CHAPTER 9
SUMMARY AND CONCLUSION

9.1 BACKGROUND

The road accident scene in India, as in many developing countries, is characterized by mixed traffic comprising human-powered vehicles such as bicycles and tricycles [cyclerickshaws], animal-drawn carts, and motor vehicles of various sizes, shapes and speeds. Serious efforts have not been made to adopt traffic segregation measures. The total number of accidents has been consistently increasing - 55,478 in 1960; 114,079 in 1970; 152,076 in 1980 and 255,278 in 1988. It takes about 30 years for population in India to get doubled, whereas it takes only 10 years for accidents. (Though only about 27 per cent of the population of the country live in urban areas, about 75 per cent of the accidents occur in cities and towns. There were only 306,313 vehicles in India in 1951. This increased to 1.865 million in 1971 and further to 16.693 million in 1989. Thus during the last four decades the number of motor vehicles increased by more than fifty five times. Among motor vehicles, the maximum growth rate has been shown by two wheelers. In 1951, India had only 26,890 registered motor cycles and scooters. However in 1977 the number of motor cycles and scooters swelled to 0.576 million and further to 10.617 million in 1989. The road net-work in India is one of the largest in the world. The total road length in the country in 1950-51 was about 0.4 million km. Today it is about 2 million km. [Yojana, 1991]. In a study it is brought out that India is loosing Rs.350 crores per annum in road accidents. During Seventh Five Year Plan the Government had to invest Rs. 795 crores per year on road development. Thus, about 44 per cent of annual investment on road is lost due to road accidents alone. Victor [1990] estimated the loss due to road accidents as Rs. 7.5 billion, which amounts to about 0.4% of Gross National Product in India.

9.2 NEED FOR IN-DEPTH ANALYSIS OF ACCIDENT SCENE IN MADRAS

Road accidents are influenced by a large number of factors related to road conditions, traffic flow, environmental state and road user behaviour. But models have been generally built ignoring the complexity of accident occurrence and involving only one or two variables like population, vehicle ownership, road length, etc. Such models over-simplify
the complexities of the accident incidence. Number of authors have attempted to study the accidental scene by relating to econometric and social variables like real earned income, alcohol consumption, vehicle speed, percentage of male drivers to total drivers, ratio of motor cycles to cars, industrial activity, safety regulation, etc. These models are better than the previous group since they have considered at least a set of variables which indirectly influence the occurrence of road accidents. However they too would not be useful in Indian context, where the contributing factors are large in numbers associated with road conditions, road user behaviour and traffic flow characteristics. Some authors have built models using traffic volume and road features like road curvature, pavement width and number of junctions per km. Models discussed here suffer due to their failure in taking all important variables which directly contribute to accident occurrence. These models also do not reflect and account for mixed traffic flow prevailing in urban areas in India. Modelling the traffic accident scene bringing together the influence of all relevant factors is therefore requiring attention.

The length of road network maintained by the corporation of Madras has been 1301 km. in 1971, 1406 km. in 1981 and 1960 km. in 1992 out of which the length of bus route roads has been 218 km. in 1985 and 260 km. in 1990 [Corporation of Madras, 1972; Government of Tamil Nadu, 1992]. The length of National Highway within the limits of Madras is 30 km. in 1990. Anna Salai, Periyar Salai and Waltax Road are the three arterials in Madras City forming part of the National Highways. The mixed traffic in city roads consists of slow moving vehicles, such as animal drawn vehicles, bicycles, cyclerickshaws, tricycles and fast moving vehicles such as motorized two wheelers, cars, buses, trucks and trailers. Between 1980 and 1990, the licensed trucks in Madras increased from 5,362 to 18,935; buses from 1,678 to 2,329; cars from 30,646 to 88,707; taxis from 2,558 to 5,716; motor cycles from 58,435 to 2,80,800; and autorickshaws from 2,236 to 6,130. The total number of road accidents in Tamil Nadu has increased from 14,950 in 1971 to 34,634 in 1990. Of this about 17 to 50 per cent of accidents have been in Madras City alone. Number of road traffic accidents registered in Anna Salai (11.46 km.) has been 530 compared to 237 in Periyar Salai (7.13 km.) in the year 1966 [Highways Research Station, 1970]. Number of accidents registered in Anna Salai has increased to 607 in 1985 and further to 840 in 1990 and the accidents in Periyar Salai has increased to 370 in 1985 and to 562 in 1990. While the total road length in Madras is 2,020 km., the length of Anna Salai and Periyar Salai is only 18.59 km., but it accounts for about 20 per cent of the accidents in the city [Institute of Road Transport, 1991a]. As far as accidents are concerned these two roads are considered critical stretches which require detailed analysis.
9.3 MODEL BUILDING

Even though there could be many ways of approaching the problem of building a comprehensive model involving a large number of variables, the one which could accommodate a large number of variables and help to examine the influence of each variable is through stepwise multiple linear regression approach. Anna Salai, with a length of 11.46 km, has been considered for analysis in 12 sections and Periyar Salai, with a length of 7.13 km, has been considered in 11 sections. Road sections have been identified keeping in mind that there is no appreciable variation in traffic volume within such sections. Data pertaining to eight half-yearly periods [1985 - 1988] on twenty-two independent variables relating to traffic flow characteristics, interaction between different modes, road conditions and traffic management measures introduced have been used to build the model. Figure 6.1 gives details for certain variables considered. Number of accidents that occur in a road section in six months period has been taken as the dependent variable. Stepwise regression analysis has yielded five models by truncating at different stages. The model that closely reflects the accident scene has been selected for estimating the accidents. In order to select the most appropriate model, the five models built have been used to estimate the accident scene for three periods - January to June, 1989; July to December, 1989; and January to June, 1990. The estimated number of accidents are compared with the accidents recorded at sites and the model which represents the accident scene closely is selected. The final model with R² = 0.8467 and adjusted R² = 0.8330, is of the following form:

\[
y = -17.76 + 3.55 (x_1) + 10.85 (x_2) + 4.25 (x_3) - 4.02 (x_4) - 2.35 (x_5) + 2.87 (x_6) + 0.14 (x_7) + 2.21 (x_8) + 15.51 (x_9) + 0.32 (x_{10}) - 1.60 (x_{11}) + 63.63 (x_{12}) - 5.59 (x_{13}) + 2.75 (x_{14})
\]

where \( y \) = number of accidents in 6 months period in road section considered; \( x_1 \) = Average daily traffic volume of cars (expressed in ten thousands); \( x_2 \) = Average daily traffic volume of two wheelers (expressed in ten thousands); \( x_3 \) = Average daily traffic volume of buses (expressed in ten thousands); \( x_4 \) = Average daily traffic volume of trucks (expressed in ten thousands); \( x_5 \) = Average daily traffic volume of bicycles (expressed in ten thousands); \( x_6 \) = Number of pedestrians who violate the rules by attempting to cross the road at unauthorized locations during peak hour (expressed in thousands); \( x_7 \) = Interaction of buses with other fast moving vehicles represented as \( x_7 \cdot (x_1 + x_2 + x_3) \); \( x_8 \) = Interaction of truck with other fast moving vehicles represented as \( x_8 \cdot (x_1 + x_2 + x_3 + x_4) \); \( x_9 \) = Interaction of bicycle with other fast moving vehicles represented as \( x_9 \cdot (x_1 + x_2 + x_3 + x_4 + x_5) \); \( x_{10} \) = Interaction of pedestrian violators with fast moving vehicles represented as \( x_{10} \cdot (x_1 + x_2 + x_3 + x_4 + x_5) \); \( x_{11} \) = Interaction of bicycle with other fast moving vehicles represented as \( x_{11} \cdot (x_1 + x_2 + x_3 + x_4 + x_5) \); \( x_{12} \) = Interaction of pedestrian violators with fast moving vehicles represented as \( x_{12} \cdot (x_1 + x_2 + x_3 + x_4 + x_5) \); \( x_{13} \) = Length of road section in km.; \( x_{14} \) = Width of road section in metres; \( x_{15} \) = Number of deflections in road alignment; \( x_{16} \) = Disturbance index (expressed by taking the total width of all side streets, side roads and drive ways on both sides of the road section and dividing it by twice the length of road
section concerned); \(x_{20} = \text{Bicycle lane index (expressed as total length of bicycle lane on both sides of the road divided by twice the length of road section)}; x_{21} = \text{Handrail index (expressed as total length of handrails available on both sides of the road along the kerbs divided by twice the length of road section)}; \) and \(x_{22} = \text{Congestion index (expressed as the difference between permitted speed limit and journey speed, divided by permitted speed limit)}.\)

The estimated regression coefficients of variables representing two wheelers, pedestrian interaction, length of road section, width of road section and disturbance index are positive and significant while that of bus interaction and deflections are negative and significant when tested by t-statistic at 5% significance level. The combined effect of all the variables in the model is significant at 5% level when tested by F-statistic. The selected model has been used for estimating the accidents for eight half yearly periods [1985 to 1988] in Anna Salai and Periyar Salai. It is found that the model explains the accident scene satisfactorily during the past also. The model is also used for estimating accidents in totally different road sections namely Waltax Road, New Avadi Road, T.V.K. Road, Eldams Road and Taluk Office Road and it is found that the estimated accidents are in close agreement with the accidents recorded at site. It is therefore taken that the model built is useful one to study accident scene.

9.4 ESTIMATION OF FUTURE ACCIDENT SCENE

One of the usefulness of this model is to study the accident scene in future by subjecting the road sections to have various management measures like introduction of cycle track, pedestrian guard handrails, etc (A). Models have been built exclusively to estimate traffic flow in different sections taking into account variables such as the land use characteristics, number of work places, width of road section, etc. Considering the pattern of development likely to take place along the road sections, traffic volumes have been estimated (B). Making use of data pertaining to (A) and (B), the model has been used to estimate the accident scene upto 2001 for both Anna Salai and Periyar Salai. It has been shown that introduction of pedestrian guard handrails and exclusive cycle tracks results in appreciable reduction in accidents. Similarly prohibiting two wheelers on major city roads also helps to reduce accidents.
9.5 CONCLUSION

- The model built making use of 15 variables could be considered as a reliable comprehensive model to estimate the accident scene in urban roads in Indian context. This accounts most of the variables directly influencing the road accident scene in multi-modal traffic flow conditions, commonly seen in urban roads of India.

- This model could also be used to study the effect of making certain improvements as part of traffic management measures on road accident scene.

- This model has been built and tested for Madras conditions which normally represents the scene seen in similar metropolitan cities in India. The same model could be studied and evaluated for similar urban centres in developing countries.

- It was really a difficult task to collect data pertaining to 22 variables for the period 1985-1990, mainly because the agencies/organizations concerned have not maintained the data in usable form. Since this problem, to be investigated, has to be based on behaviour of variables in the past, considerable time and effort have been spent in going through many records and reports of a number of agencies and organizations to extract the required data. Several cross checks were made at every stage, comparing with other reports and publications to find out their acceptability for use in model building.

- This study could not consider more road sections from roads other than Anna Salai and Periyar Salai, since data could not be obtained from agencies/organizations. It is therefore necessary that organizations/agencies should endeavour to maintain good data base to study accident scenes and take appropriate action to introduce suitable management measures.