

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
<p>Scene photos <i>Taken along the direction of vehicle's travel</i></p>		
<p>Vehicle photos <i>Damages sustained by the vehicle</i></p>		
<p>Injury severity</p>	<p>No injury</p>	<p>Fatal</p>
<p>Contributing factors <i>Leading to an accident</i></p>	<p>Sleepy driver</p>	<p>Sleepy driver Narrow shoulder width</p>
<p>Contributing factors <i>Leading to an injury</i></p>	<p>Not applicable (No injury)</p>	<p>Manmade concrete barrier Seatbelt not used by occupants Passenger compartment intrusions</p>

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

Category	Accident ideals	Injury ideals
Human	<ul style="list-style-type: none"> • Sober/vigilant • Adheres to traffic rules • Uses available safety systems (e.g., side/rear mirrors, lights as appropriate to conditions) 	<ul style="list-style-type: none"> • Proper loading and securing of loads • Uses available safety systems (e.g., seat belts and helmets)
Vehicle	<ul style="list-style-type: none"> • Safe-drivable condition (e.g., good tires, brakes, steering) • No room for overloading (occupants and cargo) 	<ul style="list-style-type: none"> • No passenger compartment intrusion • Seat belts available in all seating positions
Infrastructure	<ul style="list-style-type: none"> • Good surface condition (e.g., dry, even, unbroken) • Proper signage/warnings (e.g., curves, mergers) • Sufficient shoulder width • Good layout/traffic flow • Visibility not obstructed 	<ul style="list-style-type: none"> • No rigid barrier without proper impact attenuators • “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 and does not allow overloading of occupants and cargo that affects the dynamics of vehicle. 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.

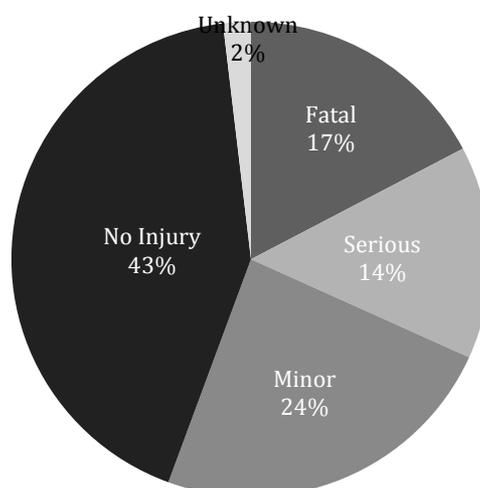


Figure 1. Distribution of accidents by highest injury severity

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%).

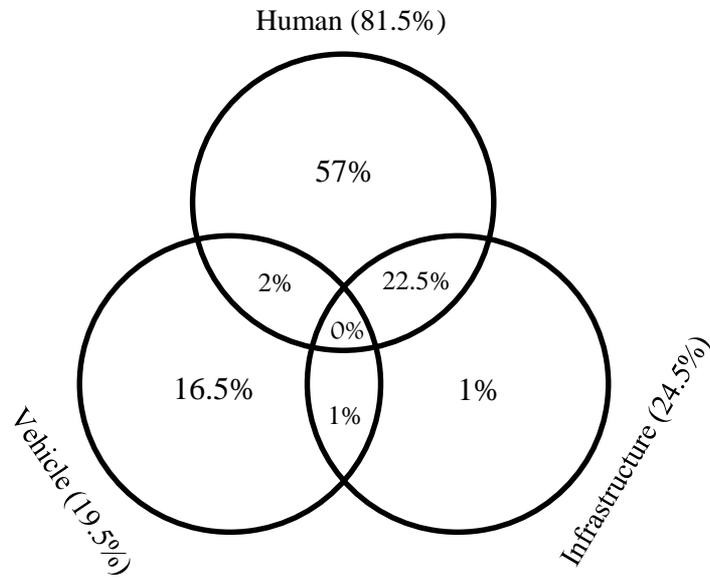


Figure 2. Distribution of accidents by contributing factors influencing accident occurrence

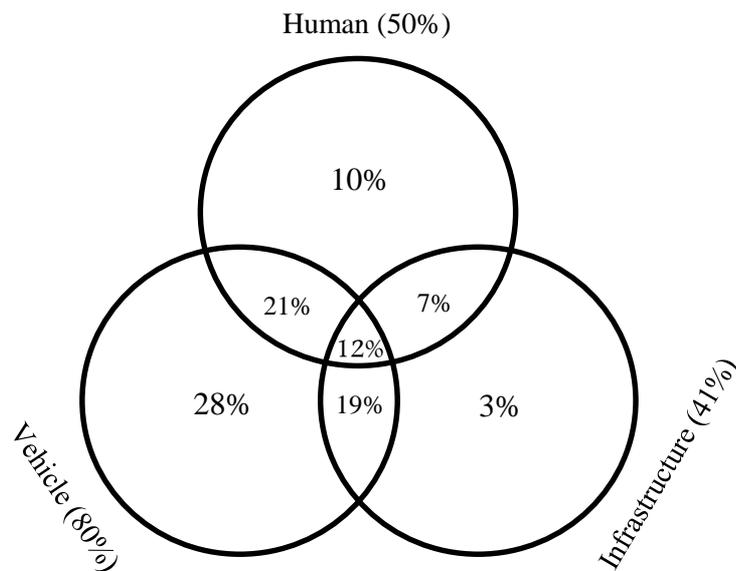


Figure 3. Distribution of fatal/serious injury accidents by contributing factors influencing injury occurrence

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 (50 Trucks, 12 Cars, 1 Minitruck)	63	29
Speeding – Excessive speed for conditions (21 Cars, 12 Trucks, 1 Minitruck, 1 Bus)	35	16
Speeding - Exceeding speed limit (28 Cars, 1 Truck, 1 Minitruck, 1 Bus)	31	14
Improper lane change (11 Trucks, 5 Cars, 1 Bus)	17	8
Driving too slow for conditions (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 (26 Cars, 4 Trucks, 1 Minitruck)	31	46
Overloading of occupants (number of occupants > seating capacity) (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 (20 Cars, 19 Trucks, 1 Minitruck, 1 Bus)	41	60
Seatbelts not available/usable (10 Trucks, 1 Bus)	11	16
Passenger Compartment Intrusion – Underride/Override (7 Cars, 2 Trucks)	9	13
Pedestrian Impact/Run over	4	6
Unsecured Cargo (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%)
<ul style="list-style-type: none"> • Speeding (30%) • Driver Sleep/Fatigue (29%) • Lane changing (8%) 	<ul style="list-style-type: none"> • Brake fade in trucks (11%) • Tire bursts (5%) 	<ul style="list-style-type: none"> • Poor road markings/signage (9%) • Narrow or no shoulders (8%) • Sharp curvature (7%) • 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%)
<ul style="list-style-type: none"> • Seat belt not used (46%) • Overloading (6%) 	<ul style="list-style-type: none"> • Passenger compartment intrusion (73%) • Seat belts not available/usable (16%) 	<ul style="list-style-type: none"> • Object impacts with roadside and median manmade structures (28%) • 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
1150	Pedestrian - Fitness To Walk	
	1151	Pedestrian - Alcohol
	1197	Pedestrian - Other

HUMAN – 1000		
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
	2203	Overloading - people
	2297	Other

VEHICLE - 2000		
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