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Safety Of Roads Using A Modeling Technique

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Abstract

All events in traffic contain some kind of interaction but of course to a varying extent. There is an interaction between the road users contains communication. Accidents and serious conflicts indicate such total breakdown in the interaction. These are often due to breakdowns in the communication. An accident could be defined as unplanned and uncontrolled event in which action and reaction of an object, substances and person results in to personal injury or damage to property.

The problems of road accidents have been increasing day by day resulting in increase of both social and economic loss to the country. The accidents percentage has been highest in Chennai in Tamilnadu. Hence in this study an attempt is made to study the road accidents in a systematic approach.

Predominantly human factors are considered to be the major cause of accidents; however this study attempts to highlight other causes of accidents and to reduce the accidents through systems approach.

The main objective of the study is to identify the various causes for road accidents in selected stretches in Chennai City and to develop the System Dynamics simulation model for the prevailing conditions.

Introduction

In India 94968 persons were killed and 465282 were injured by motor vehicles. In Tamilnadu level 9468 and 12036 were killed, 63008 and 71099 were injured by motor
vehicles according to 2005 and 2007 statistics respectively. The use of any service depends on the safety, reliability and convenience offered by the service.

The accidents occur due to various reasons and playing a hand in the causative is the road geometric. The road geometry though designed as per standards undergoes changes with time in terms of widening, encroachments etc. the road design may then become inefficient for maneuvering especially for heavy vehicles like buses. Hence it becomes necessary to evaluate the causes of accidents with respect to the human factors.

Objectives of the Study

The following are the objectives of the study:

1. To identify the various causes for road accidents in selected stretches in Chennai City.
2. To develop the System Dynamics simulation model for the prevailing conditions.
3. To suggest appropriate model to reduce the road accidents and ensure road safety.

Methodology

On reviewing the literatures major reasons for accidents and accident pattern has to be identified. The objective of the study is then formulated based on the previous studies. The cause of accidents is an important aspect considered in this study. Data

relating to it has been collected from the Chennai City Traffic Police (CCTP). The factors (human, environment, road, vehicle and other) which are main cause of accidents are to be studied and identified based on the data collected. Then few stretches in city is taken and its geometrics (carriage way width, median, etc) and road characteristics (roughness, potholes, etc) are studied. Now the collected data has to be analyzed and a System Dynamics Model is going to be developed in STELLA software. The model is then to be calibrated and validated. Finally the appropriate model is to be developed and recommendations on road safety are going to made.

System Dynamics

System dynamics has a long history as a modeling paradigm with its origin in the work of Forrester (1961), who developed the subject to provide an understanding of strategic problems in complex and dynamic systems. System dynamics models, by giving insight into feedback processes, provide system users with a better understanding of the dynamic behaviour of systems. It is a methodology whereby complex, dynamic and non linear interactions in social systems can be understood and analyzed and new structures and policies can be designed to improve the system behaviour. System dynamics presents system approach and prescribes a coherent set of steps for conducting a system inquiry. It is the result of 'Cross Fertilization' among elements of traditional management, feedback control theory and computer simulation. The principal concern of a system dynamics is to understand the forces operating in a system in order to determine their influence on the stability of the system. System dynamics modeling requires explicit recognition of two types of flows namely physical flow and information flow. Physical flows are conserved flows and information flows are not conserved flows, which neither reduces of the level nor increases the value of the rate unlike a physical flow, which accumulate the levels.

Problem Definition

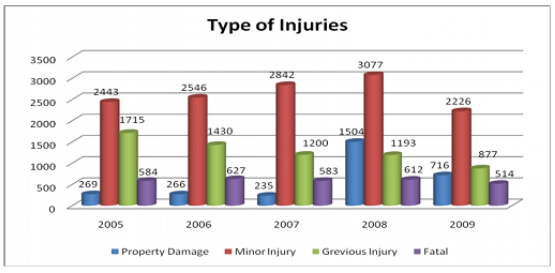
The first phase in the model building process involves recognizing and defining a problem. Important properties of dynamic problems are that they contain quantities that vary over time. Two important skills in recognizing dynamic problems are, knowing how to infer causal relationships and knowing how to interpret graphs of variables plotted against time.

Causal Loop Diagram

A causal loop diagram shows the cause and effect of each variable with respect to other variables. Usually a positive effect is indicated using the '+' sign and negative effect with '-' sign. The causal loop diagrams are represented separately for the individual sectors and as a whole. Causal loop diagram was prepared for rail, bus, IPT, private vehicles and non motorized trips separately.

Model Development

The model of a Road Accidents will be developed for this study, using the system dynamics approach, has been implemented in the 'STELLA' 9.1.4 environment. The modeling tool, which is an object oriented simulation environment, allows the development of Road Accident models with significantly less effort than using traditional programming languages. It has a user-friendly graphical interface and supports modular program development.



Yearly Distribution of Accidents

Distribution of Accidents

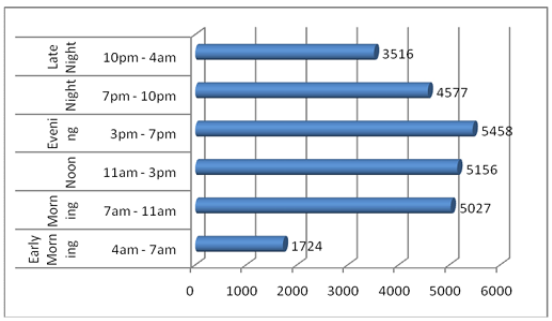
Section No	Type of injury	Numbers
304 A	Fatal	2920
338	Grievous Injury	6415
337	Minor Injury	13134
279	Property Damage	2990

Source: CCTP, Chennai

Month wise Accident occurrences

Month	No of Accidents
Jan	1990
Feb	2179
Mar	2319
Apr	2325
May	2053
June	2147
July	2411
Aug	2445
Sep	2218
Oct	2103
Nov	1496
Dec	1734

Source: CCTP, Chennai



Time wise Accident Occurrence

Results of all Scenarios

Year	Total Accidents				
	Do Minimum	Partial Efforts	20 % Reduction	Desirable	Ideal
2005	4,543	4,543	4,543	4,543	4,543
2006	5,043	4,770	4,413	4,311	3,452
2007	5,598	5,008	4,286	4,092	2,623
2008	6,214	5,258	4,164	3,884	1,993
2009	6,899	5,521	4,045	3,688	1,515
2010	7,658	5,796	3,930	3,501	1,151
2011	8,501	6,086	3,818	3,324	875
2012	9,437	6,390	3,710	3,157	665
2013	**10,476**	**6,709**	**3,605**	**2,998**	**505**
2014	11,629	7,044	3,502	2,847	384
2015	12,909	7,396	3,403	2,703	292
2016	14,330	7,765	3,307	2,568	222
2017	15,908	8,153	3,214	2,439	168
2018	17,659	8,560	3,123	2,316	128
2019	19,603	8,988	3,035	2,200	97
Final	**21,761**	**9,437**	**2,949**	**2,089**	**74**

Source: Model Results

Results

The following are the results for the study:

- In the do minimum scenario the number of accidents is increased from 4543 to 21761 numbers.

- In the partial efforts scenario it gets increased to 9437 from 4501 which is 56.6% less when compared to Do Minimum Scenario.
- In the partial efforts scenario 43 lakh rupees are spent for training in terms of public awareness, training for transport, highways and police officials.

- In the desirable scenario the accidents are getting reduced from 4543 to 2089 in numbers.
- In the 20 % target reduction in accident scenario the accidents are getting reduced to 3605 in the tear 2013 from 4543 in base year and in this scenario 20 % reduction in accidents is achieved as per the policy of Tamil Nadu Government.

Conclusions

The following are the conclusions for the study:

➢ 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% of accidents around 65 lakhs rupees needed for training the police, transport and highway officials.

➢ 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 and Ideal scenario gives best results more than the Road Safety Policy of Tamil Nadu.

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