Crash Investigation and Black Spot Assessment

By

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WRI India Sustainable Cities - India Vision Zero
Bhubaneswar, 18-20 September 2016
JPRI Crash Investigation Methodology

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Crash Notification
- Police
- Ambulance

Crash Investigation
- Examination
  - Crash Scene
  - Crash Vehicles

Crash Reconstruction

Injury Analysis

Scientific Data Collection Process
- Engineering Data
  - PC Crash
  - Speed Estimations
  - Delta - V

Injury Data
- AIS (AAAM)
- Injury Correlation
Lack of reliable crash data
Changing the way India looks at crashes

- Scientific basis required.
- Purpose should not be limited to which driver is responsible for the crash.
- Determination of all possible contributing factors leading to the crash and the consequential injuries.
Example case

- Crash location: Intersection
- Crash time: 01:15 hrs
- One occupant of car fatal.
- The occupant was entrapped and evacuation took hours.

Courtesy: Google Earth
Crash Scene Examination

• Identification and marking of vehicle trajectories (skid/brake marks), point of impact and final resting positions.

• Taking pictures and measurements.
Crash Scene Diagram (to scale)

Legend
1 - Tipper’s tyre mark
2 - Car’s tyre mark
O - oil pool
W - wheel bolt print
G - Gouge marks of truck and car
Crash Vehicle Examination
CCTV Footage

Courtesy: Ahmedabad City Police
Speed Estimation – Tipper

Time - 1:45:705 (m:ss:ms)  
Distance : 17.4m for tipper

Time - 1:47:278 (m:ss:ms)
Speed Estimation – Car

Time - 1:45:685 (m:ss:ms)

Distance : 9m for car

Time - 1:47:269 (m:ss:ms)
## Speed Calculations

<table>
<thead>
<tr>
<th>Velocities to be found</th>
<th>Values</th>
<th>Results (kmph)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tipper average speed (kmph)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V = \frac{d}{t} \times 3.6$</td>
<td>$d = 17.4 \text{ m}$</td>
<td>$t = 1.573 \text{ s}$</td>
</tr>
<tr>
<td><strong>Car average speed (kmph)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V = \frac{d}{t} \times 3.6$</td>
<td>$d = 9 \text{ m}$</td>
<td>$t = 1.825 \text{ s}$</td>
</tr>
</tbody>
</table>
Reconstruction: PC Crash Simulation

Driver vision obstruction due to median plantation and structures.

Low sight distance resulted in late reaction by tipper driver.
Contributing factors for this crash

- Overloaded tipper
- Car driver did not wait to check before crossing
- Car occupant entrapment
- Car occupant evacuation time
- Vision obstruction because of median plantation

*Is there a more systematic way to identify these factors?*

Haddon Matrix.
Haddon Matrix

• Created by Dr. William Haddon Jr.

• A physician and doctor.

• Widely considered to be the father of modern injury epidemiology.

• Haddon Matrix was developed in the late 1950s.
The Haddon Matrix: 3 Factors

- Specifying and examining the 3 factors

HUMAN  VEHICLE  INFRASTRUCTURE/ENVIRONMENT
The Haddon Matrix: 3 Phases

In a timeline of 3 phases of a traffic accident:

• **Pre-crash:** Prevention of crash

• **Crash:** Prevention/reduction of injury

• **Post-crash:** Life-sustaining
The Haddon Matrix: 3 x 3

PHASES

FACTORS
The Haddon Matrix

<table>
<thead>
<tr>
<th>PHASE</th>
<th>HUMAN</th>
<th>VEHICLE</th>
<th>INFRASTRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-CRASH</td>
<td>Crash Prevention</td>
<td>1. Information</td>
<td>2. Roadworthiness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Police enforcement</td>
<td>5. Handling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Speed control</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRASH</td>
<td>Injury prevention during the</td>
<td>4. Use of safety systems</td>
<td>5. Occupant restraints</td>
</tr>
<tr>
<td></td>
<td>crash</td>
<td></td>
<td>6. Other Safety devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7. Crash protective design</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Applying Haddon Matrix to Tipper-car crash

<table>
<thead>
<tr>
<th>PHASE</th>
<th>HUMAN</th>
<th>VEHICLE</th>
<th>INFRASTRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRE-CRASH</strong></td>
<td>Crash Prevention</td>
<td>Car - Violation of right of way</td>
<td>Roadworthiness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Truck - Overloading</td>
<td>Working lights</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Good brakes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Handling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Speed control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vision obstruction due to median plantation</td>
</tr>
<tr>
<td><strong>CRASH</strong></td>
<td>Injury prevention during the crash</td>
<td>Use of safety systems</td>
<td>Crash protective roadside objects</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>POST-CRASH</strong></td>
<td>Life Sustaining</td>
<td>First-aid skill</td>
<td>Car – Occupant Entrapment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Access to medics</td>
<td>Car – Occupant Evacuation</td>
</tr>
</tbody>
</table>
JPRI - WRI-India Crash Data Collection Forms

- 3-4 page form and coding manual for in-depth data collection
Analysis: Fatal Pedestrian Accidents in Kolkata City

Infrastructure has 100% influence on the occurrence of fatal pedestrian accidents

Source: Kolkata city fatal accident study report 2014 - 2015

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## Contributing factors for fatal pedestrian accidents

<table>
<thead>
<tr>
<th>Human (81%)</th>
<th>Vehicle (100%)</th>
<th>Infrastructure (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speeding more than 30Kmph (77%)</td>
<td>Pedestrian knocked down to the ground (66%)</td>
<td>Poor pedestrian infrastructure – crossing (72%)</td>
</tr>
<tr>
<td>Driver inattention / Distraction (8%)</td>
<td>Pedestrian run over (34%)</td>
<td>Poor pedestrian infrastructure – walking alongside (28%)</td>
</tr>
<tr>
<td>None</td>
<td>Vision obstruction due to vehicle interiors (8%)</td>
<td>None</td>
</tr>
</tbody>
</table>

*Source: Kolkata city fatal accident study report 2014 - 2015*
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Black spots

- GPS Coordinates of 316 fatal accidents from Nov 2014 to Nov 2015.

- No 2 fatal accidents occurred at the same location.

- Fatal accidents are widely spread around Kolkata city.
Infrastructure factors leading to fatal pedestrian crossing accidents

- 72% of fatal pedestrian accident occurs when pedestrians are trying to cross the road.
- 76% of fatal pedestrian crossing accident occurs at or near junctions.

Source: Kolkata city fatal accident study report 2014 - 2015
Example fatal pedestrian crossing accident
Crossing distance >10 m

Source: Kolkata Traffic Police
Infrastructure factors leading to fatal pedestrian walking alongside accidents

- 28% of fatal pedestrian accidents occur when pedestrians are walking alongside the road.

Source: Kolkata city fatal accident study report 2014 - 2015
Black spot assessment on Mum – Pune E’way “Zero Fatality Corridor” Project

<table>
<thead>
<tr>
<th>S. No</th>
<th>Contributing factor</th>
<th>Frequency</th>
<th>Frequency Type</th>
<th>No. of Fatal Victims (Average per year)</th>
<th>No. of Injured Victims (Average per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Narrow/No shoulder</td>
<td>218.09</td>
<td>Distance (km)</td>
<td>19</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>Roadside/Median concrete structure</td>
<td>275.00</td>
<td>Count</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>Roadside steep slope/drop-off</td>
<td>79.14</td>
<td>Distance (km)</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Poor/ineffective road signage</td>
<td>20.00</td>
<td>Count</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>Sharp road curvatures</td>
<td>162.00</td>
<td>Count</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>Gaps-in-median</td>
<td>88.00</td>
<td>Count</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>Unguarded overhead bridge pillars</td>
<td>122.00</td>
<td>Count</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Unguarded Bridge/Jersey wall</td>
<td>166.00</td>
<td>Count</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Unguarded Underpasses</td>
<td>96.00</td>
<td>Count</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Entry/Exit road</td>
<td>76.00</td>
<td>Count</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Driver vision obstruction</td>
<td>37.00</td>
<td>Count</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>Roadside trees</td>
<td>21.37</td>
<td>Distance (km)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>Curb stones</td>
<td>67.44</td>
<td>Distance (km)</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>Guardrail end taper</td>
<td>169.00</td>
<td>Count</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>Flower pots in the median</td>
<td>14.24</td>
<td>Distance (km)</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Making Overhead Bridge Pillars Forgiving
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ASSESS ROAD SAFETY USING CRASH DATA

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Summary

• On-site crash investigations required for reliable crash data.

• Haddon Matrix needs to be applied for systematic determination of all contributing factors in a crash.

• Contributing Infrastructure Factors identified can then be analysed for assessing black spot issues and providing suitable interventions.

• Infrastructure design has a significant influence on road accidents.
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Thank You

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PUNE

AHMEDABAD

KOLKATA

19 September, 2016