Micro Level Accident Prediction Modelling For Chennai City

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Abstract

Road accidents in the past few decades have emerged as one of the biggest cause of caution in the world. Road accidents cases in the country have increased by 1.8% during 2014 compared to 2013. Over 1,47,000 people were killed in road accidents in 2013 alone. There is one death every four minutes, 16 children die daily, 214 road crashes occur every day in India. In state level, Tamilnadu has the maximum number of accidents occur of 14.9% in Tamilnadu which is the state with the maximum number of road crash Injuries. Chennai is second in the country in rate of road crash deaths. Chennai has the fastest growth of vehicular population after pune, which is another reason for the large number of accidents. Hence it is imperative to study the root cause of accident occurrences by developing macro, meso, micro level simulation model, to reduce the accident level and ensuring the road safety. In Micro level accident prediction model, under desirable scenario accidents get reduced from 66% to 58% of accidents. Training the persons working for recording accidents & enforcing regulations, will help in reducing accidents ensuring better traffic safety.

Key words: micro level, stella software, dynamic model

INTRODUCTION

Road traffic accident is serious global problem. Each year over one million people are killed and 50 million injured on roads around the world. Without new and effective action, deaths in low to middle income countries are forecast to rise steeply. At the same time, progress has slowed in recent years in the better performing countries where investment in preventing and reducing serious health loss from road traffic injury is not commensurate with its high socio- economic cost. The rapid population growth and increasing economic activities have resulted in the tremendous growth of motor vehicles. This is one of the primary factors responsible for road accidents in many metropolitan cities and chennai is not an exception. The traffic movements on city roads have been compounded by frequent interruptions, resulting in drastic reduction in speed, leading to congestion and accidents. The ability to predict accident rates is very important to transportation planners and engineers, because it can help in identifying hazardous locations, sites which require treatment, as well as spots where deviations (either higher or lower rates) from expected (predicted) warrants further examination. 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.

METHODS USED

System Dynamic Model

It is a methodology whereby complex, dynamic, and nonlinear interactions in social systems can be understood and analyzed and new structures and policies can be designed to improve the system behavior.

The Road Accident model has been developed in this study, using the System Dynamics Simulation Software “STELLA”. The STELLA is object oriented simulation software, which allows the development of any complex, dynamic and nonlinear systems with significantly less effort than using traditional programming languages. It has a userfriendly graphical interface and supports modular program development. [2].

The system dynamics modeling tool has four basic building blocks.

- Stocks or levels are used to represent anything that accumulates.
- Flows or rates represent activities that increase and decrease stocks. An example of flow includes birth rate or death rate
- Connectors are used to establish the relationship among variables in the model, which is represented as arrows graphically in the model.
- Converters transform input into output. Converters can accept input in the form of algebraic relationships, graphs, and Tables.

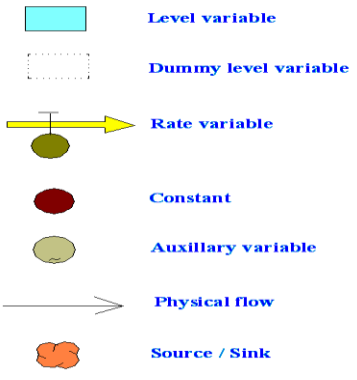

Figure 1.1 Flow Diagramming Symbols

System Dynamic Model

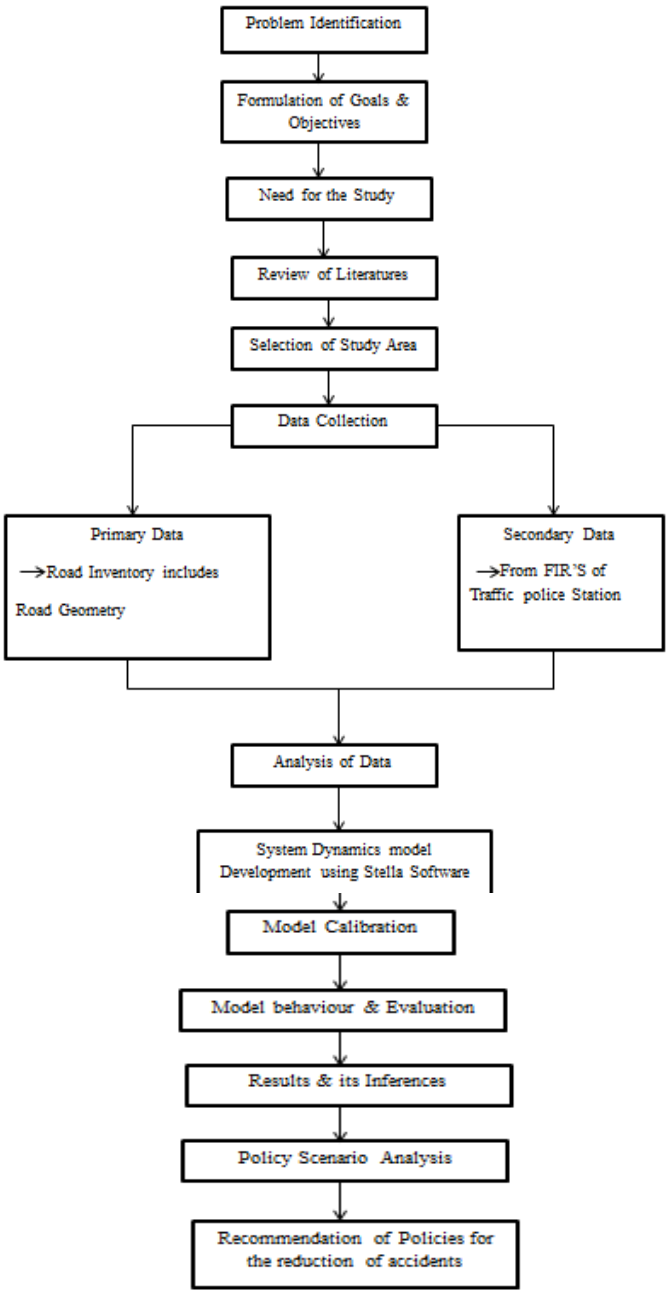

Figure 1.2 Study Methodology

SOFTWARE USED

- The model of the Transport and Economy interaction using the System Dynamics (SD) approach has been implemented in the 'STELLA' environment ('STELLA 9.1' package).
- The modeling tool which is an object- oriented simulation environment allows the development of interaction models with significantly less effort than using traditional programming languages.
- It has a user-friendly graphical interface and supports modular program development.

Data Collection

For the selected study corridor namely 'EVR Periyar Salai' (is also famously known as Poonamallee Road) the data have been collected from police records secondary sources.The data collected consists of details on Name of roads, Occurrence of accidents, Injury types, type of vehicle and types of damages occurred. The primary observations and measurements of road geometrics has as well carried out along the study stretch which includes the road geometrics like curbs, Roadway width, sidewalks, driveways, view obstruction on corners, physical obstruction on roadway, ditches, traffic signals and signs, pavement markings, street lights, and road surface

The secondary data also included Age, Sex, Registration number, direction, date & time, Location, Number of persons injured or affected. The accident data collected has been statistically analyzed to identify the pattern of occurrence of accidents. Primary and secondary survey which combines to form the analysis of data then develops a simulation model and validates the model.

Different Level In Analysis

- For the Accident prediction modeling, there are three levels are considered namely Macro level, Meso level and Micro level.
- Macro level analysis is undertaken to study the 'EVR Periyar Salai' as one corridor and analyzed the causes of occurrence of accidents and to evolve suitable preventive measures.
- Meso level is the next level detail modeling analysis considered for all intersections alone along the study corridor to find out the number of vulnerable intersections or nodes to avail for particular type of accidents & to locate the hotspot in a particular stretch.
- Micro level is the third level detailed modeling analysis which would evolve valuable information to reduce the occurrence of accidents at in-depth level. From this micro level analysis, the highly vulnerable accident occurring node is identified for further analysis.
- Micro level is the important analysis to predict the accident in a particular vulnerable node in whole study stretch and the vulnerable nodes are Koyambedu Roundabout and Anna arch junction.

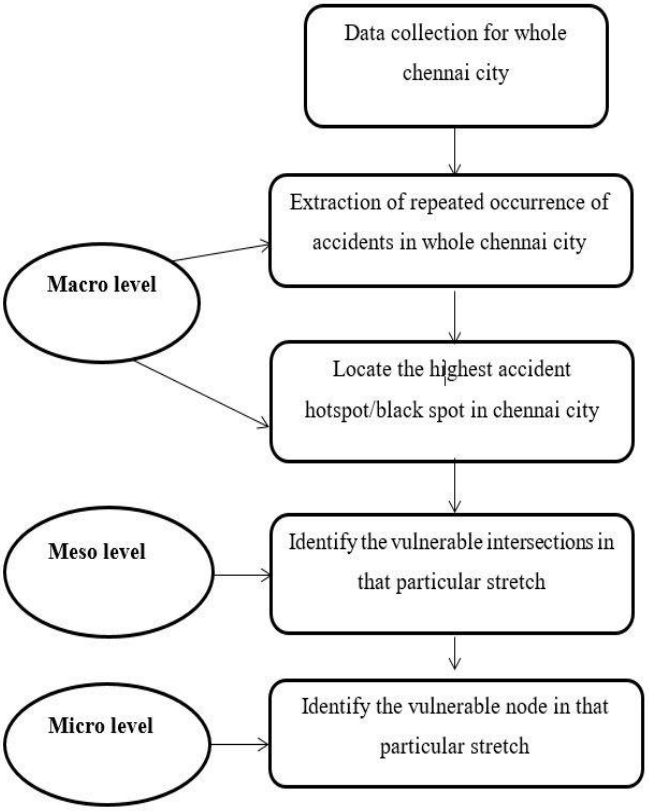

Figure 1.3 Data Collection Flow Chart

Analysis of Accidents

The various types of analysis of accidents are done in whole study stretch. According to the type of injuries, Month wise and Time wise of occurrence of accidents.

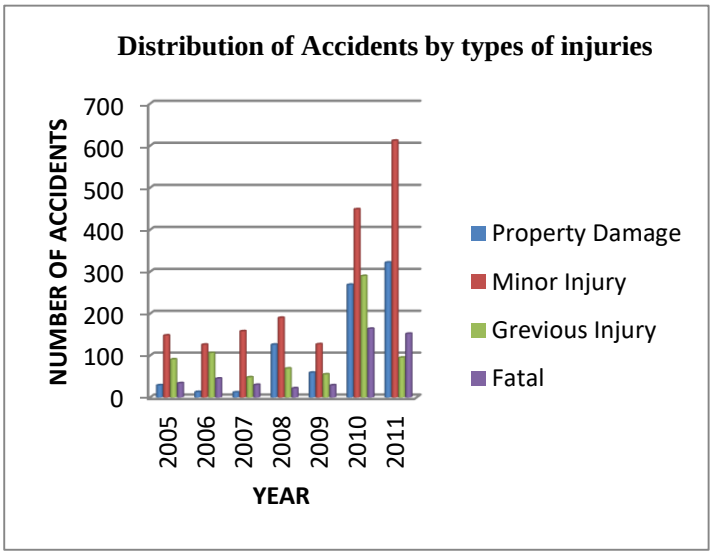

Figure 1.4 Distribution of Accidents by Injuries

Figure 1.4 shows the yearly distributions of accidents from 2005 to 2011 according to the type of injuries namely property damage, Minor Injury, Grievous Injury, Fatal Accidents. It is observed from the Figure that the major increasing injury is only Minor injury. In the year, 2010 & 2011 the minor injury is increasing dramatically.

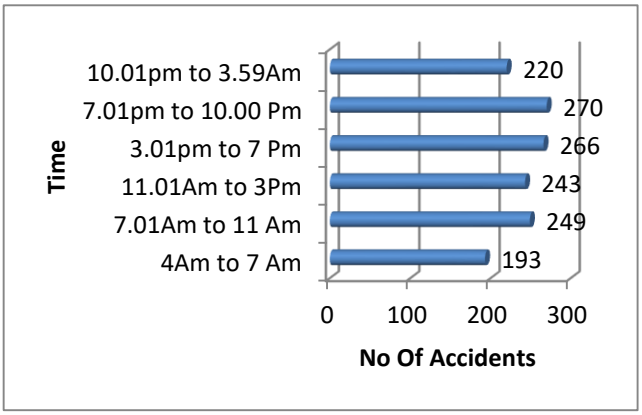

Figure 1.5 depicts the distribution of accidents in age wise manner. In which the evening hour's accidents is more when compared to the morning hours. In morning hours 450 accidents occurred. In lunch hours 243 accidents occurred. In evening hours 300 accidents occurred in whole of study corridor.

Preperation of Tables

S.No	Cities	Accident	Injuries	Death
1	Tamilnadu	67,232	7378	15176
2	Maharastra	61,637	23,175	12,803
3	Kerala	36,282	26,219	4049
4	Uttarpradesh	31,134	22,337	16,287
5	Rajasthan	24,628	4,890	10,289

Table 1.1 Road crash deaths in 2014

S.No	Year	No of Accidents
1	2005	639
2	2006	564
3	2007	520
4	2008	838
5	2009	508
6	2010	1441
7	2011	1532

Table 1.2 Annual variations in accidents in the Study Corridor

I. Micro Level – Do Minimum Scenario

The human factors, drunken driving, overtaking, over speed, speed violation, rash driving which are considered in the model. Inflow in the model represents as increase to the present level values; outflow denotes the decrease of the present level value. In the road factors, obstruction, geometric design, junction design, capsized, signs & markings are considered in the model. In vehicle factors sudden break, reverse moving, mechanical defect, Head on collisions are considered in the model. In the environmental factor, obstruction, street light, building, lamp post are considered as model variables.

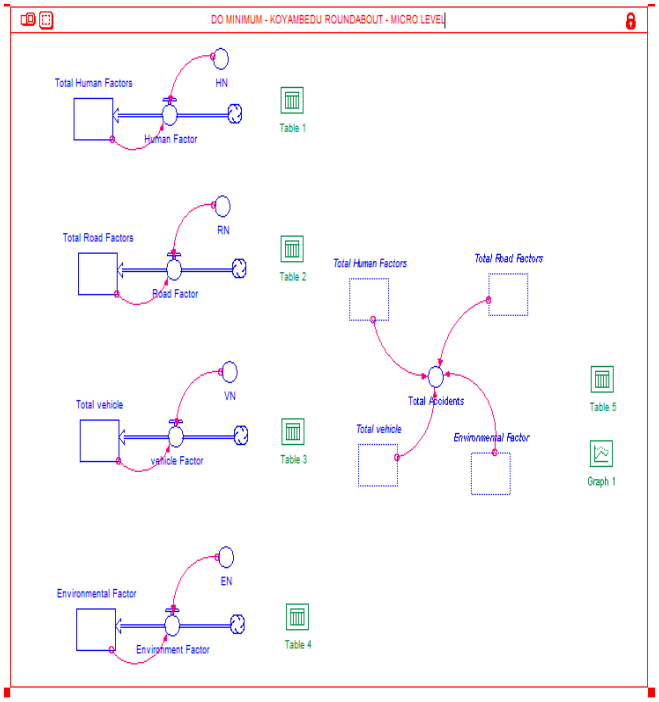

Fig 1.6 Micro Level – Do Minimum Scenario

II. Micro Level – Partial Scenario (50% Reduction)

In partial scenario 50 percent reduction, total accidents is reduced from 168 accidents to 87 accidents which is almost 50 % reductions by applying government schemes and policies towards reduction of accidents. In partial scenario, due to human factor 37 accidents, road factor 25 accidents, vehicle factor 15 accidents, and environmental factor 10 accidents were occurred in micro level analysis.

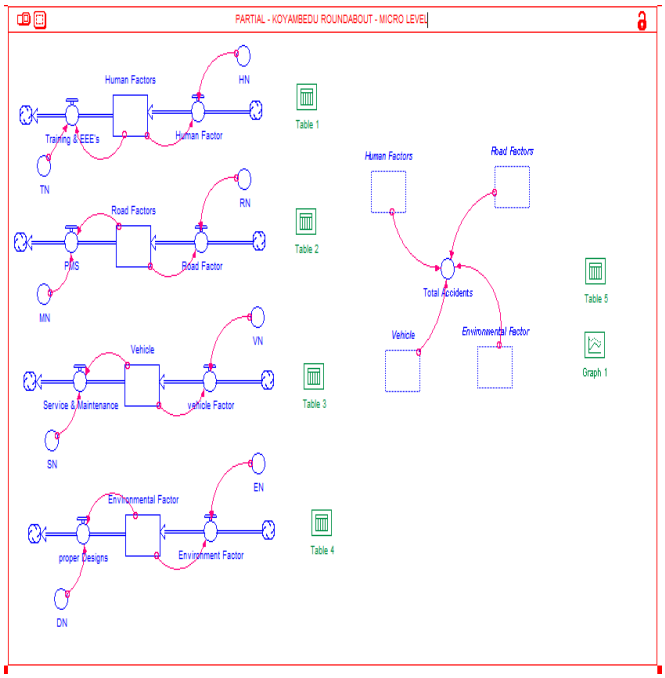

Fig 1.7 Micro Level – Partial Scenario

III. Micro Level – Desirable Scenario (85% Reduction)

In Desirable scenario, total accidents are reduced from 168 accidents to 55 accidents which records 85 percent reduction. In desirable scenario, due to human factor 26 accidents, road factor 15 accidents, vehicle factor 9 accidents, and environmental factor 5 accidents were occurred in micro level analysis.

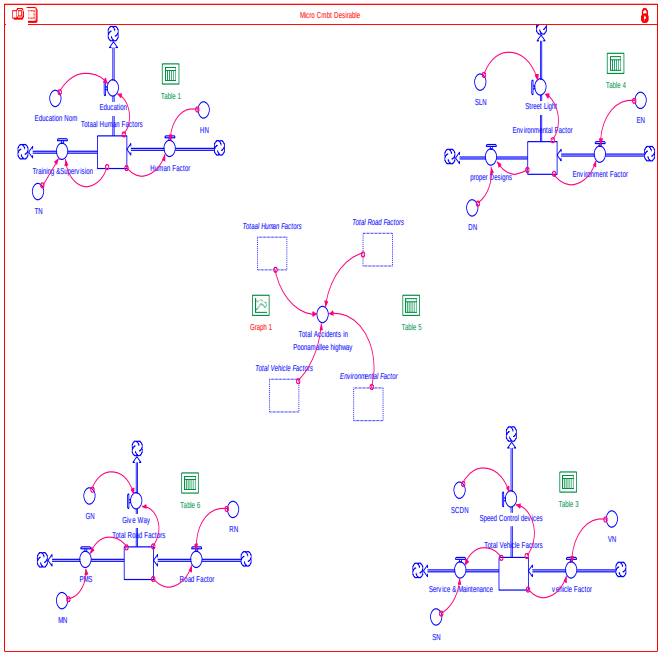

Fig 1.8 Micro Level – Desirable Scenario

IV. Micro Level – Ideal Scenario (95% Reduction)

In ideal condition, micro level analysis is important to monitor by strict enforcement. The outflows are observance of rules and regulation, education for driver, traffic police to awareness of safety and precaution measures, Training and supervision for transportation authorities in human factor. In vehicle factor, the outflows are air conditioned fittings and light helmets, speed control devices, Service and maintenance. In road factor, redesigning of junctions, give way for minor roads depending upon volume of vehicles present in minor roads and also pedestrians. In environmental factor, the outflows are improving visibility, street light condition, proper designs for building construction in road curve which is obstruction to flow of vehicles. In ideal condition, the total accidents which is reduced from 168 to 48 accidents finally which reveals an substantial reduction in accidents. In ideal condition scenario, due to human factor 23 accidents, road factor 13 accidents, vehicle factor 8 accidents, and environmental factor 4 accidents were occurred in micro level analysis.

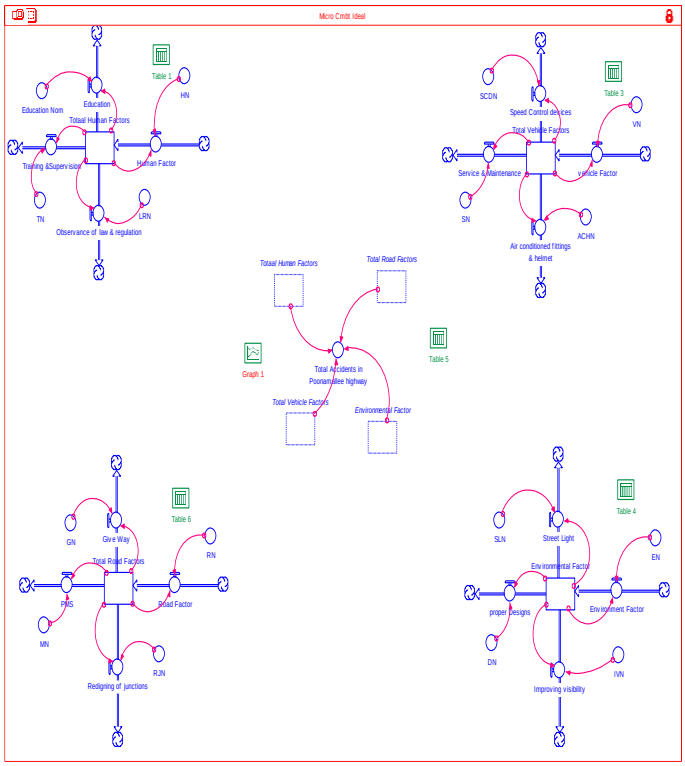

Fig 1.9 Micro Level – Ideal Scenario

Model Validation

Most of statistical mathematical modeling always begins with the collection of data from which the model is developed, whereas the System Dynamic methods reverse this order beginning with the development of a model and afterward collecting the data to populate it and to validate its dynamic behavior. Statistical models must rely on mathematical tests because models can only describe correlations. Any casualty between variables must be inferred from the correlation and that only close correlation supports such influences.

$$\%Error = \frac{predicted\ value - Actual\ value}{Actual\ value}$$

RESULTS

- In micro level model the Anna Arch Junction, in Do minimum scenario the total number of accidents is increased from 19 to 73 accidents, which is 74% of accidents is increased.
- Partial scenario shows that the accident gets reduced to 45 when compared to Do Minimum scenario. In Desirable scenario, the results get reduced from 74% to 58% of accidents.
- Study reveals that accidents in Anna Arch junction in EVR Periyar salai, human factors influence 53%, road factors 24%, vehicle factors 22% and environmental factors 1% with respect to the share in total accidents.

INFERENCES

- It shows that System Dynamic Model gives accurate results.
- Allowing existing trend to continue would worsen the current accident scenarios almost in all models with many folds to the maximum of more than ten-fold in some model cases. Hence all effective measures are applied and simulations have been conducted to enhance the existing and forecasted worst situations.

CONCLUSIONS:

- To reduce the accidents, equal importance must be given for training the public, transport, highways and police officials. Then only appropriate reduction in accidents will be achieved.
- To achieve target of Tamil Nadu Road Safety policy to reduce 20 percent of accidents (by 2013 taking 2006 as a base year) around 65 lakhs rupees per year is needed for training (for training sector alone) the police, transport and highway officials and increase the public awareness.
- If 65 lakhs rupees is spent per year the accident trend will reduce from 4543 to 3605 by the year 2013 which is the target of the Tamilnadu road safety policy.
- Desirable scenario gives best results more than the Road Safety Policy of Tamil Nadu. Though it appears unrealistic this scenario is obviously presented here just to show the influence of extensive training and public awareness.

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