ISSN: 2513-2512

R4TLI Conference Proceedings 2016
Paper Reference: *R4TLI-B31*

Development of Relationships between Traffic Volume, Number of Accidents and Road Infrastructure Improvements

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1. Introduction

The national road network of Sri Lanka (Class A and Class B road network) serves 80% of the island's road traffic [1] and these national roads have been prime agents for road accidents [2]. The cluster of national roads inside the Western Province connecting a majority of socioeconomically active locations of the country, has the highest demand from both passenger and freight movements which has caused simultaneous increases in congestion and safety problems during the recent past [3]. Under the above circumstances, this research was conducted as an attempt to develop relationships between number of road accidents and road infrastructure improvements to predict the need of infrastructure improvements of the near future, in order to proactively direct the infrastructure providers.

The study was carried out on a 20 km road segment with a high traffic demand and a high frequency of accidents on the A4 road, inside the Colombo District of the Western Province as a case study targeting 25 hazardous locations that were identified and validated through maps plotted with historical data on road accidents from 2010 to 2014 [3]. The SICRS [3] had identified both the hot-spots (congested road sections) and the black-spots (accident prone road sections) separately on A4 road. It had recommended to the Road Development Authority (RDA) possible solutions to mitigate existing problems when improving the road by the end of the year 2014. The RDA having performed two consecutive widening and improvement projects on the studied length of the A4 road from 2010-2013 and 2013-2015, the objective of this study was to identify a relationship among traffic volumes, road accidents and the road infrastructure improvements.

2. Methodology and Analysis

For this research, traffic volumes (ADT) and number of accidents for the selected 25 hazardous locations from the year 2010 to 2014 were gathered as secondary data from the RDA and the Traffic Police Headquarters of Sri Lanka respectively. Using an appropriately modified safety improvement checklist by La Cava and Cafiso [4] to audit safety on roads, the road infrastructure improvements on the studied road segment were audited from 2010 to 2014 using primary data gathered through interviews with relevant authorities. In order to quantify the road infrastructure improvements, the audit was converted in to infrastructure improvement index values for each location from 2010 to 2014 by allocating weights for each feature included in the checklist according to perceived importance as shown below in Table1.

Table 8 - Infrastructure Improvement Index

No.	Road Infrastructure Improvement	Weight
1	Segregation of transport modes (NMT mode lanes)	5
2	Adequate Lighting Conditions	5
3	Adequate turning circles by design (at junctions and bends)	10
4	Imposed speed limits/ Prohibitions on overtaking at critical areas	10
5	Increased skidding resistance of surfaces (Junction and bends)	10
6	Provided shoulders/ Pedestrian Walkways/ Drainage Systems	10
7	Well guided/placed lane markings and improved road signs	15
8	Islands/ Centre medians/ Guard rails	15
9	Adequate visibility by design (other legs of junctions, forth coming bends)	20
	Total Infrastructure Improvement Index value	100

Traffic volumes, road accidents and the road infrastructure improvement index were analysed and developed various combinations of linear relationship. Based on correlation check, the traffic volume was removed and the following was found to be the most significant model, which deals with Fatal Accident (A) and infrastructure improvement index (I) at locations considered along the 20 km road segment. Correlation matrix of the final fit is given in Table 2.

Table 2 - Pearson Correlation Values (and P Values) of parameters

	$\mathbf{A_{(f,P)}}$	$\mathbf{I_{(P)}}$
$\mathbf{I_{(P)}}$	-0.130 (0.196)	-
$\mathbf{I_{(F)}}$	-0.320 (0.045)	0.921 (0.000)

$$I_{(F)} = 5.98 + 0.9841\, I_{(P)} + 5.18\, A_{(f,\,P)}$$

(R-sq 85.79%, R-sq (adj) 85.49%)

$A_{(f,\,P)}$ – Number of fatal accidents during the present year

$I_{(P)}$ – Infrastructure improvement index value from the present year

$I_{(F)}$ – Infrastructure improvement index value for future year

3. Conclusion

The linear model that was developed in this study can be used to predict the consequential infrastructure improvement index value for a forthcoming year. It can be concluded that this study reveals a numerical relationship that can be used to proactively determine the need for providing safer roads for the users by relevant authorities (in Sri Lanka, the RDA) to target the infrastructure maintenance and/or improvement to a level greater than or equal to the level predicted by the model based on present fatal accidents and present infrastructure existence. This study could be improved by further fine tuning the weightage assigned for infrastructure improvement, and incorporating more accurate historical data on traffic volume and speed as other additional inputs.

Reference:

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