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Study on Reduction in Delay due to Road Accidents using Variable Message Sign

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Abstract: Road accidents cause loss of life or property damage. It also imposes a substantial cost to society, when delays, congestion and secondary accidents are taken into consideration. They are the major contributors to lack of reliability and thus there is a need for Traffic Management. An Intelligent Transportation System (ITS) technology is used to manage the incidents by incorporating Incident Management System (IMS) in the form of Variable Message Signs (VMS). IMS is the systematic, planned and coordinated use of various resources to reduce the duration and impact of road accidents, and to improve the safety of motorists, crash victims and its responders. This paper presents a traffic simulation approach to evaluate the impacts of incident management system (Variable Message Sign). The study was carried out in major arterial roads of Tiruchirappalli city. The traffic characteristics of the road network namely traffic volume (veh/h) and speed (km/h) were obtained using video graphic survey. Base scenario i.e. existing network was created, calibrated and performance measures were evaluated using VISSIM simulation software. The calibrated model was used for evaluating the accident impacts incorporating various parameters such as accident duration, VMS activation time and response time. In this paper, one accident at the most common location was modelled for the selected road network considering the historical data. And the effect of VMS was studied along with the performance measure such as delay and travel time.

Keywords: *Accidents, Traffic Management, Micro-simulation, Travel information*

1. Introduction

IMS is a key area of concern for road authorities. Unplanned incidents, such as vehicle crashes or breakdowns, often occur during peak periods when traffic networks are already over saturated. The type and timing of accident response is crucial to minimize the impact of accidents on the traffic network. Non-infrastructure solutions for handling the effects of traffic congestion, by using ITS, are becoming increasingly important to monitor traffic conditions, detect any incidents, and implement appropriate remedies such as modified traffic signal plans or driver information signage.

The effects of proposed ITS measure i.e. incident management strategies using VMS can be difficult to predict and evaluate using traffic flow theories, but can be modeled using micro-simulation models such as VISSIM, can provide an excellent platform for evaluating various incident management techniques without affecting real road users. (Susan McMillan, 2009).

2. Need for the Study

Developing countries are facing big challenges in traffic management as there is drastic demand for transport infrastructures leading to frequent accidents causing fatalities. IMS should be considered in all stages of developing and implementing a network management and operations program, as a key to reduce congestion, travel duration and impact of traffic accidents, to avoid risk of secondary crashes and to improve the safety of motorists, crash victims and traffic incident responders. ITS could be used as a tool for providing safe and efficient travel for the road users through proper traffic management and advanced traveler information systems by alerting the users about the incident that has occurred and also displaying the appropriate alternative route. The high implementation and maintenance cost has resulted in a situation where it has not yet been possible to apply all the ITS technologies in India. Thus, there is a need to identify certain appropriate tool that would be suitable for developing an incident management system for the Indian conditions.

3. Data Collection

In order to study the heterogeneous traffic situation considering the effect of accident, the study area plays a vital role. In Trichy city, after analyzing the collected accident data, major junction namely Head Post Office (HPO) junction as shown in ***Figure 1*** has been taken as the study site for the evaluating the impact of incident management strategies.

Figure 2 gives the distribution of fatal and non-fatal accidents on the selected road network.

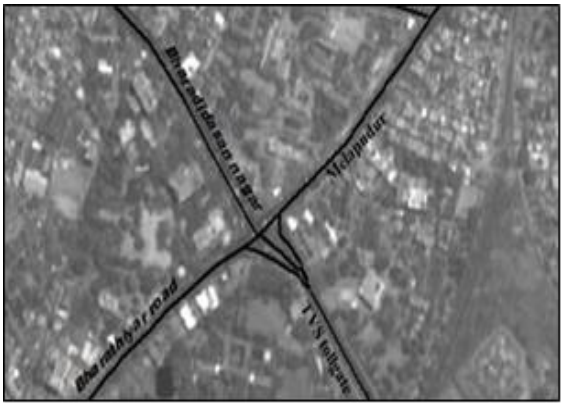


Figure 1 *HPO Junction of Trichy City*

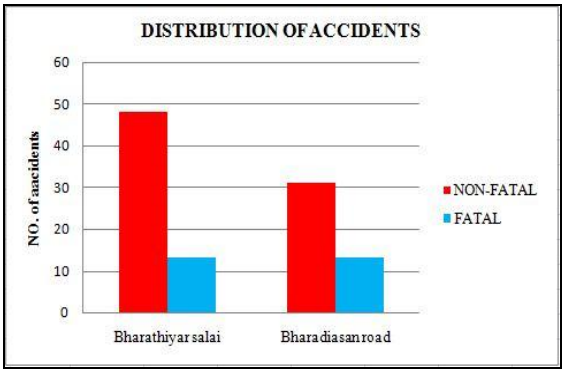
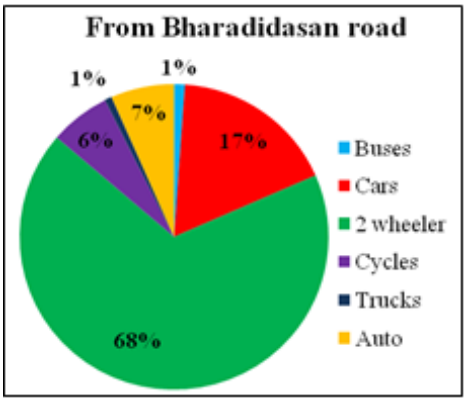


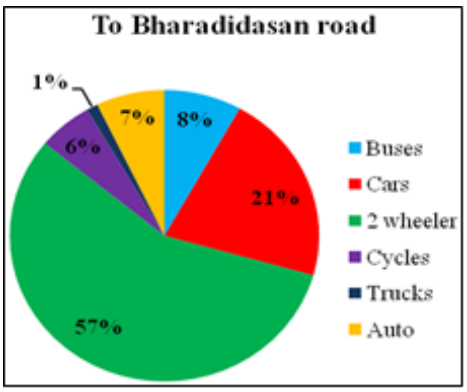
Figure 2 *Distribution of Fatal and Non-fatal accidents on the selected roads*

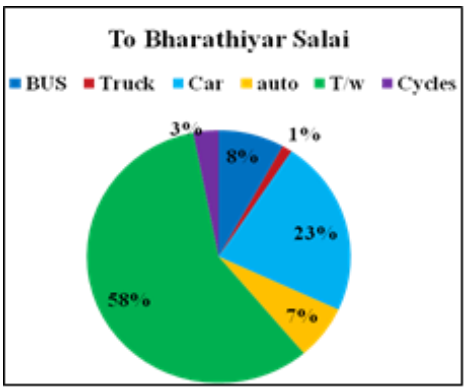
4. Data Analysis

4.1 Volume Studies

The most important traffic characteristics to be collected from the field include traffic volume and speed. Video graphic survey was carried out to obtain the traffic flow parameters on the selected road. The vehicle composition for each road was obtained along with speed of different types of vehicles. The survey was conducted for AM peak hour i.e. 8.00 – 10.00 AM on all the selected roads. The speed was obtained by considering the spot speed technique. The traffic control data were collected from field for each road. The vehicle composition during the peak hours of traffic obtained from video graphic survey for selected roads are shown in ***Figure 3***.







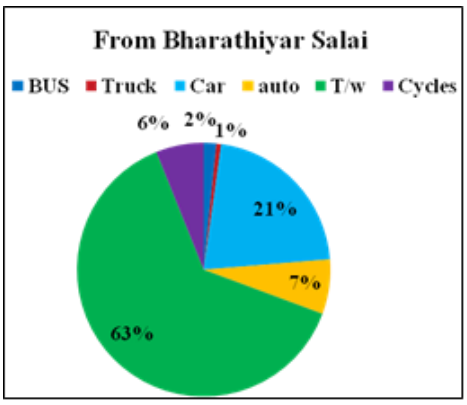


Figure 3 *Vehicle composition of the selected roads*

Major composition of the traffic on the selected roads was contributed by two wheelers falling in the range of 57-68%. Cars and two wheelers together add up to 78-85 % of the traffic in the city. In addition, non-motorized traffic inclusive of cycles and cycle rickshaws formed nearly 4- 7% of total traffic carrying on the roads.

4.2 Speed Studies

Spot speed studies have been carried out on all the selected roads during the morning peak hours of traffic.The long base method (27 m base length) was adopted for the study obtained from video graphic survey. The 85th percentile speeds were calculated from the cumulative frequency graph. The speed of different class of vehicle for each selected road has been calculated in order to incorporate the speed distribution in the simulation model. ***Table 1*** shows the speed of different class in Bharathidasan road.

Table 1: *Spot Speed results for the different vehicle classes*

Type of vehicle	Speed (km/h)			
	Average	Min	Max	85th percentile
Bus/Minibus	34	28	45	36
Truck	28	26	30	29
Cars/Vans	39	28	51	49
Auto	30	26	36	33
Two wheeler	41	26	72	57
Cycle	15	7	20	17

5. Simulation Model

The network layout for the study area was created using the VISSIM software. The vehicle inputs reqiured for each road was inputed into the model using the data colleted from the survey along with the composition of vehicles. The road links were created using the road geometry details collected.

The traffic control data namely existing signal details have been programmed into the model. The simulation was run for one hour. The model was calibrated by varying the default values of Wiedemann 94 Car following behaviour [5]. The performance measures were evaluated from the simulated model. The travel time evaluated at links in the network is tabulated in ***Table 2***.

Table 2 *Travel time simulated for HPO junction*

Road Name	Travel Time (min)
BHARATHIYAR-HPO	1.8
TVS-HPO	2.3
AMERICAN-HPO	0.95
MELAPUDUR - HPO	1.3

The average delay in the network was evaluated. ***Table 3*** shows the average delay in HPO junction obtained from the model.

Table 3 *Average delay in HPO intersection*

Road Name	Average Delay(sec)
BHARATHIYAR-HPO	35
TVS-HPO	34
AMERICAN-HPO	33
MELAPUDUR - HPO	40

5.1 Validation

The traffic volume observed in survey and volume simulated from model were compared. If the error percentage in less than or equal to 10% then the model created is equivalent to real network. ***Table 4*** shows the error percentage obtained from the data at HPO junction.

Table 4: *Comparison of traffic volume observed and simulated at HPO junction*

Road Name	Simulated	Observed	Error %
Bharathidasan	1220	1259	3
Melapudur	2225	2293	3
TVS Tollgate	2273	2396	5
Bharathiyar	1490	1507	1

The error percentage was almost less than or equal to 10% for the network links, which indicates that the model is validated. Thus, this model can be further used for evaluating the incident impacts considering various parameters.

6. Incident Modelling

The variables that were required for modelling incidents were

- **Incident Location –** Location along Bharathidasan road near HPO roundabout
- **Incident Durations -** Three incident durations were considered namely 15mins,30mins and 45mins for studying the impact of variation in duration over the performance of the network.
- **Level of Closure (loc) -**Bharathidasan road is 6 lane divided, so 2 level of closure were considered i.e. 33% and 66.6%
- **TOC response time -** The response time was taken as 5mins from the start of incident.
- **VMS response level -** VMS OFF (Level 0) (LV0) – no message displayed on VMS and Level 1 (LV1) - incident occurrence + alternate route

6.1 Role of VISSIM

Incident Modeling was carried out considering a scenario where all variables were altered considering one locationand impact of variables due to incident was studied. The above described variables were input in to VISSIM. The model was created in such a way that when VMS OFF, the vehicles use the original route where incident as occurred. When VMS ON, the vehicles were diverted to the alternate route modelled in VISSIM using ROUTE icon for the stipulated duration and then they were made to travel through original route. Thus model has been simulated and the impact study was carried out.

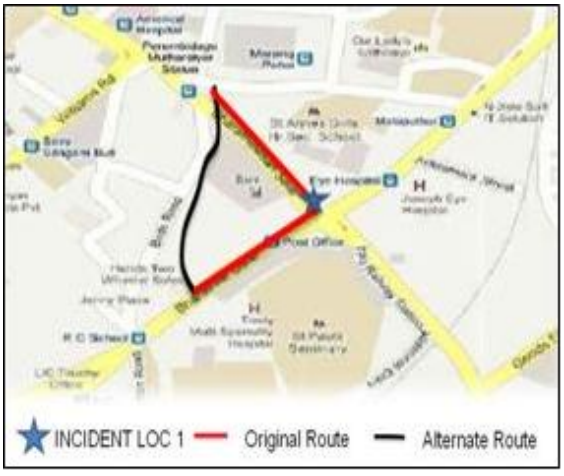


Figure 4 *Incident location 1 along Bharathidasan road*

6.2 Scenario–Varying incident durations and evaluating the performance measures for Location 1

6.2.1. Delay Analysis

The model was simulated by varying the VMS level and incident duration for a fixed location namely location 1. The Average delay obtained from the model was given in ***Table 5***.

Table 5 *Average Delay per vehicle in Location 1*

Incident duration	Lane Closure	Alternate route	VMS Response Level	Average Delay/veh (min)
15mins	1 of 3	-	LEVEL 0 - OFF	11.21
		Sub-arterial	LEVEL 1 - loc+alt	7.85
	2 of 3	-	LEVEL 0 - OFF	11.25
		Sub-arterial	LEVEL 1 - loc+alt	9.25
30mins	1 of 3	-	LEVEL 0 - OFF	12.99
		Sub-arterial	LEVEL 1 - loc+alt	8.16
	2 of 3	-	LEVEL 0 - OFF	13.09
		Sub-arterial	LEVEL 1 - loc+alt	9.26

6.2.2 Network Performance Delay

The overall delay in the network due to incident at location 1 was analyzed and displayed in ***Figure 5*** and ***Figure 6***.

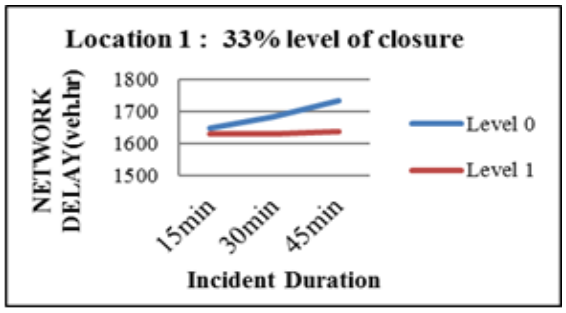


Figure 5.*Network delay due to 1 lane closed*

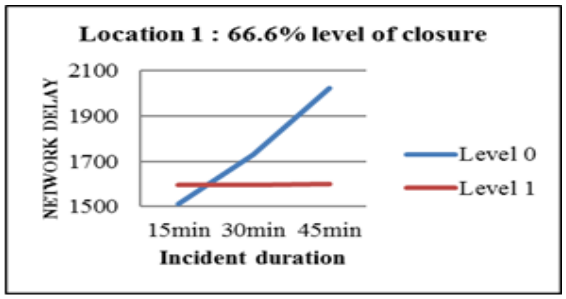


Figure 6.*Network delay due to 2 lanes closed*

6.2.3 Travel Time Analysis

Travel Time is function of lane closure, VMS, Response Time, incident duration.The Average travel time without alternate and with alternate obtained from the model is shown in ***Figure 7*** and ***Figure 8***.

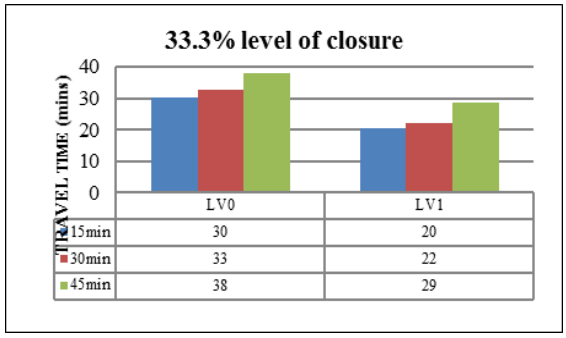


Figure 7 *Average Travel time for lane 1 closure*

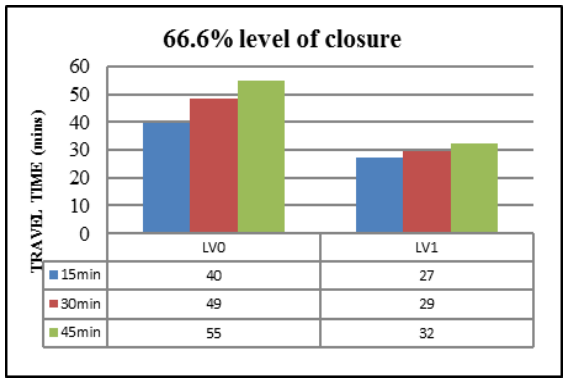


Figure 8 *Average Travel time for 2 lane closure*

7. Conclusion

The conclusions drawn from the study were:

- The base scenario was created using the existing network details and the simulated model evaluated the performance measures of the modeled road network. The average speed obtained from simulation model for the network created was 37 kmph. The average delay for the network was 40 sec.
- In Location 1, there was a delay of almost 4 min per vehicle when there was no VMS whereas with VMS along with alternate route displayed the delay per vehicle was almost 2 min and the travel time increased by 15 min when no VMS provided whereas its increased by 4 min with VMS
- From the model simulated, we can conclude that use of VMS as incident management strategy was been found to be very effective by reducing the delay and travel time in the overall network

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