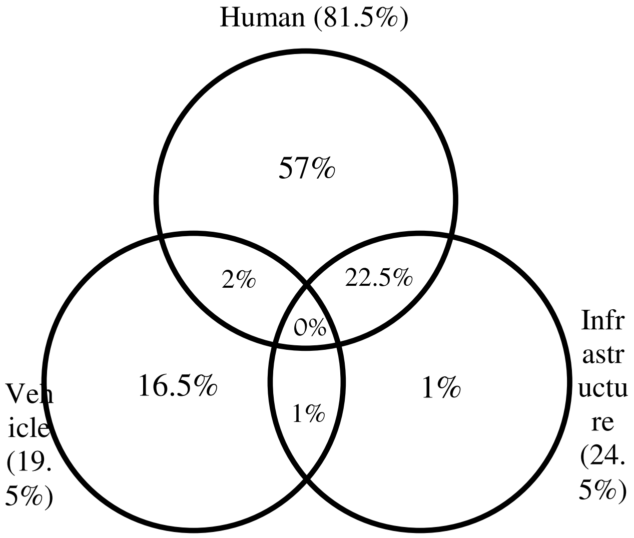


Figure 2. Distribution of accidents by contributing factors influencing accident occurrence

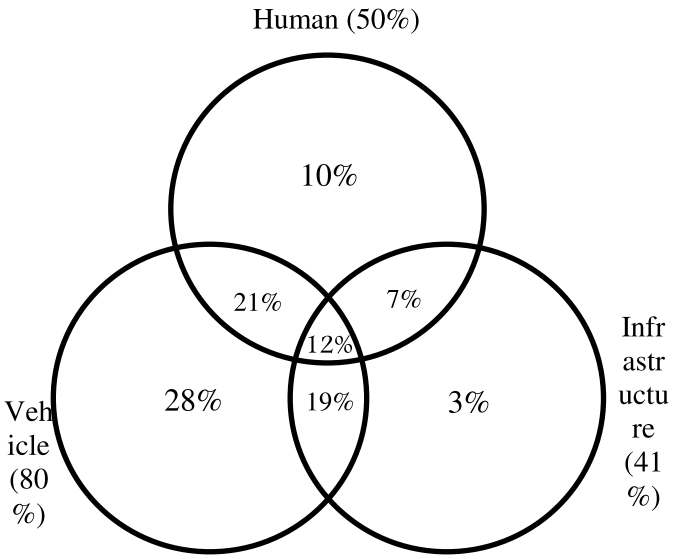


Figure 3. Distribution of fatal/serious injury accidents by contributing factors influencing injury occurrence

*Factors influencing occurrence of injuries (68 fatal/serious accidents)*

Of the 214 accidents, 68 accidents involved fatal or serious injury to at least one occupant or pedestrian. The distribution by contributing factors (human/vehicle/infrastructure) is shown in the Venn diagram presented as Figure 3. This diagram shows that vehicle factors alone (28%) had the greatest influence on a fatal/serious injury outcome, followed by a combination of human and vehicle factors (21%) and combination of vehicle and infrastructure factors (19%).

When the overlapping combinations are considered, infrastructure factors, which were not so pronounced as a stand-alone (showing only a 3% influence) become more evident (41%).

**FINDINGS**

The focus of this paper is on the application of a new methodology modified for India, and the findings presented here are offered as demonstration of types of results obtained using this new methodology. For more details on the findings themselves, see the *Mumbai–Pune Expressway Road Accident Study* [5].

## Accident occurrence

Accident causal factors were analyzed using the new methodology for all 214 accidents, as described under Methodology. The findings are presented by contributing factor type (human, vehicle, or infrastructure). *Please note that more than one factor can influence an accident; hence, the sum of percentage influence may not be equal to sum of factors influencing accidents.*

*Human factors*

Table 3 shows the top five contributing human factors that influenced accidents. Speeding and fatigue are the main contributors. Other contributing factors include following too closely (4%), parked vehicle on road (4%), wrong usage of lanes (3%), parked vehicle off road (2%), overtaking from left of vehicle (2%), illegal road usage (2%), driving under the influence of alcohol or drugs (1%) and dangerous pedestrian behavior on roadway (1%).

Table 3. Contributing human factors influencing accident occurrence

| **Contributing human factors (Accident occurrence)** | **Number of accidents** | **% Influenced** |
|---|---|---|
| Driver Sleep / Fatigue<br>*(50 Trucks, 12 Cars, 1 Minitruck)* | 63 | 29 |
| Speeding – Excessive speed for conditions<br>*(21 Cars, 12 Trucks, 1 Minitruck, 1 Bus)* | 35 | 16 |
| Speeding - Exceeding speed limit<br>*(28 Cars, 1 Truck, 1 Minitruck, 1 Bus)* | 31 | 14 |
| Improper lane change<br>*(11 Trucks, 5 Cars, 1 Bus)* | 17 | 8 |
| Driving too slow for conditions<br>*(13 Trucks, 2 Cars)* | 15 | 7 |

*Vehicle factors*

Table 4 shows the top five contributing vehicle factors that influenced accidents. "Other defect" was also listed as a contributing vehicle factor, with an influence in 1% of accidents. Clearly, though, this category is dominated by brake fade, followed by tire burst.

Table 4. Contributing vehicle factors influencing accident occurrence

| **Contributing vehicle factors (Accident occurrence)** | **Number of accidents** | **% Influenced** |
|---|---|---|
| Brake fade *(24 Trucks)* | 24 | 11 |
| Tire burst *(7 Cars, 2 Buses, 2 Trucks)* | 11 | 5 |
| Steering defect *(3 Trucks)* | 3 | 1 |
| Suspension defect *(2 Trucks)* | 2 | 1 |
| Overloading | 1 | 0.5 |

*Infrastructure factors*

Table 5 gives the top five contributing infrastructure factors that influenced accidents, with the top four showing fairly equal weight. Other factors include improper gap-in-median (1%), vision obstruction because of plantation (0.5%) and uphill gradient (0.5%). The top five factors together contribute to about 32% of all accidents occurring on Mumbai–Pune Expressway.

Table 5. Contributing infrastructure factors influencing accident occurrence

| **Contributing infrastructure factors (Accident occurrence)** | **Number of accidents** | **% Influenced** |
|---|---|---|
| Poor road markings/signage *(11 Trucks, 8 Cars)* | 19 | 9 |
| Narrow shoulder *(13 Cars, 3 Trucks, 1 Bus)* | 17 | 8 |
| Sharp curvature *(10 Trucks, 5 Cars)* | 15 | 7 |
| Inadequate warning about accident/parked vehicle *(11 Trucks, 2 Cars, 2 Buses)* | 15 | 7 |
| No shoulder | 3 | 1 |

The factor "inadequate warning" was judged to be a failure of the Infrastructure/Accident ideal condition of "proper signage", although it could also fall under a Human/Accident category, depending on the circumstances. See discussion under Limitations/Refinements.

### Fatal/serious injury occurrence

Injury causal factors were analyzed using the new methodology for the 68 fatal/serious injury accidents. The findings are presented below. *Please note that more than one factor can influence injury; hence, the sum of percentage influence may not be equal to sum of factors influencing injuries.*

*Human factors*

Table 6 shows the contributing human factors that influenced fatal or serious injury outcomes. As can be seen, failure to use a seat belt was the single largest human factor influencing injury.

Table 6. Contributing human factors influencing fatal/serious injury occurrence

| **Contributing human factors (Injury occurrence)** | **Number of accidents** | **% Influenced** |
|---|---|---|
| Seat belt not used<br>*(26 Cars, 4 Trucks, 1 Minitruck)* | 31 | 46 |
| Overloading of occupants<br>(number of occupants > seating capacity)<br>*(3 Cars, 1 Truck)* | 4 | 6 |
| Occupants in cargo area | 1 | 1 |
| Other | 1 | 1 |

*Vehicle factors*

As Table 7 shows, passenger compartment intrusion causing injury occurred in 27 cars and 21 trucks. The breakdown across the four collision types seen for the cars was as follows: 37% were object impacts, 26% were rollovers, 22% were collisions with trucks, and 15% were collisions were cars. For the trucks that involved injuries from passenger compartment intrusion, the collision types and percentages were as follows: 53% were collisions with trucks, 20% were rollovers, 14% were cargo intrusions, and 14% were object impacts.

Table 7. Contributing vehicle factors influencing fatal/serious injury occurrence

| **Contributing vehicle factors (Injury occurrence)** | **Number of accidents** | **% Influenced** |
|---|---|---|
| Passenger Compartment Intrusion – Other<br>*(20 Cars, 19 Trucks , 1 Minitruck, 1 Bus)* | 41 | 60 |
| Seatbelts not available/usable<br>*(10 Trucks, 1 Bus)* | 11 | 16 |
| Passenger Compartment Intrusion – Underride / Override<br>*(7 Cars, 2 Trucks)* | 9 | 13 |
| Pedestrian Impact / Run over | 4 | 6 |
| Unsecured Cargo<br>*(3 Trucks)* | 3 | 4 |

*Infrastructure factors*

The largest percentages of infrastructure influences on fatal/serious injury involved object impacts, as shown in Table 8. Most of the objects encountered along the expressway are manmade structures located on the roadside or median. On the expressway, these objects included concrete barriers/walls (27%), guard rails (18%), flower pots (14%), bridge walls (14%), overhead bridge pillars (14%), sign posts, curb stones, etc. Flower pots and curb stones may look harmless, but in the event of an impact, these can be quite devastating to the car and its occupants. Natural objects can be just as deadly; trees accounted for 14% of object impacts on the expressway. Also, as noted in the previous paragraph, a lot of passenger compartment intrusions, which significantly reduce occupant safety, have been caused by collisions with these objects.

Table 8. Contributing infrastructure factors influencing fatal/serious injury occurrence

| Contributing infrastructure factors (Injury occurrence) | Number of accidents | % Influenced |
|---|---|---|
| Object impact - roadside/median - manmade structures *(17 cars, 1 truck, 1 minitruck)* | 19 | 28% |
| Roadside - Steep slope/Drop off *(5 trucks, 3 cars)* | 8 | 12% |
| Object impact - roadside - trees/plantations | 3 | 4% |
| Object impact – Other | 2 | 3% |

The expressway also includes numerous sections with bridges over canals and mountain regions with steep drop offs. It has been noted that adequate barriers are not provided to prevent vehicles from tipping over and plummeting down slopes or into hillsides. Figure 4 presents one such example of an inadequate barrier on a hillside.

Figure 4. Cliffside barrier breached in a crash

## DISCUSSION

### Comparison to standard approach

The results of the new methodology show that human factors are not the only significant contributors to crashes or injury on Indian roads. While the main contributing factors leading to accidents on the expressway (Table 9) during the study period were, in fact, shown to be heavily weighted to human error, infrastructure was found to be a factor in nearly one fourth of all the accidents analyzed, and vehicle problems were a factor in nearly a fifth. This could be unique to infrastructure, vehicle maintenance, and lack of enforcement issues that exist in developing countries.

Table 9. Main contributing factors leading to accidents
(Based on 214 Accidents on the Mumbai–Pune Expressway)

| Human (81.5%) | Vehicle (19.5%) | Infrastructure (24.5%) |
|---|---|---|
| • Speeding (30%)<br>• Driver Sleep/Fatigue (29%)<br>• Lane changing (8%) | • Brake fade in trucks (11%)<br>• Tire bursts (5%) | • Poor road markings/signage (9%)<br>• Narrow or no shoulders (8%)<br>• Sharp curvature (7%)<br>• Inadequate warning of accident / broken down vehicles (7%) |

The findings are even more striking for injury causes. Table 10 is a summary of the main factors contributing to fatal/serious injuries in the expressway during the study period. In this case, vehicle factors contributed to injuries in 80% of the fatal/serious injury crashes analyzed, with passenger compartment intrusion occurring in 73% of these accidents. Again, lack of safety standards and regulatory requirements contribute significantly to these accidents and injuries.

Table 10. Main contributing factors leading to fatal/serious injuries
(Based on 68 Fatal Serious Accidents on the Mumbai–Pune Expressway)

| Human (50%) | Vehicle (80%) | Infrastructure (41%) |
|---|---|---|
| • Seat belt not used (46%)<br>• Overloading (6%) | • Passenger compartment intrusion (73%)<br>• Seat belts not available / usable (16%) | • Object impacts with roadside and median manmade structures (28%)<br>• Roadside steep slopes / drop offs (12%) |

### Limitations/Refinements

The methodology for India is in its infancy, and will be expanded with more data in the future. Probably the greatest opportunity for refinement is in the baseline "ideals" used. For example, the factor "inadequate warning" of a crash or breakdown was judged to be an infrastructure failure, per the Infrastructure/Accident ideal of "proper signage". This is under the theory that, especially along expressways, there should be a patrolling team which cordons off the vehicles and accident site with appropriate warning signs and devices. However, it could also be considered failure of a Human/Accident ideal condition *if* one existed, that covered vehicle occupants' failure to place safety triangles or flares on the road. In this case, interpretation plus lack of a fitting "ideal condition" for accident avoidance under human factors, pushed all such events into the Infrastructure/Accident category.

Similarly, some "ideal" conditions would benefit from being stated as more specific subsets. For example, the ideal infrastructure conditions for accident causation could be clarified to specifically include "road is smooth and free of potholes or significant defect" and "road is free of contaminants (water, gravel, oil, etc.) affecting traction/steering", etc. versus the current, broadly phrased "good surface condition". Ideal vehicle conditions regarding accident avoidance could specify such safety systems as working headlights and taillights (and a related human factor noting lights should be "on" in low visibility conditions); at present, condition of lights is not routinely or reliably recorded in most accident reports, although where information on poor condition of the lighting system is available, it is coded in the model.

As the codes listed in Appendices A and B show, there are many categories that overlap. In the absence of an existing baseline for Indian road conditions (such as the standard rating systems available for the SRA model), the ideals set forth in Table 2 are a first attempt to pull some of these categories together in an intuitive way. The goal is to form a broadly-stated standard designed to make coding easier and subsequent analyses more meaningful.

## CONCLUSIONS

The use of the new methodology to examine crashes on the Mumbai–Pune Expressway shed light on the influences of vehicles and infrastructure. Human factors alone (57%) were found to have the highest influence on the occurrence of accidents, followed by the combination of human and infrastructure factors (22.5%) and vehicle factors alone (16.5%). Vehicle factors alone (28%) were found to have the greatest influence on a fatal/serious injury outcome, followed by a combination of human and vehicle factors (21%) and combination of vehicle and infrastructure factors (19%).

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## APPENDIX A: CONTRIBUTING FACTORS FOR ACCIDENT

| HUMAN – 1000 | | |
|---|---|---|
| **Code** | **Category** | **Description** |
| **1100** | **Driver - Fitness To Drive** | |
| | 1101 | Driver - Alcohol |
| | 1102 | Driver - Other Stimulation substances - drugs, medication |
| | 1103 | Driver - Sleep/Fatigue/Drowsiness |
| | 1104 | Driver - Illness or disability - mental or physical |
| | 1147 | Driver - Other |

| HUMAN – 1000 | | | |
|---|---|---|---|
| **1150** | **Pedestrian - Fitness To Walk** | | |
| | | 1151 | Pedestrian - Alcohol |
| | | 1197 | Pedestrian - Other |
| **1200** | **Speed** | | |
| | | 1201 | Speeding - Exceeding speed limit |
| | | 1202 | Speeding - Excessive speed for conditions |
| | | 1203 | Speeding - Speed limit unknown |
| | | 1204 | Driving too slow for conditions |
| | | 1205 | Parked - vehicle on road (full or partial) |
| | | 1206 | Parked - vehicle off the road |
| | | 1207 | Parked - vehicle due to traffic |
| | | 1297 | Other |
| **1300** | **Distraction - Driver** | | |
| | | 1301 | Driver using mobile phone |
| | | 1302 | Driver distraction inside vehicle |
| | | 1303 | Driver distraction outside vehicle |
| | | 1304 | Driver Inattention |
| | | 1347 | Other |
| **1350** | **Distraction - Pedestrian** | | |
| | | 1351 | Pedestrian using mobile phone |
| | | 1354 | Pedestrian inattention |
| | | 1397 | Other |
| **1500** | **Driver Behaviour** | | |
| | | 1501 | Use of wrong lane (includes overtaking in undivided roads) |
| | | 1502 | Illegal road usage (includes travelling in the wrong direction) |
| | | 1503 | Violation of Right of Way |
| | | 1504 | Following too closely |
| | | 1505 | Overtaking on left side of vehicle |
| | | 1506 | Changing lanes / Turning suddenly or without indication |
| | | 1547 | Other |
| **1550** | **Pedestrian Behaviour** | | |
| | | 1551 | Pedestrian - Dangerous behaviour on roadway |
| | | 1597 | Other |
| | | 9999 | Unknown |

| VEHICLE - 2000 | | | |
|---|---|---|---|
| **Code** | **Category** | | **Description** |
| **2100** | **Vehicle Defect** | | |
| | | 2101 | Defective - Tires |
| | | 2102 | Defective - Brakes |
| | | 2103 | Defective - Steering |
| | | 2104 | Defective - Suspension |
| | | 2197 | Defective - Other |
| **2200** | **Vehicle Misuse** | | |
| | | 2201 | Overloading - goods |
| | | 2202 | Goods not secured properly |

| VEHICLE - 2000 | | |
|---|---|---|
| | 2203 | Overloading - people |
| | 2297 | Other |
| **2400** | **Vision Obstruction** | |
| | 2401 | Due to vehicle interiors |
| | 2497 | Other |

| INFRASTRUCTURE - 3000 | | |
|---|---|---|
| **Code** | **Category** | **Description** |
| **3100** | **Road Surface Defects** | |
| | 3101 | Defective road surface |
| | 3102 | Slippery road surface |
| | 3103 | Deposits on road surface (oil, mud, fluids, etc.) |
| | 3197 | Other |
| **3200** | **Road Design** | |
| | 3201 | Sharp Curvature |
| | 3202 | Bridge |
| | 3203 | Shoulder - Narrow |
| | 3204 | Shoulder - None |
| | 3205 | Uphill gradient |
| | 3247 | Other |
| **3250** | **Pedestrian Infrastructure** | |
| | 3251 | Poor pedestrian infrastructure - Crossing |
| | 3252 | Poor pedestrian infrastructure - Walking alongside |
| | 3253 | Public Bus stop |
| | 3297 | Other |
| **3300** | **Road Information** | |
| | 3301 | Poor road marking/signage |
| | 3302 | Poor street lighting |
| | 3303 | Poor object conspicuity |
| | 3304 | Inadequate warning about accident / parked vehicle |
| | 3397 | Other |
| **3400** | **Vision Obstruction** | |
| | 3401 | Parked vehicles |
| | 3402 | Manmade objects |
| | 3403 | Trees/Plantation |
| | 3404 | Hill Crest |
| | 3405 | Road Curvature |
| | 3497 | Other |
| **3500** | **Road Traffic Flow** | |
| | 3501 | Undivided |
| | 3502 | Gap-in-median |
| | 3503 | Intersection |
| | 3504 | Work zone |
| | 3597 | Other |

## APPENDIX B: CONTRIBUTING FACTORS FOR INJURY

| HUMAN - 1000 | | |
|---|---|---|
| **Code** | **Category** | **Description** |
| **1600** | **Safety System Use** | |
| | 1601 | Seat belt not used |
| | 1602 | Helmet not used |
| | 1603 | Occupants in cargo area |
| | 1604 | Overloading of occupants |
| | 1697 | Other |
| **1800** | **Lifesaving Skills** | |
| | 1801 | Improper accident/breakdown management |
| | 1802 | Lack of first-aid skills |
| | 1803 | Improper evacuation of occupants |
| | 1897 | Other |

| VEHICLE - 2000 | | |
|---|---|---|
| **Code** | **Category** | **Description** |
| **2600** | **Crash Protection** | |
| | 2601 | Seatbelts not available/usable |
| | 2602 | Runover (for Pedestrian, M2W riders) |
| | 2603 | Passenger Compartment Intrusion - Underride/Override |
| | 2604 | Passenger Compartment Intrusion - Other |
| | 2605 | Retrofitted fuel kit |
| | 2606 | Protruding/oversized cargo |
| | 2607 | Unsecured Cargo |
| | 2697 | Other |
| **2800** | **Vehicle** | |
| | 2801 | Entrapment |
| | 2802 | Fire |
| | 2897 | Other |

| INFRASTRUCTURE - 3000 | | |
|---|---|---|
| **Code** | **Category** | **Description** |
| **3600** | **Road Furniture** | |
| | 3601 | Object impact - road side - trees/plantation |
| | 3602 | Object impact - road side - manmade structures |
| | 3603 | Object impact - Other |
| | 3604 | Road Side - Steep slope/Drop off |
| | 3697 | Other |
| **3800** | **Medical Response** | |
| | 3801 | EMS availability |
| | 3802 | Distance to hospital |
| | 3897 | Other |