“Crash Risk analysis for Vulnerable road Users For Urban Roads-A case study of Vadodara City”

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• Road safety aspects in India
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• Objective of study
• Study area
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• Result and discussion
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World Wide Road Safety Scenario

- Injuries: 50 million
- Deaths: 1.3 million
- And still rising...
## World Wide Fatalities

### Number of persons killed per 100000 population

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of persons killed per 100000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qatar</td>
<td>32.37</td>
</tr>
<tr>
<td>South Africa</td>
<td>32.53</td>
</tr>
<tr>
<td>Botswana</td>
<td>26.5</td>
</tr>
<tr>
<td>Malaysia</td>
<td>25</td>
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<td>Russia</td>
<td>22.95</td>
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<td>Kuwait</td>
<td>18.28</td>
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<td>USA</td>
<td>14.86</td>
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<td>Korea, R</td>
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<td>India</td>
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<td>9.83</td>
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<td>6.54</td>
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<td>France</td>
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<td>Japan</td>
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<td>Germany</td>
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<td>Denmark</td>
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<td>UK</td>
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<tr>
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<td>Sweden</td>
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<td>Singapore</td>
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<td>Brazil</td>
<td>3.33</td>
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<td>Pakistan</td>
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### Number of persons killed

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of persons killed</th>
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<td>India</td>
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<td>China, PR</td>
<td>8,5613</td>
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<tr>
<td>USA</td>
<td>4,3320</td>
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<td>Russia</td>
<td>3,2605</td>
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<tr>
<td>South Africa</td>
<td>1,0800</td>
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<td>Indonesia</td>
<td>1,1880</td>
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<td>Japan</td>
<td>6477</td>
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<td>Korea, R</td>
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<td>Brazil</td>
<td>6071</td>
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<td>Malaysia</td>
<td>5684</td>
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<td>Italy</td>
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<td>India</td>
<td>4961</td>
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<td>France</td>
<td>4515</td>
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<td>Pakistan</td>
<td>3168</td>
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<td>UK</td>
<td>2744</td>
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<td>Canada</td>
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<td>Australia</td>
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<td>Philippines</td>
<td>459</td>
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<td>Botswana</td>
<td>446</td>
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<td>Qatar</td>
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<td>Denmark</td>
<td>204</td>
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</table>
Projection Of Fatalities In World

- **Scenario 1: Do Nothing**
  - 94 million additional fatalities

- **Scenario 2: Act Now**
  - Today
Road Safety: An Epidemic

- **1.4 million** people are killed and **50 million** are injured worldwide per annum due to road crashes.

- **Developing countries account for 90% of the casualties. It’s the leading cause of death of young people worldwide.** If unabated, the number of deaths will increase to **1.9 million per annum (worldwide)** by 2020.
Road Safety Aspects In India

1,25,000 deaths every year
10% of global road fatalities

342 deaths per day, equivalent to a jumbo crash everyday – no survivors
15 deaths per hour
One of the top three causes of death for 5-44 yr age group
Total Road Crashes In India During 2002-2011

Source: Road Accidents in India (2011). New Delhi, Transport Research Wing, Ministry of Road Transport and Highways, Government of India.
Fatalities In Indian States

Fatalities > 5000
(8 States Total 79000) - 69%

Fatalities: 500 to 5000
(13 States Total 34000) - 30%

Fatalities < 500
(14 States Total 1600) - 1%

- Fatalities/million population
- Fatalities
Fatalities In Major Indian Cities

![Graph showing fatalities in major Indian cities.]
Fatalities by Road user type in India

- **Two Wheelers**: 22%
- **Car, Taxis etc.**: 13%
- **Pedestrians**: 13%
- **Non-motorized vehicles & other objects**: 13%
- **Buses**: 7%
- **Bicycles**: 6%
- **Auto Rickshaws**: 6%
- **Trucks**: 11%
- **Other Motor Vehicles**: 9%

*Share of VRUs – 53%*
Non-motorized Traffic Fatalities In Metropolitan Cities Of India
Objective Of Study

• To perform the descriptive analysis of vulnerable road users accident data for Vadodara city.

• To identify the various factors responsible for the pedestrian and cyclist crashes.

• To suggest suitable measures to reduce the pedestrian and bicycle accidents.
Study Area

• Vadodara is the third largest city in the state of Gujarat, with an area of 149 square km with a plain and undulating topography and a population of 16.67 lakhs according to 2011 census.
• The average household income of Vadodara is about Rs.6920. The average household size is about 4.6. About 80% of households own at least one two-wheeler and 63% own at least one cycle. Only about 14% of the households own cars.
• The percentage of male population to the total population is about 52%, which indicate 923 female per 1000 male
Land Use Pattern Of Vadodara

- Residential: 55%
- Commercial: 3%
- Industrial: 10%
- Open space and garden: 7%
- Restricted area: 3%
- Roads and railways: 19%
- River bank: 3%
Number Of Crashes In Vadodara

[Graph showing the number of crashes reported from 1997 to 2010, categorized into Fatal, Major, and Minor incidents.]
Methodology And Data Collection

• The traffic accidents data used in this research was obtained from the police station of Vadodara for the year of 2012. There are total 16 police stations in Vadodara from where all FIRs have been collected.
• All the details regarding accidents was filled in that accident recording form with proper coding for analysis. The information included were FIR number, Accident date and location, Collision type, Collision spot, Single vehicle accident, Hit & Run ,Number of occupant, number of fatality and injuries, vehicle type, and the data related to victim like age, sex, gender, injury etc.
• In all, 192 pedestrian crashes and 62 bicyclist crashes in the year 2012.
Pedestrian Crash Risk Analysis

• There are total 192 pedestrian road accident occurred during the year of 2012 in Vadodara city. The proportion of minor, major and fatal pedestrian accidents are 78(41%), 84(43%), and 30(16%) respectively.

• The pedestrian crash analysis is done considering various factors like type of accident, location of accident, month of accident, Age of victim, and impacting vehicle responsible for type of accident.

• For all the type of accidents for pedestrian (Fatal, minor, Major) Cars were the most dominating impacting vehicle responsible for crashes.
Pedestrian Crash Risk Analysis

Collision spot of accidents

Hit and run cases v/s accident severity
Pedestrian Crash Risk Analysis

Accident severity Versus Type of Road

<table>
<thead>
<tr>
<th>Type of Road</th>
<th>Fatal</th>
<th>Major</th>
<th>Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial road</td>
<td>9%</td>
<td>51%</td>
<td>40%</td>
</tr>
<tr>
<td>Collector road</td>
<td>13%</td>
<td>33%</td>
<td>54%</td>
</tr>
<tr>
<td>National Highways</td>
<td>46%</td>
<td>42%</td>
<td>12%</td>
</tr>
</tbody>
</table>

Accident severity versus age of victim

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Minor</th>
<th>Major</th>
<th>Fatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 yrs</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>6-15 yrs</td>
<td>3</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>16-35 yrs</td>
<td>32</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>36-60 yrs</td>
<td>32</td>
<td>27</td>
<td>13</td>
</tr>
<tr>
<td>&gt; 60 yrs</td>
<td>14</td>
<td>17</td>
<td>4</td>
</tr>
</tbody>
</table>
Month Wise Accident Analysis

![Graph showing the number of accidents per month. The highest number of accidents is in January and February, with a peak of 24. The lowest number of accidents is in July, with 5.]

- January: 24 accidents
- February: 24 accidents
- March: 18 accidents
- April: 15 accidents
- May: 22 accidents
- June: 14 accidents
- July: 5 accidents
- August: 12 accidents
- September: 14 accidents
- October: 12 accidents
- November: 10 accidents
- December: 22 accidents
Impacting Vehicles For Different Type Of Crashes

**Fatal Crashes**
- Truck: 21%
- LCV: 20%
- Bus: 7%
- Car: 10%
- Auto rikshaw: 7%
- Two wheelers: 4%

**Major Crashes**
- Truck: 58%
- LCV: 18%
- Bus: 10%
- Car: 3%
- Auto rikshaw: 4%
- Two wheelers: 1%

**Minor Crashes**
- Truck: 58%
- LCV: 17%
- Bus: 13%
- Car: 4%
- Auto Rikshaw: 4%
- Two wheelers: 3%
Bicycle Risk Analysis

• Out of total 764 traffic injury accidents taken place in year 2012. The 63 accidents are reported as bicycle victim.

• For Vadodara city, The mode share of bicycle is found to be decreasing from 18% (RITES 2006) to 10% (Prajapati 2010) which is quite less for any city.

• On other hand, The percentage contribution of the bicycle accidents is around 9% of total accidents and is one of the major problem for any city to support sustainable transportation.

• It is thus very much important to access each and every crashes of bicycle and take suitable measure to control them.
# Bicycle Risk Analysis

<table>
<thead>
<tr>
<th>Impact Vehicle</th>
<th>Minor accident</th>
<th>Major accident</th>
<th>Fatal accident</th>
<th>Total accident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>3 (4.84%)</td>
<td>2 (3.23%)</td>
<td>0</td>
<td>5 (8.06%)</td>
</tr>
<tr>
<td>LCV</td>
<td>0</td>
<td>0</td>
<td>1 (1.61%)</td>
<td>1 (1.61%)</td>
</tr>
<tr>
<td>Bus</td>
<td>1 (1.61%)</td>
<td>0</td>
<td>0</td>
<td>1 (1.61%)</td>
</tr>
<tr>
<td>Car</td>
<td>6 (9.68%)</td>
<td>5 (8.06%)</td>
<td>0</td>
<td>11 (17.74%)</td>
</tr>
<tr>
<td>Auto rickshaw</td>
<td>1 (1.61%)</td>
<td>1 (1.61%)</td>
<td>0</td>
<td>2 (3.23%)</td>
</tr>
<tr>
<td>Two wheeler</td>
<td>28 (45.16%)</td>
<td>12 (19.35%)</td>
<td>1 (1.61%)</td>
<td>41 (66.13%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>1 (1.61%)</td>
<td>0</td>
<td>1 (1.61%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>39 (62.9%)</strong></td>
<td><strong>21 (33.87%)</strong></td>
<td><strong>2 (3.22%)</strong></td>
<td><strong>63 (100%)</strong></td>
</tr>
</tbody>
</table>
Bicycle Crash Risk Analysis

Accident Vs. Type of Victim

- 5-15 yr: 2 Fatal, 1 Major, 3 Minor
- 16-29 yr: 0 Fatal, 6 Major, 12 Minor
- 30-44 yr: 1 Fatal, 3 Major, 10 Minor
- 45-59 yr: 0 Fatal, 1 Major, 11 Minor
- 60-69 yr: 1 Fatal, 3 Major, 1 Minor
- > 70 yr: 2 Fatal, 2 Major, 0 Minor

Crashes By Collision Spot And Type

- Head on: 4 Unknown, 0 Intersection, 1 Minor
- Hit from back: 5 Unknown, 0 Intersection, 1 Minor
- Hit from side: 3 Unknown, 1 Intersection, 8 Minor
- Not noticed: 4 Unknown, 1 Intersection, 9 Minor
Results And Discussion

• Total 764 road accident occurred during the year of 2012 in Vadodara metropolitan. The biggest victim type is M2W that is 40% of total crashes and pedestrian is the second biggest victim type in road accidents having share of 28% of total road accidents and bicyclist having share of 9% of total road accident. Hence the safety of the vulnerable road user is to be given prime importance.

• In Vadodara motorized two-wheeler is the primary mode of travel and they grow up as to be the impacting vehicle for 50% of pedestrian and 66% of bicycle crashes. Hence, it is now very much necessary to encourage the public transportation system by enforcing Very high paid parking policies so that motorized two wheelers may shift to public transportation.
• The maximum pedestrian accident occurs on Wednesday and Thursday (i.e. 32 crashes) The minimum pedestrian accident recorded on Tuesday (20 crashes). Therefore we can say that there is no any trend observed in pedestrian accident on weekend and on week days.

• The maximum number of pedestrian accidents occurred between 6:00 pm to 9:00 pm. The number of pedestrian accidents occurs during this time is 46, out of which 40 pedestrian accidents are severe injury crashes and 6 pedestrian accidents are fatal crashes. It is thus very much important to check the lighting scheme at regular intervals and proper maintenance of the Street lights and other lighting sources should be done.
• The maximum number of pedestrian accidents occurred while crossing the roads. Proper regulations and enforcement should be made to fill the gaps between the pedestrian psychology of crossing and the person’s behavior while driving the vehicle.

• For bicycle and pedestrian crashes maximum number of crashes occurs at arterial roads which is around 71% for bicycle and 55% for pedestrian crashes. When the accident spots of the arterial roads were surveyed than it was found that all the roads were poorly furnished with respect to accident safety. Hence, some safety measures like pedestrian signs, Zebra crossings, etc. should be made at the major intersections of the arterial roads.
• The mode share of the bicycle is found to be very less. There is about 95% road sections have less than 10% bicycle share of traffic volume. More appropriately 76.5% road section have less than 6% bicycle share of traffic volume. The share of bicycle may be encouraged by implementing “park and ride” and many other such policies.

• The 63% of crashes of the bicycle is having work trip. Efficient public transportation system may result into modal shift from bicycle to public transport and reduce the exposure to the bicycle crashes. The use of the bicycle for the other purpose may be encouraged, but in case of work trips they must be discouraged by providing monthly passes of the bus.
• There is about 50% of accidents occurred by hit from back. It reveals that drivers failed to recognize the bicycle on the road. So enforcement of speed regulation plays major role to prevent accidents. It is impossible to differentiate high speed and low speed traffic due to unclassified and unstandardized road which leads to increase risk for bicyclist.

• The pedestrian and the bicyclist crashes are the most concerning issue of the cities. it is very much important to provide the road infrastructure which allows such mode to travel safety. It is now very much necessary to revise the designing of the streets for Indian cities and it should be made such that safety of the VRU’s is increased.
Limitation Of The Work

• The present paper is just the descriptive analysis of the various road crashes for pedestrian and bicycle taking place in the urban cities. Thus, the future scope may be to do the descriptive analysis of all the road users and to develop some mathematical model for the various factors affecting the rate of accidents.

• Also, the data source for the accident data was from First investigation report obtained from the police station. The other sources of accident are not used for the study.

• Further the scope of the study is limited to major roads of the urban area only. Same type of the work can be done for the minor roads of the cities.
References


11. Rune Elvik (2009), Institute of transport and economics, Norway.
