ACCIDENT PREDICTION MODELS FOR URBAN UNSIGNALISED INTERSECTIONS

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ABSTRACT
Nowadays, road safety is a topic that we discuss too often. There are many factors that cause road accidents. Among that, roadway and traffic conditions are two major factors. By analysing these factors, we can reduce the number of accidents. Crash models are found to be effective in the road safety analysis. In this study, Accident Prediction models are developed for the unsignalised urban intersections. Accident Prediction models for three legged intersections and four legged intersections are separately developed. Previous Accident Prediction Models for intersections predict the number of accidents for the intersection as a whole. This model can predict the number of accidents for each approach leg of an intersection. By knowing the factors that affect safety, we can do proper treatment and upgrading.

Keywords: Accident Prediction Models (APM), Intersections, Unsignalised, Urban, Approach leg, Roadway factors, Traffic factors.

1. INTRODUCTION
In a Transportation system roads are an integral part. Today our road network of (3.314 million kilometres) serves as the bloodline of the country. Urbanization, expansion in road networks and motorization can be called the root causes of increasing global road accident rate. Ministry of Road Transport & Highways report reveals that India witnessed one road accident every minute in the year 2011 which claimed one life in 3 minutes. Road accident statistics 2012 of Kerala showed that Thiruvananthapuram district with 550 deaths topped the list of fatalities among the 14 districts. Thrissur district with 535 deaths in was second followed by Ernakulam with 516 deaths.

These facts are leading us to an important point. That is, the measures we are adopting now are not enough or this is not the correct way to approach this problem. According to a research done by the WHO representative in India in 2012, Out of the estimated 1.4 million serious road accidents/collisions occurring annually in India, hardly 0.4 million are recorded. Further, only a minimal percentage of these...
collisions are scientifically investigated, in the absence of which, the real causes and consequences are never known.

Road safety can only be improved when we understand the causes and consequences of road accidents/collisions so as to work out remedial measures. Crash models are used to analyse or predict accidents. According to Organization for Economic Co-operation and Development [OECD], there are four types of crash models, Descriptive models, Predictive models for aggregate data, Micro models for non-aggregate data and accident consequence models.

Predictive models for non-aggregate data or Accident Prediction Models (APMs) are a way to gain insight into causes of road accidents. This study is carried out to analyse the accident data to identify the causes of accidents occurred. An Accident Prediction Model (APM) will be created for urban unsignalised intersections. The accident prediction models will be able to improve the location of accidents and thus helps to reduce the number of accidents.

2. METHODOLOGY

2.1 Identification of Study Area
Unsignalised intersections of Ernakulam and Kozhikode are selected. Only intersections in the city premises are selected. Care was taken in order to avoid intersections with very low traffic volume and accident frequency.
Three legged and four legged intersections are considered for this study. Details of ‘45’ intersections were collected. It consists of ‘25’ unsignalised three legged intersections, of which 15 from Calicut and 10 from Ernakulam. Then ‘20’ unsignalised four legged intersections, of which ‘15’ from Calicut and ‘5’ from Ernakulam.

2.2 Crash Data Collection
Number of accidents is the dependent variable. In India, Traffic Police is the agency that collects the accident data. Crash data was obtained from City traffic police station of Ernakulam and Calicut. Crash history from 2008 to 2010 (3 years) is considered for the development of APM

2.3 Road Geometry and Traffic Parameter Data from Field Studies
Road geometric data and Traffic flow data are the independent variables for the Accident Prediction Models (APM). Road geometry of each leg of each intersection is collected separately. Geometric features of each leg up to 20m from the intersection are considered. Road geometry data of intersections was also collected after the traffic volume survey at respective intersections. Traffic flow data is an important variable to be considered. Average daily traffic (ADT) is the flow data variable used. In order to determine ADT, volume counts of 3 hours (peak) were taken. Manual count was taken. Traffic flow data consists of volume entering and leaving each leg of intersections. Classified volume count was considered.

2.4 Selection of Variables for Analysis and Modelling
From the Traffic flow data and Road geometry data collected, some variables are selected for analysis and modelling. They are listed in table 1
TABLE 1. VARIABLES FOR MODELLING

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>ABBREVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entering volume</td>
<td>ADTE</td>
</tr>
<tr>
<td>Exiting volume</td>
<td>ADTX</td>
</tr>
<tr>
<td>Total volume</td>
<td>TADT</td>
</tr>
<tr>
<td>Entering volume in PCU</td>
<td>EPCU</td>
</tr>
<tr>
<td>Exiting volume in PCU</td>
<td>XPCU</td>
</tr>
<tr>
<td>Total volume in PCU</td>
<td>TPCU</td>
</tr>
<tr>
<td>Approach width</td>
<td>AW</td>
</tr>
<tr>
<td>Flared width</td>
<td>FW</td>
</tr>
<tr>
<td>Turning restriction</td>
<td>TR</td>
</tr>
<tr>
<td>Presence of Central island</td>
<td>CI</td>
</tr>
<tr>
<td>Presence of median</td>
<td>PM</td>
</tr>
<tr>
<td>Median height</td>
<td>MH</td>
</tr>
<tr>
<td>Median width</td>
<td>MW</td>
</tr>
<tr>
<td>Centre marking</td>
<td>CM</td>
</tr>
<tr>
<td>Presence of Bus stop</td>
<td>BS</td>
</tr>
<tr>
<td>Presence of Lighting</td>
<td>PL</td>
</tr>
<tr>
<td>Shoulder width</td>
<td>SW</td>
</tr>
<tr>
<td>Presence of Parking</td>
<td>PP</td>
</tr>
<tr>
<td>Speed restrictions</td>
<td>SR</td>
</tr>
<tr>
<td>Pedestrian facilities</td>
<td>PC</td>
</tr>
<tr>
<td>Total number of accidents</td>
<td>TOT</td>
</tr>
<tr>
<td>Fatal accidents</td>
<td>FI</td>
</tr>
<tr>
<td>Grievous injury</td>
<td>GI</td>
</tr>
<tr>
<td>Minor Injury</td>
<td>MI</td>
</tr>
</tbody>
</table>

3. MODELLING AND ANALYSIS

Models are developed using LIMDEP 7.0. Separate models are developed for three legged and four legged intersections. Models developed are given below.

**Model for total accidents in three legged intersections**

A Poisson regression model is obtained for the total number of accidents in three legged intersections

\[
TOT = e^{(8.81E^{-6}TPCU + 0.138TR - 0.478CI - 9.62EFW + 0.586BS + 0.678PP + 0.522CM)}
\]

**Model for total accidents in four legged intersections**

A Poisson regression model is obtained for the total number of accidents in four legged intersections

\[
TOT = e^{(9.04E^{-6}IADT - 4.68EFW - 0.653CM + 0.404PL + 0.335W)}
\]
A Negative Binomial Model has been developed for the number of fatal accidents in three legged intersections

\[ FI = e^{-9.03E-05TPCU - 0.4086DW - 8.68BS} \]  

(3)

**Model for fatal accidents in four legged intersections**

A Poisson regression model is obtained for the total number of accidents in four legged intersections.

\[ FI = e^{-4.39E-05TPCU - 0.263DW + 1.612MW - 3.08MH - 1.47BS} \]  

(4)

**Model for grievous injury accidents in three legged intersections**

A Poisson regression model is obtained for the grievous injury accidents in three legged intersections.

\[ GI = e^{(1.22E-05TPCU - 0.683SR + 1.179PP - 0.48PM + 0.65PL - 6.07EFW)} \]  

(5)

**Model for grievous injury accidents in four legged intersections**

A Poisson regression model is obtained for the number of grievous injuries in four legged intersections

\[ GI = e^{1.43E-05TPCU - 5.20EFW + 2.87MH - 0.83CM} \]  

(6)

**Model for minor injury accidents in three legged intersections**

A Poisson regression model is obtained for the total number of accidents in four legged intersections

\[ MI = e^{-1.07E-05TADT - 0.209DW + 0.95CM} \]  

(7)

**Model for minor injury accidents in four legged intersections**

A Poisson regression model is obtained for the total number of accidents in four legged intersections

\[ MI = e^{-2.02E-05TPCU + 1.013MM - 0.35TR + 0.545PC} \]  

(8)

**4. MODEL VALIDATION**

All together '8 'models were developed. Separate models are developed for three legged and four legged intersections. Models for predicting total number of accidents and models for predicting the severity of accidents are developed. Chi square test was conducted for validation.

### TABLE 2. MODEL VALIDATION

<table>
<thead>
<tr>
<th>Models</th>
<th>Chi-Square</th>
<th>Df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28.13739</td>
<td>14</td>
<td>0.010</td>
</tr>
<tr>
<td>2</td>
<td>10.86697</td>
<td>11</td>
<td>0.100</td>
</tr>
<tr>
<td>3</td>
<td>8718665</td>
<td>14</td>
<td>0.000</td>
</tr>
<tr>
<td>4</td>
<td>3339.539</td>
<td>11</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>43.85238</td>
<td>14</td>
<td>0.000</td>
</tr>
<tr>
<td>6</td>
<td>33.11236</td>
<td>11</td>
<td>0.000</td>
</tr>
<tr>
<td>7</td>
<td>20.65547</td>
<td>14</td>
<td>0.100</td>
</tr>
<tr>
<td>8</td>
<td>8.876243</td>
<td>11</td>
<td>0.100</td>
</tr>
</tbody>
</table>
5. CONCLUSION

On the whole, the results of modelling shows that traffic exposure function TPCU (Total volume in a leg expressed in PCU) produced much better results than TADT (Total Average Daily Traffic). The most influential variables are found to be FW (Flared Width of approach leg) and DW (difference in flared width and approach width). These variables are found to be negatively correlated. If FW and DW are increased, number of accidents can be reduced.

In the models for predicting total accidents in three legged intersections, Presence of Centre Island reduces the number of accidents. Presence of bus stops, presence of parking and presence of centre marking increases number of accidents. But it is found that presence of central marking reduces total number of accidents at four legged unsignalised intersections. Total number of accidents decreases as the shoulder width is increased in four legged intersections.

For fatal accidents prediction model, presence of bus stops reduces the number of fatal accidents. As median width is increased number of fatal accidents in four legged intersection increases. But as the median height increase number of fatal accidents in four legged is decreased.

In the models for predicting grievous injuries, speed restrictions and presence of marking in three legged intersections reduces the number of accidents in three legged intersections. In four legged intersections, presence of centre marking reduces the number of accidents.

In the models for predicting number of minor injury accidents, presence of turning restrictions at four legged intersections reduces the number of accidents.

These models can be used to predict the number of accidents and from the results obtained we can provide proper treatment to roads in order to reduce the number of accidents.

REFERENCES