CROSS/ ROADS\
LINKING MOBILITY SOLUTIONS

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Safety Modeling of Urban Roads – A Case Study of Tiruchirappalli City

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Introduction

- **1.25 million die** each year as a result of road accidents worldwide and if no action is taken, road accidents are predicted to be the **7th leading cause of death by 2030**
- **50 million people** incur non-fatal injuries each year as a result of road traffic crashes
- Low and middle income countries account for about 90% of the world's road fatalities
- India accounts for 10% of global road accidents and has highest death rate in the world

Introduction

- Rapid population growth & increase in economic activities leads to enormous growth of motor vehicles
- **High motorization growth rate** & **rapid expansion of the road network** and **urbanization** - impacts on road safety levels
- Tamil Nadu tops in road accidents in the entire country with a percentage share of 13.8%
- Tamil Nadu shares about 10.7% of the total road accident fatalities and 15.9% of total persons injured in road accidents

Causes of Road Accidents

- According to the National Crime Records Bureau (NCRB), **over speeding** and **unsafe driving** were the most important reasons for road fatalities
- Road accidents are influenced by many factors such as traffic flow, geometric design of road sections, horizontal curvature, vertical grade, lane width, and shoulder width etc.
- A better understanding of the factors associated with accidents is required in order to identify and implement more effective countermeasures to reduce the occurrence of accidents

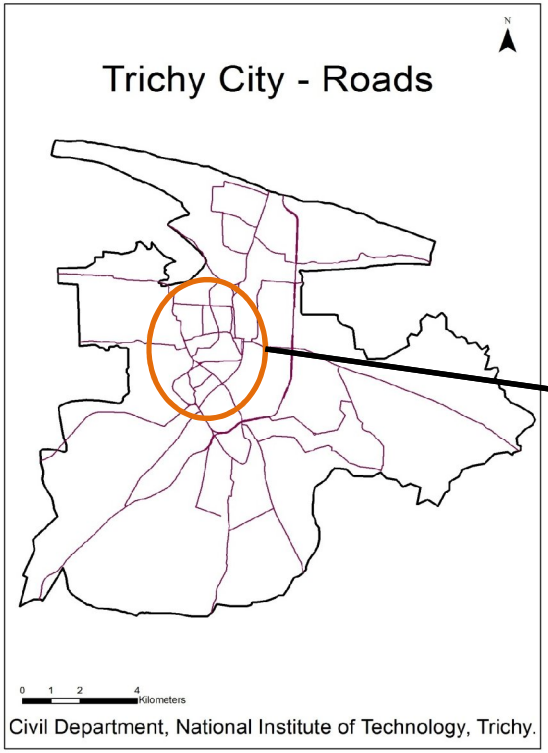
Literature Review

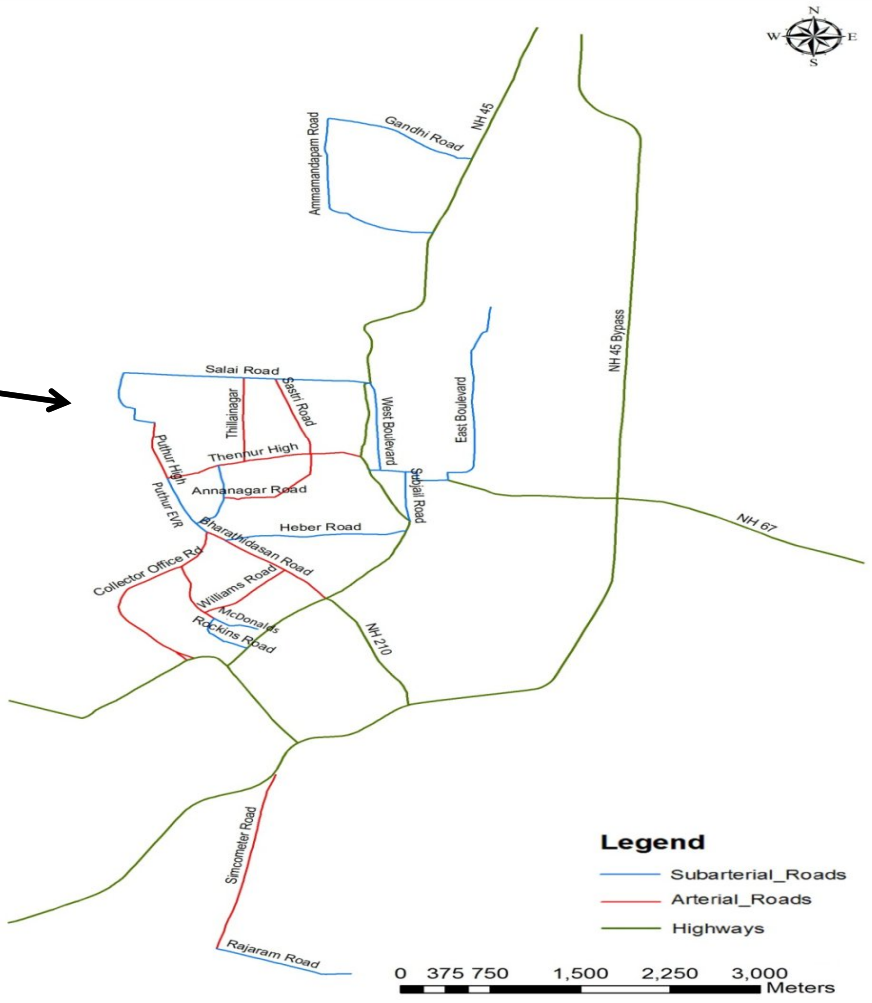
Author & Year	Modeling Method	Findings
Sawalha and Sayed (2001)	Generalized linear model	10% accident reduction can be achieved by improving undivided arterial with a raised curb median
Greibe (2003)	Generalized linear model	number of access roads and speed limit were the important variables in a road link model
Basyouny (2009)	Poisson-lognormal model (PLN)	Accident frequency is significantly influenced by section length, Annual average daily traffic (AADT), crosswalks density, land use, unsignalised intersection density and number of lanes between signals
Prajapati (2013)	Negative Binomial Model	Number of fatal crashes increases as traffic level and road length increases and decreases as junction per kilometer increases

Objectives

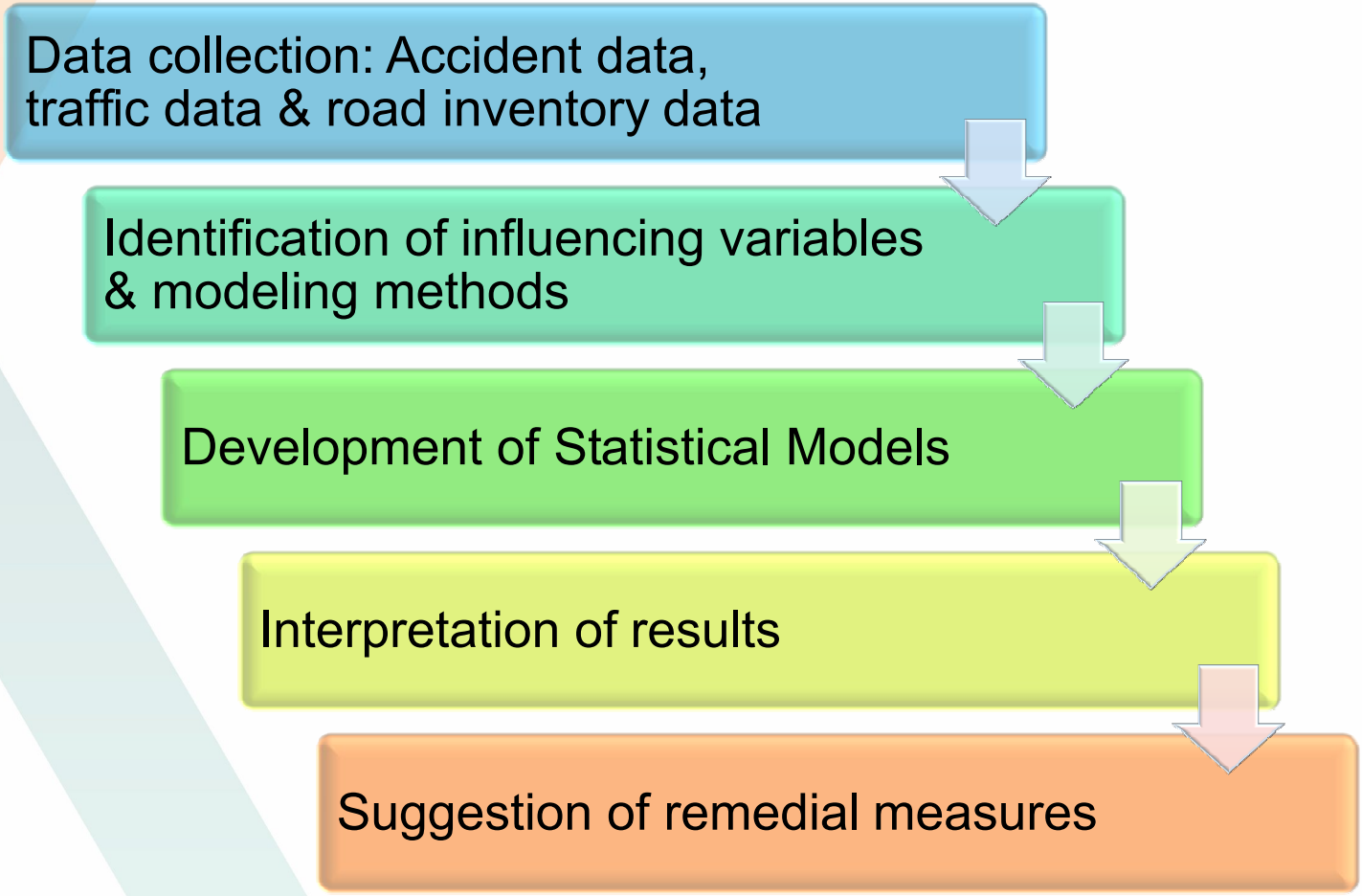
- To analyze accident data based on type, severity and vehicles involved in accident
- To identify the explanatory variables that influence the occurrence of accidents on urban roads
- To develop models and to analyze the relationship between road accidents and influencing factors
- To recommend strategies to reduce the number of accidents and their severity in order to enhance safety

Study Area

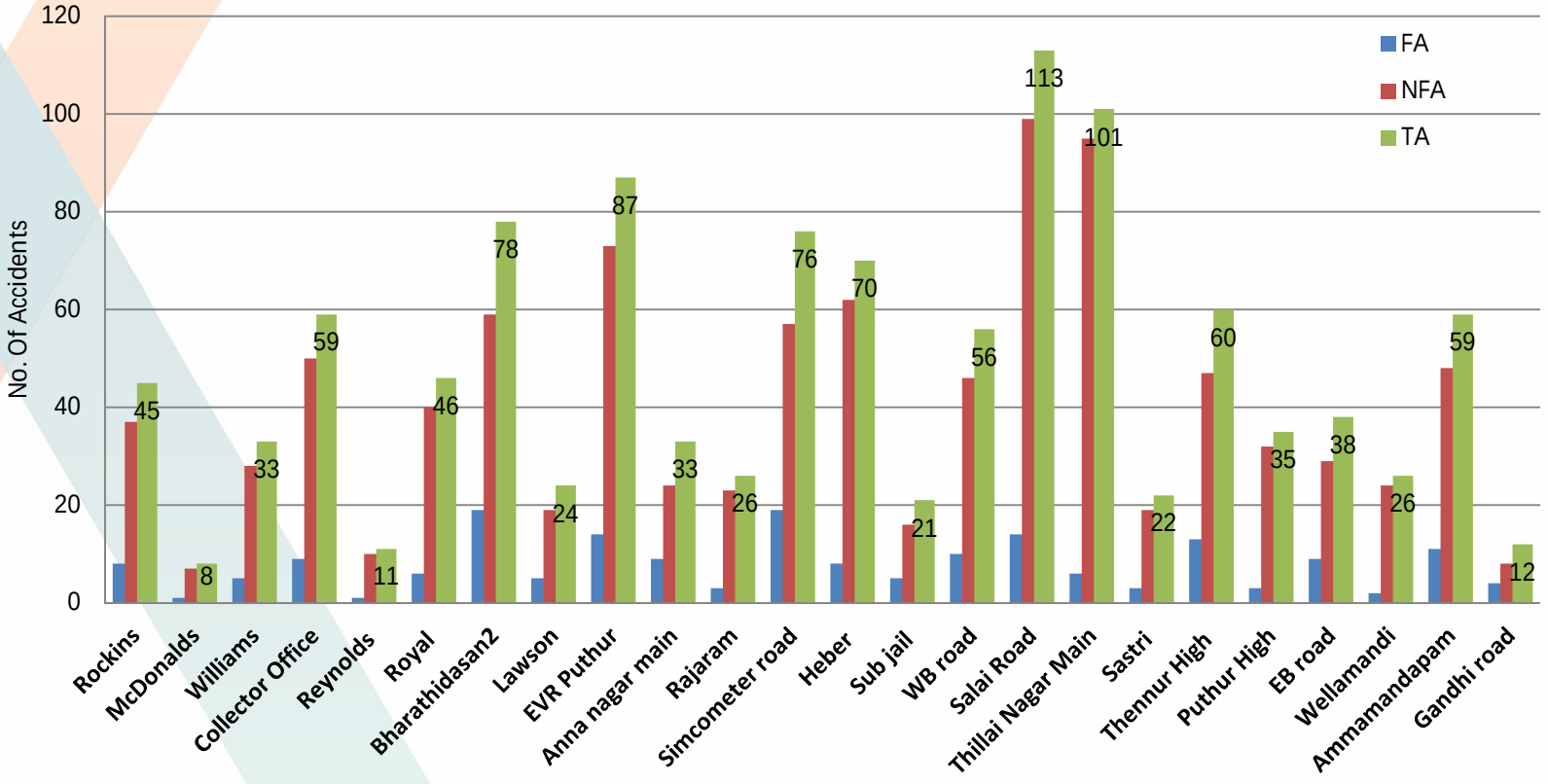

Trichy City - Roads
0 1 2 4
Kilometers
Civil Department, National Institute of Technology, Trichy.


Gandhi Road
NH 45
Ammamandapam Road
NH 45 Bypass
Salai Road
Sastri Road
Thillainagar
West Boulevard
East Boulevard
Puthur High
Thennur High
Puthur EVR
Annanagar Road
Stanley Road
Heber Road
NH 67
Bharathidasan Road
Collector Office Rd
Williams Road
McDonalds
Rockins Road
NH 210
Simcometer Road
Rajaram Road
Legend
Subarterial_Roads
Arterial_Roads
Highways
0 375 750 1,500 2,250 3,000
Meters

Methodology

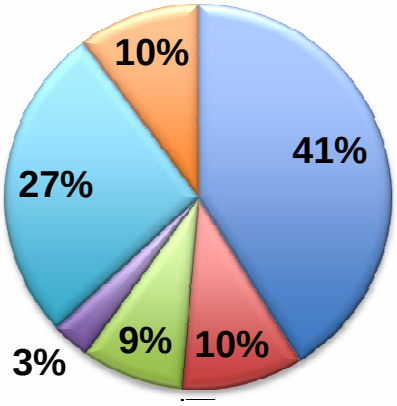


Distribution of Accidents (2010-15)

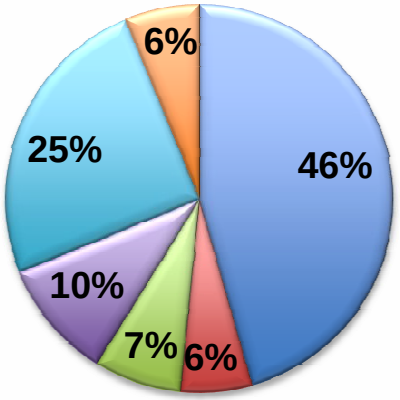


Distribution of Accidents

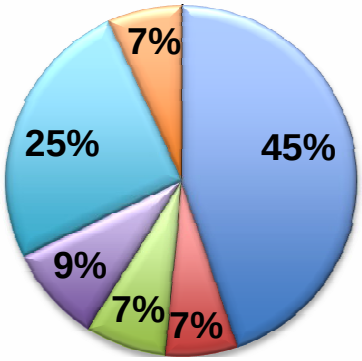
Fatal Accidents



Non - Fatal Accidents



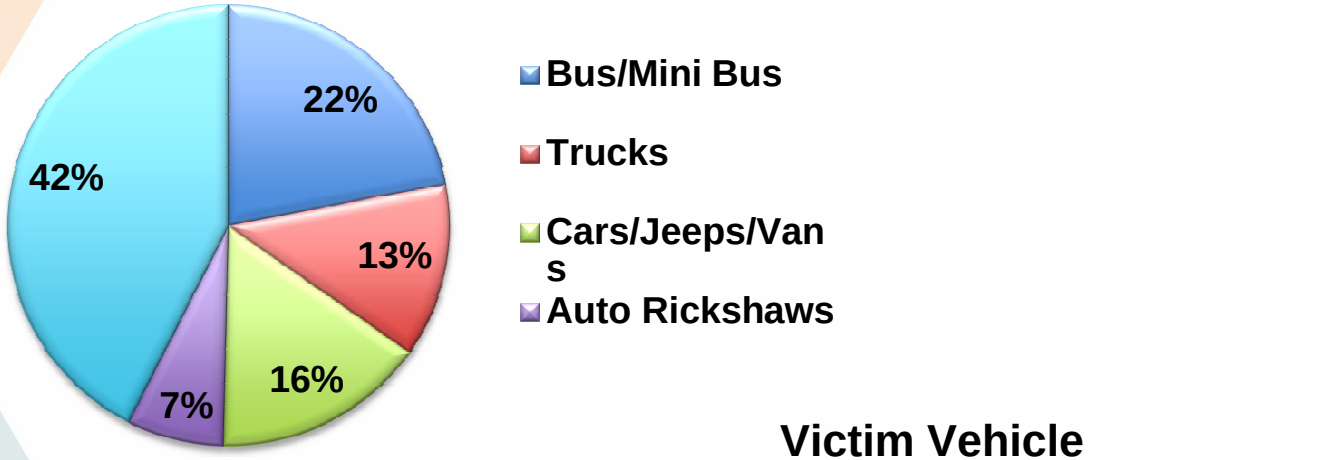
Total Accidents



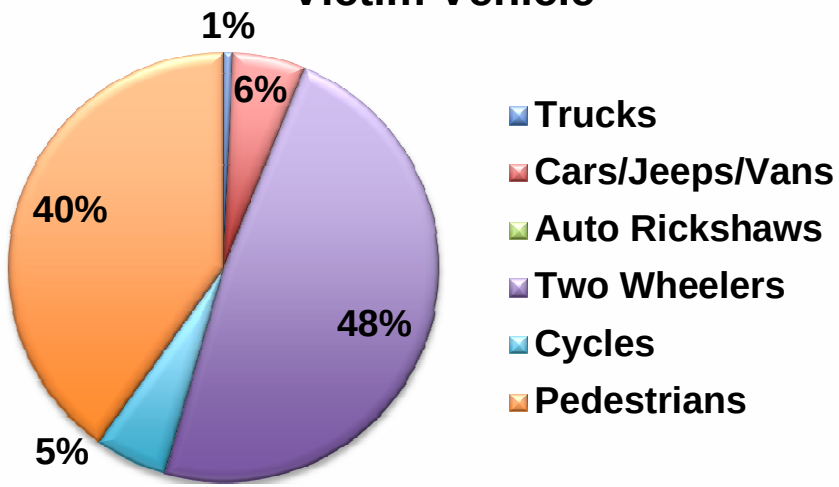
- 2 lane 2 way undivided
- 2 lane 2 way divided
- 2 lane 1 way undivided
- 4 lane 2 way undivided
- 4 lane 2 way divided
- 6 lane 2 way divided

Vehicles Involved in Accidents

Accused Vehicle



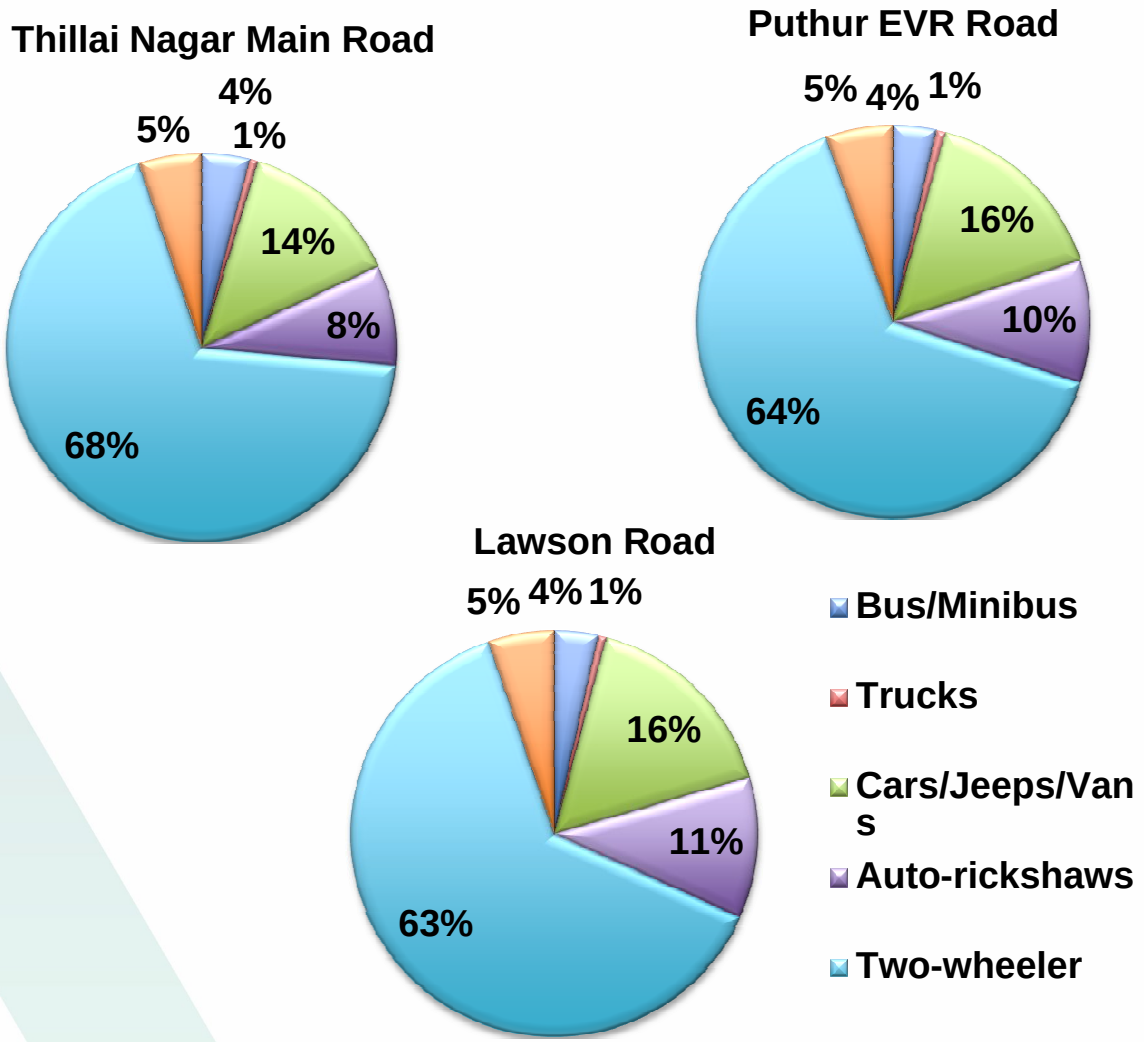
Victim Vehicle



Traffic Survey

- Traffic studies provide a basis for planning and designing traffic facilities, including the selection of geometric standards, economic analysis, and the determination of priorities for traffic management and operation
- Most important traffic characteristics to be collected from the field include traffic volume and speed
- Classified volume counts and spot speed measurements were carried out for 24 roads

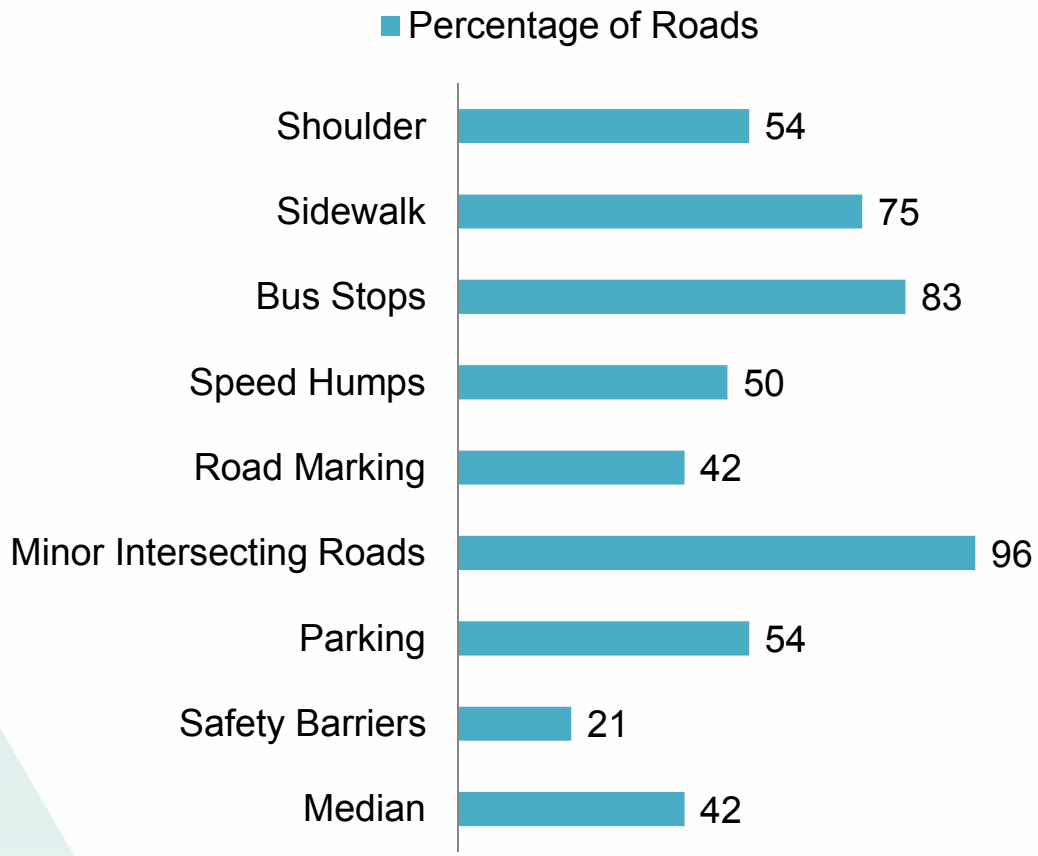
Traffic Survey



Traffic Speed

- Spot speed study - long base method
- minimum speed - 27.1 kmph
- maximum speed - 43.2 kmph
- highest 85^{th} percentile speed - 51 kmph
- Posted speed limit in the selected roads is 30 kmph
- 75% of selected roads exceed the speed limit

Road Inventory Data



Accident Prediction Model

- Count data models are mostly adopted for developing APMs.
- Poisson and Negative Binomial Model are traditional count data models
- The main objective of modeling with many explanatory variables is to understand the complex relation or effect of different urban road variables with accidents.

Poisson Model

•Generalized linear model with Poisson response and link log is developed with logarithm of mean (Number of accidents) as a function of observed variables

$$\log(\mu_i) = \mathbf{x}_i'\boldsymbol{\beta}.$$

•Exponentiating above Equation,

$$\mu_i = \exp\{\mathbf{x}_i'\boldsymbol{\beta}\}$$

•An exponentiated regression coefficient represents a multiplicative effect of the i-th predictor on the mean.

Poisson Model Estimates

	Model - 1			Model - 2		
Parameter Estimates	β	Sign.	IRR	β	Sign.	IRR
Intercept	1.259	<0.0001	3.523	2.169	<0.0001	8.746
CW	0.035	0.011	1.035	-	*	-
SL	-0.332	0.027	0.717	-0.712	0.001	0.491
ADT	0.017	<0.0001	1.018	-	*	-
PL	-	*	-	0.960	0.0003	2.611
Pearson Chi-Square	4.638			11.210		
Likelihood Ratio test	70.216	<0.0001		23.289	<0.0001	
Alkaline's Information Criterion (AIC)	76.735			81.792		
Finite Sample Corrected AIC (AICC)	80.372			83.792		
Bayesian Information Criterion (BIC)	79.826			84.110		

Negative Binomial Model

- Negative Binomial regression model is a standard model that are widely used in modelling road accidents since it also accounts for the unnoticed heterogeneity in the accident data
- The equation for developing Negative Binomial regression model is given as follows:

Where *EXP* ($\mu_i = EXP(\beta X_i + \varepsilon_i)$ Gamma-distributed disturbance term nd variance α

Negative Binomial Model Estimates

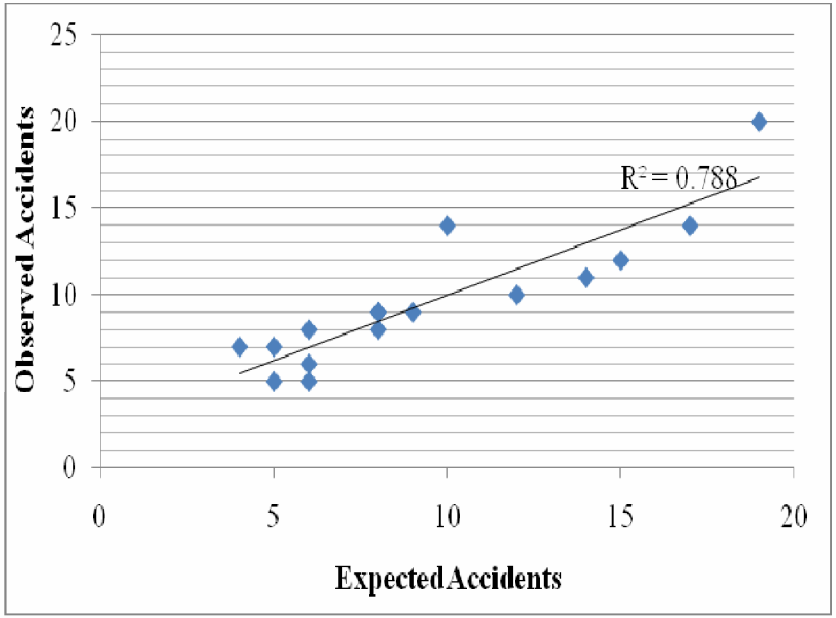
	Model - 1			Model - 2		
Parameter Estimates	β	Sign.	IRR	β	Sign.	IRR
Intercept	1.013	<0.0001	4.920	1.595	<0.0001	4.930
SL	-0.329	0.046	0.718	-0.335	0.045	0.716
ADT	-	-	-	0.019	<0.0001	1.019
TW	0.029	<0.0001	1.029	-	-	-
Pearson Chi-Square	13.000			13.000		
Likelihood Ratio test	43.802	<0.0001		42.722	<0.0001	
Alkaline's Information Criterion (AIC)	109.370			109.382		
Finite Sample Corrected AIC (AICC)	111.370			111.382		
Bayesian Information Criterion (BIC)	111.687			111.700		

The model form is given as,

Accident Frequency =

exp [1.013 - 0.329(SL) + 0.029(TW)]

Model Validation



1/3rd of the data was used for model validating. The error term comes to 1.724%

Conclusions

The study recommends that

- increasing shoulder width to 2.5 m in all the road segments reduces the occurrence of accidents by 2.3 % since it provides buffer space for vehicle or pedestrian movement.
- avoiding bus stops near the intersections and by regulating the access from minor roads, collisions can be reduced.
- providing speed breakers near intersections helps to reduce speed of the vehicles and thus accidents can be avoided.

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THANK YOU