CHAPTER 6

INFERENCES AND DISCUSSION

6.1 GENERAL

Reviewing this context, most of us would be inclined to believe that one of the two road users involved in a road accident is responsible for the same. The root cause of these accidents could throw up the combination of factors which drove the situation out of human control, yet analysts are prone to emphasize that the user should have been aware of the risks in various scenarios, and should have operated within limits where the consequences of human error would not be as disastrous. Fig. 6.1 shows the chart representing factors involved in road safety management. In this chapter various accident mitigation measures that have been suggested for accident prone locations are discussed.

![Figure 6.1 Chart Representing Factors Involved in Road Safety Management](image-url)
6.2 REMEDIAL MEASURES

6.2.1 Remedial Measures Suggested for Salem City

The following remedial measures have been suggested to reduce the rate of accidents in the major accident prone locations in Salem city and are presented in Table 6.1.

Table 6.1 Remedial Measures Suggested for Salem city

<table>
<thead>
<tr>
<th>S.No</th>
<th>Accident-Prone Location</th>
<th>Accident Causes Identified</th>
<th>Remedial Measures Suggested</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cherry Road</td>
<td>✓ Encroachment on both sides by street vendors ✓ Road side vehicle parking on both sides</td>
<td>✓ Widening of road is not possible but divided road should be provided. ✓ Encroachments should be removed ✓ Road side parking should be restricted ✓ Channelizing islands and narrow medians should be provided</td>
</tr>
<tr>
<td></td>
<td>(Undivided Road, total length is 3km and Carriage way width is 7.5m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Saradha College Road</td>
<td>✓ Road side vehicle parking ✓ Connects NH 7 &amp; SH2 ✓ Improper right turn of vehicles from main road</td>
<td>✓ Road side parking should be restricted ✓ Encroachments should be removed ✓ Speed restriction to be followed strictly</td>
</tr>
<tr>
<td></td>
<td>(Divided Road, total length is 2.8 km, classified as SH and Carriage way width is 9.0m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Kannankuruchi Road</td>
<td>✓ Poor visibility from branch road ✓ Road width is not adequate near Kali temple road ✓ No proper road markings</td>
<td>✓ Traffic signal is to be installed ✓ Transformer obstructing vision is to be shifted ✓ Kali temple road should be widened ✓ proper road markings should be made</td>
</tr>
<tr>
<td></td>
<td>(Undivided Road, total length is 5.6 km, classified as ODR and Carriage way width is 7.5 m)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6.1 (Continued)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Accident-Prone Location</th>
<th>Accident Causes Identified</th>
<th>Remedial Measures Suggested</th>
</tr>
</thead>
</table>
| 4    | Yercaud Road (Undivided Road, total length is 7km and Carriage way width is 7.5m) | ✓ No proper road markings  
✓ Advertisement board obstructs visibility | ✓ Median should be provided  
✓ proper road markings should be made  
✓ Advertisement board is to be removed  
✓ Street lighting is to be provided  
✓ Traffic signal is to be installed |
| 5    | Omalur Main Road (Divided Road, total length is 2.8 km, classified as SH and Carriage way width is 9.0m) | ✓ No proper road markings  
✓ Advertisement board and tree branches obstructs visibility  
✓ Improper right turn of vehicles from main road  
✓ Unpaved left turning portion | ✓ Advertisement board and tree branches should be removed  
✓ Median should be provided to stop improper right turn of vehicles  
✓ Left turning portion should be paved  
✓ Street lighting is to be provided |
| 6    | Junction Main Road (Undivided Road, total length is 2.4 km, classified as SH and Carriage way width is 6.5m) | ✓ Poor visibility from cut road for left turn due to encroachments  
✓ Encroachment on both sides by street vendors | ✓ Encroachments should be removed  
✓ Signal is to be installed  
✓ Channelizing islands should be provided |
| 7    | Salem Steel Plant Road (Divided Road, total length is 11.5 km, classified as SH and Carriage way width is 7.0m) | ✓ Main road width is not adequate  
✓ Street lighting is not adequate in main road  
✓ Improper right and left turn of vehicles from main road  
✓ Encroachment on both sides by street vendors | ✓ Main road should be widened  
✓ Street lighting is to be provided  
✓ Median openings made by the public should be closed strictly  
✓ Encroachments should be removed  
✓ Speed restriction to be followed strictly |
Table 6.1 (Continued)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Accident-Prone Location</th>
<th>Accident Causes Identified</th>
<th>Remedial Measures Suggested</th>
</tr>
</thead>
</table>
| 8    | Ellampillai Road (Undivided Road, total length is 17.2 km and Carriage way width is 5.5m) | ✔ Road width is not adequate  
✔ No proper road markings  
✔ Pot holes in roads | ✔ Road width should be widened  
✔ Traffic signal is to be installed  
✔ Medians and road markings should be provided  
✔ Channelizing islands should be provided |
| 9    | Sankari Main Road (Undivided Road, total length is 7.5km and Carriage way width is 7.5m) | ✔ Pot holes in roads  
✔ Poor visibility due to tree branches  
✔ Medians and channelizing islands are damaged | ✔ Traffic signal is to be installed  
✔ Pot holes should be repaired  
✔ Obstructing tree branches should be cut  
✔ Medians and channelizing islands should be maintained |
| 10   | Tiruchy Road (Undivided Road, total length is 11.4km and Carriage way width is 7.5m)  | ✔ Main road width is not adequate  
✔ Street lighting is not adequate in main road  
✔ Improper right and left turn of vehicles from main road  
✔ Encroachment on both sides by street vendors | ✔ Main road should be widened  
✔ Street lighting is to be provided  
✔ Median openings made by the public should be closed strictly  
✔ Encroachments should be removed  
✔ Speed restriction to be followed strictly |
| 11   | Ammapet Road (Divided Road, total length is 11.4km and Carriage way width is 5.5m) | ✔ Traffic signal does not function | ✔ Traffic signal should be made operative  
✔ Channelizing islands should be redesigned |
Table 6.1 (Continued)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Accident-Prone Location</th>
<th>Accident Causes Identified</th>
<th>Remedial Measures Suggested</th>
</tr>
</thead>
</table>
| 12   | First & Second Agraharam(Undivided Road, total length is 11.4km and Carriage way width is 10.5m and 10.0m) | ✓ Traffic signal does not function  
✓ Parking of vehicles near cut road  
✓ Encroachment by street vendors | ✓ Traffic signal should be made operative  
✓ Parking of vehicles should be restricted near Mahindra show room cut road  
✓ Encroachments should be removed |
| 13   | Kadaiveethy(Undivided Road, total length is 11.4km and Carriage way width is 7.5m) | ✓ Road width is not adequate in branch road adjacent to Anbu pharmacy  
✓ Advertisement board reduces visibility  
✓ Main road width is not adequate  
✓ Improper right and left turn of vehicles from main road  
✓ Encroachment on both sides by street vendors | ✓ Branch road adjacent to Anbu pharmacy is to be widened  
✓ Mini Roundabout is to be provided  
✓ Advertisement board should be removed  
✓ Parking of vehicles should be restricted  
✓ Encroachments should be removed  
✓ Speed restriction to be followed strictly |
| 14   | NH 47 Road | ✓ Poor visibility from cut road  
✓ Road width is not adequate | ✓ Advertisement board near cut road should be removed  
✓ Speed breaker is to be provided in cut road |
| 15   | Military Road (Undivided Road, total length is 11.4km and Carriage way width is 7.5m) | ✓ High speed traffic from cut road  
✓ Poor visibility  
✓ No proper road markings | ✓ Speed breaker is to be provided in cut road  
✓ Traffic signal should be made operative  
✓ Road is to be widened  
✓ Road marking is to be done |
### 6.2.2 Remedial Measures Suggested for NH – 47 Stretch

The remedial measures that have been suggested to reduce the rate of accidents in some of the major accident prone locations in NH-47 stretch has been presented in the following Table 6.2.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Accident-Prone Location</th>
<th>Accident Causes Identified</th>
<th>Remedial Measures Suggested</th>
</tr>
</thead>
</table>
| 1    | Neelambur               | ✓ Over speed of vehicle  
✓ Inadequate guidance in the road from Avinashi               | ✓ Speed restriction have to be imposed  
✓ Adequate guiding sign boards have to be Installed  
✓ Traffic signal is to installed |
| 2    | Arasur                  | ✓ Poor visibility from cut road  
✓ Speed breaker is not there in cut roads  
✓ Shoulder is not maintained             | ✓ Speed breaker should be provided in cut roads  
✓ Flashing amber signal for main road is provided  
✓ Shoulder is to be maintained well       |
| 3    | Nasiyanur               | ✓ Poor visibility from cut road  
✓ Speed breaker is not there in cut roads             | ✓ Warning sign should be erected in advance about median opening and crossing of vehicles  
✓ Speed breaker should be provided in cut roads  
✓ Flashing amber signal for main road is provided  
✓ Service roads are to be properly made at the connecting points with main road with better visibility |
| 4    | Chithode                | ✓ East side of NH is in gradient  
✓ Poor visibility from cut road  
✓ Speed breaker is not there in cut roads | ✓ Warning sign should be erected in advance about median opening and crossing of vehicles  
✓ Speed breaker should be provided in cut roads  
✓ Flashing amber signal for main road is to be provided  
✓ Service roads are to be properly made at the connecting points with main road with better visibility |
Table 6.2 (Continued)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Accident-Prone Location</th>
<th>Accident Causes Identified</th>
<th>Remedial Measures Suggested</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Bye-pass road crossing near IRTT</td>
<td>✓ One side of the bye-pass road is in Downward gradient &lt;br&gt; ✓ Over speed of vehicle &lt;br&gt; ✓ There is an outward slope for the right turning vehicles from Chithode old road</td>
<td>✓ Warning sign should be erected in advance about median opening and crossing of vehicles &lt;br&gt; ✓ Speed breaker in other roads are to be provided &lt;br&gt; ✓ Mild super elevation is to be provided for the right turning vehicles from Chithode old road, till that this right turning is to be banned</td>
</tr>
<tr>
<td>6</td>
<td>Lakshmi Nagar Bye-pass junction</td>
<td>✓ Poor visibility for the turning traffic from Bhavani &lt;br&gt; ✓ Non availability of flashing amber signal for main road</td>
<td>✓ Provide adequate lighting for entire intersection area &lt;br&gt; ✓ The straight traffic from Bhavani should be banned and is to be converted into left and then right &lt;br&gt; ✓ Flashing amber signal for main road is to be provided &lt;br&gt; ✓ Speed breaker in other roads are to be provided</td>
</tr>
<tr>
<td>7</td>
<td>Near Kumarapalayam</td>
<td>✓ Advance warning is not there about crossing of vehicles &lt;br&gt; ✓ Shoulder is not maintained &lt;br&gt; ✓ Speed breaker is not there in service roads</td>
<td>✓ Warning sign should be erected in advance about median opening and crossing of vehicles &lt;br&gt; ✓ Shoulder is to be maintained well &lt;br&gt; ✓ Speed breaker should be provided in service roads &lt;br&gt; ✓ Flashing amber signal for main road is to be provided</td>
</tr>
<tr>
<td>8</td>
<td>Near Mettukadai</td>
<td>✓ Advance warning is not there about crossing of vehicles &lt;br&gt; ✓ Limited sight distance due to presence of horizontal curve near by &lt;br&gt; ✓ It is in Downward gradient</td>
<td>✓ Warning sign should be erected in advance about median opening and crossing of vehicles &lt;br&gt; ✓ Speed breaker is to be provided in cut road and service road &lt;br&gt; ✓ Flashing amber signal for main road is to be provided</td>
</tr>
</tbody>
</table>
Table 6.2 (Continued)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Accident-Prone Location</th>
<th>Accident Causes Identified</th>
<th>Remedial Measures Suggested</th>
</tr>
</thead>
</table>
| 9    | Near Valayakaranur      | ✓ There is no opening in median  
✓ Limited visibility due to presence of curve near by | ✓ Opening in median should be provided opposite to SSM College connecting the service roads  
✓ Speed breaker is to be provided in cut road and service road  
✓ Flashing amber signal for main road is to be provided  
✓ Blind horizontal curve may be made smooth |
| 10   | Near Kallipalayam       | ✓ Presence of mild horizontal curve near by  
✓ It is in Downward gradient | ✓ Speed breaker should be provided in service roads and cut roads  
✓ Flashing amber signal for main road is to be provided  
✓ Mild horizontal curve may be made smooth |
| 11   | Pachampalayam          | ✓ Service roads are not properly paved at the connecting points with main road  
✓ Advance warning is not there about the joining from service road | ✓ Speed breaker is to be provided in cut road  
✓ Flashing amber signal for main road is to be provided  
✓ Service roads are to be properly paved at the connecting points with main road  
✓ Warning sign should be erected in advance about the joining from service road |
| 12   | Before Sankagiri Bye-Pass Road Crossing | ✓ Poor visibility during night time  
✓ Absence of speed breaker in old roads | ✓ Provide adequate lighting for entire intersection area  
✓ Speed breaker should be provided in old roads |
<table>
<thead>
<tr>
<th>S.No</th>
<th>Accident-Prone Location</th>
<th>Accident Causes Identified</th>
<th>Remedial Measures Suggested</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Near Mangarangampalam</td>
<td>✓ Shoulder is not maintained ✓ It is in gradient ✓ Presence of mild horizontal curve near by</td>
<td>✓ Speed breaker is to be provided in service roads and cut road ✓ Flashing amber signal for main road is to be provided/operative ✓ Shoulder is to be maintained well without any level difference with the carriageway</td>
</tr>
<tr>
<td>14</td>
<td>Pallakapalayam</td>
<td>✓ It is in gradient ✓ Presence of mild horizontal curve near by ✓ Service roads are not properly made at the connecting points with main road</td>
<td>✓ Flashing amber signal for main road is to be madeoperative ✓ Service roads are to be properly made at the connecting points with main road ✓ Speed breaker is to be provided in cut road/service roads</td>
</tr>
<tr>
<td>15</td>
<td>Magudanchavadi</td>
<td>✓ Poor visibility from cut road ✓ Speed breaker is not there in cut roads ✓ Service roads are not properly made at the connecting points with main road</td>
<td>✓ Speed breaker should be provided in cut roads ✓ Flashing amber signal for main road is to be made operative ✓ Service roads are to be properly made at the connecting points with main road</td>
</tr>
<tr>
<td>16</td>
<td>Rakkipatti</td>
<td>✓ Poor visibility from cut road ✓ Speed breaker is not there in cut roads</td>
<td>✓ Speed breaker should be provided in cut roads ✓ Flashing amber signal for main road is to be provided</td>
</tr>
</tbody>
</table>
6.3 INFERENCES

From the accident data collected for the four years (2008-11) and the analysis made for Salem city, the inferences drawn are,

- Two wheelers are primarily involved in accidents which hold about 29%, whereas buses hold about 19% of total accidents.
- Majority of accidents has taken place on the State highways
- The phase of day during which a larger number of accidents occurred was from 6 p.m. to 12 in the midnight
- On an average the fatalities in accidents is 16% and those severely injured are 21%
- Most of the persons involved in accidents are slightly injured
- About 55% of total accidents are minor accidents
- Though fatal and grievous injury accidents are less in numbers, they cause death and accidental injury in large numbers

From the accident data collected for the past five years (2010-14) and the analysis made for NH 47 stretch, the inferences drawn are

- The maximum number of accidents was caused by car, two-wheelers.
- The phase of day during which a larger number of accidents occurred was from 4 p.m. to 12 in the midnight.
- On an average the fatalities in accidents is 32.79% and those injured are 67.21%.
- Maximum number of accidents are caused by the age group of 30-40 and followed by 18-30.
On an average of 32.12% of accidents are of side on collision type.

Collision due to rear hit is 30.41%.

From the analysis of spot speed data in NH 47 stretch it is found that

- 24% of vehicles move beyond the speed of 80kmph.
- 11% of vehicles move beyond the speed of 100kmph.
- This higher speed beyond the design speed of NATIONAL HIGHWAY leads to more number of accidents.

The multiple linear regression model developed indicates that out of the 6 explanatory variables, two variables namely, \( X_2 = \) Percentage of heavy vehicles, \( X_3 = \) Vehicle speed (kmph) have more impact with number of accidents (\( Y \)), the variable \( X_4 = \) Segment length has got no effect and the three variables namely \( X_1 = \) ADT, \( X_5 = \) No. of intersections and \( X_6 = \) Number of horizontal curves less impact with number of accidents (\( Y \)). Traffic flow is on the rise due to improvement in socio economic conditions of the people coupled with increased personalized vehicle ownership, population growth and industrial evolution. In the recent years with reduction in weight of vehicles, improved engine efficiency and provision of median (divided highway), the traffic speed is on the rise.

So it is seen that increase in percentage of heavy vehicles and the rising traffic speed are the factors contributing to more number of accidents on divided highways. Traffic flow, number of curves, intersections contribute less to the number of accidents perhaps the divided highway, provision of speed breakers in the access roads and signals/ flashing amber at road crossings could be the reason for less contribution to the number of accidents. And from the
sensitivity analysis it is seen that with the increase in speed there is drastic increase in the number of accidents.

6.4 ACCIDENT REDUCTION MEASURES

The following measures are to be carried out throughout the city roads and intersections to minimize accidents.

- Working conditions of truck drives in India are well below those of their counterparts in developed countries.
- More efforts and understanding are required to educate, train and encourage truck drivers to drive safely on highways.
- The drivers are expected not to drive at excessive speed and have to avoid careless and dangerous driving. Failure to observe such safety precautions is deemed as an offence.
- Channelization is recommended for intersections with heavy traffic.
- Adequate lighting should be provided at all intersections and accident prone locations.
- Cut roads should be provided with speed breakers in order to reduce the speed of vehicles before entering the national and state highways.

Experts on behaviour – based – safety mention that human behaviour is an outcome of not only the individual’s education, skill, training and knowledge, but also by the environment he operates. Subtle influences in his immediate surroundings, such as layout planning and road design, Vehicle design characteristics and traffic laws and their enforcement would direct his behaviour in different ways, when operating a vehicle or operating in its vicinity. Because of this education programmes for road users can be effective
only up to a certain degree of effectiveness. Beyond this it becomes redundant and results only in information overload, it alone cannot eliminate the probability of road accidents.

Then what could supplement the information and publicity provided to road users, along with the efforts in mistake proofing the technology. There is a need to design the external environment that would help in influencing the behaviour of the road user at a sub-conscious level, so that he would reduce speed in certain areas, or not be tempted to veer suddenly into a high speed lane. The designer should thus make efforts to design each road according to its function and context (Socio – economic and demographic characteristics vis-à-vis spatial distribution), such that the design influences the user to comply with applicable traffic restrictions (mainly in terms of speed and lane compliance). For example, the design should make the driver expect the need to be more alert and to maintain low speed in urban areas where pedestrian density and related facilities are higher. It should motivate the driver to behave legally and should not create difficulties for the significant minority.

Condition of the road is another major factor in road safely. Timely and proper road maintenance will have a major positive impact on the road accident statistics. Potholes are not just an inconvenience they also cause a safety hazard to motorists, pedestrians and cyclists. Potholes are usually associated with the surface of the carriageway eroding away, water damage and deteriorating utility tracks. Regular effective and efficient reporting, inspection and repairing of the road with all the adequate safety measures will reduce an impact. Prior communication, keeping the motorist informed and guided, will reduce irritants and provide adequate time for proper repairing of the road.

Next comes the issue of enforcing legislation vis-a-vis bad driving. For each person who owns up to being a very good driver, there are scores who are wont to call everybody else a bad driver. There are differing
perceptions on what a “bad driver” means. These extend beyond driving skills and encompass attitudes and behaviour which exhibit scant regard to basic rules of the road (leave alone the law). These include the ability to prioritize risk and pay attention to the road. A “bad driver” is one who feel that driving rules are irrelevancy, therefore do not have to be followed and these are the drivers that cause accidents and even traffic fatalities. This kind of attitude thrives in an environment does not augur well for road safety. Take instances of drivers who are not legally qualified to drive or those who have managed to by-pass driving tests before being licensed. Or consider the numerous instances of drunk drivers or those who have succumbed to road rage. There is no death of legal provisions to make our roads safe. We have adequate laws in place. But mere laws alone are not a sufficient deterrent. That needs to be enforced without exception. Enforcement would be adequate only when people come around to expect to be at the receiving end of law for compromising their own safety and that of others.

Finally, despite of all the above, when the ‘inevitable” actually happens; the society needs to be prepared to contain the damage and where possible reverse it. One of the most common causes of a road accident fatality is the casualty suffering from an anoxia loss of oxygen supply caused by a blocked airway. On average, it takes less than four minutes for a blocked airway to cause death. There is a wealth of medical evidence to suggest a ‘golden hour’ exists for casualties after an accident. Within this time, road accident victims stand a greater chance of survival and a reduction in the severity of their injuries, if first aid and medical (Paramedic or ambulance) assistance can be immediately administered. Even though it is mandatory in many of the BOT/PPP built roads, the effectiveness of the emergency response time has good scope of improvement.
Also, thought has to be given to workers in road construction who are at risk of fatal or serious debilitating injuries. This is because of the various reasons like work is in congested areas, exposure to high traffic volumes and speeds, under conditions of low lighting, low visibility, and inclement weather. Also at the same time the work is performed routinely near both moving construction vehicles and passing motor vehicle traffic. The risk levels are adequately addressed through work zone management, signage, traffic management, working hours, diversions, speed controls etc. However the monitoring of compliance is inadequate and sometimes ignored or deliberately avoided as a measure towards cost control.

The next generation of technology that has come to the aid of making our roads safe is the GPS. It can help navigate by providing an efficient route between two locations. It can help you get back on the right track without creating panic, or taking short-cuts or violating traffic. This also minimizes stress and distraction. It supplements safe driving at night and through bad weather by providing information on the route ahead. It can also provide timely inputs to the nearest police, hospital, garage, and more, in case someone needs roadside attention. GPS devices can now be integrated with traffic monitoring systems to account for traffic patterns and adjust their navigation directions accordingly. As the GPS gradually improves in technology, these devices are also becoming increasingly popular.

6.5 SUGGESTIONS AND RECOMMENDATIONS

In recent years people and the drivers are not fully aware of road safety, and hence the accidents are happening in every second in India. To reduce the accidents this study suggested that in every road junction and connecting roads the signs and symbols should be the same; the speed level of the vehicles should be reduced near junctions. Drivers should use the indicators while turning lefts and right. Seat belts, helmets should be worn compulsorily.
The government should undertake road safety trainings to the drivers and it should be compulsory to the drivers and who participated in the training program only allowed to drive with physical fitness certificate.

After conducting detailed survey, data was used for model development and validation. It was found that most influencing safety parameters were spot speed, % of heavy vehicles, quantum of traffic, condition and level of shoulder and existence of speed breakers in cut roads. So, crashes can be reduced on a section of four lane highway through effective monitoring of above influential parameters in order of significance. On effective monitoring of these identified safety influencing parameters, a road maintaining agency can enhance overall safety and reduce accident meaningfully on divided four-lane National Highways of the country.