SAFETY EVALUATION TOOL FOR ROUNDABOUTS

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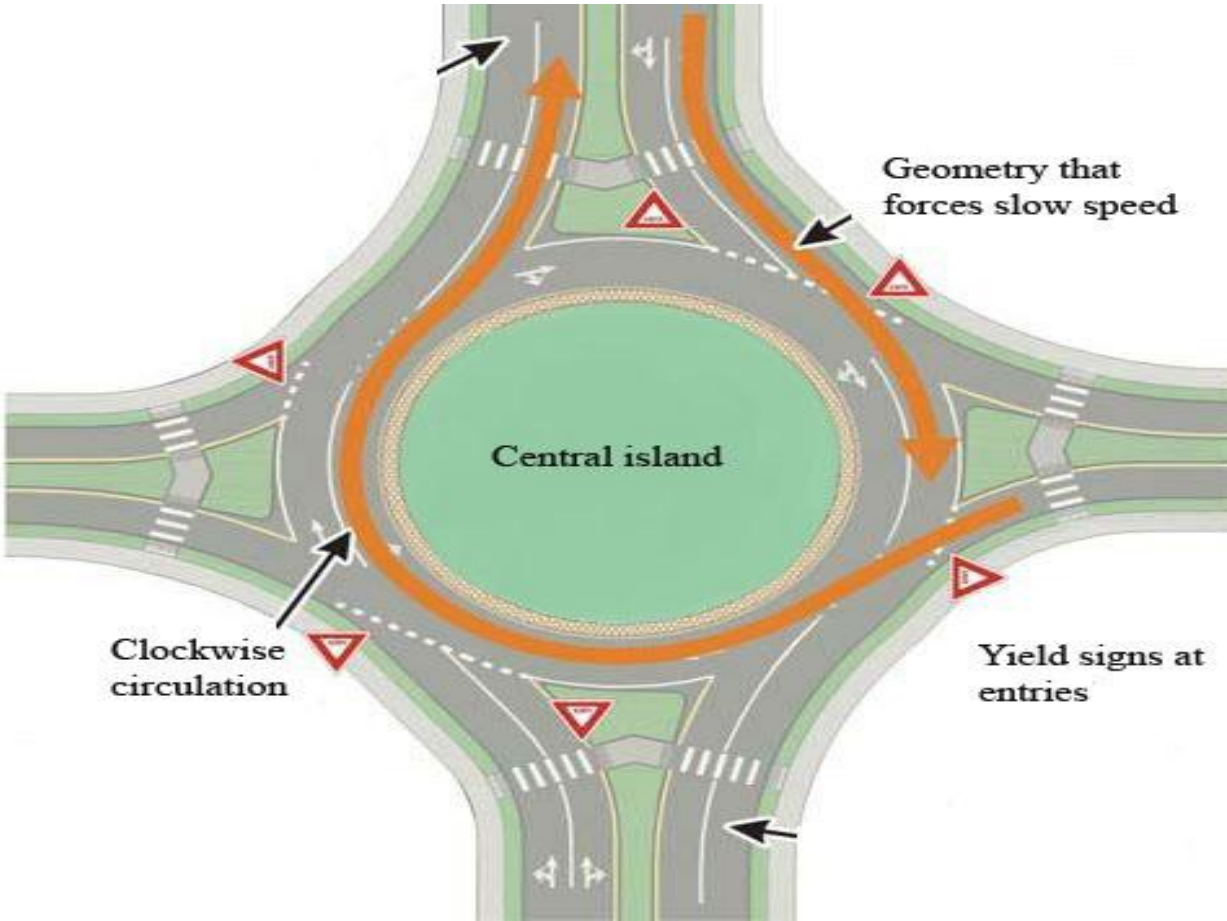
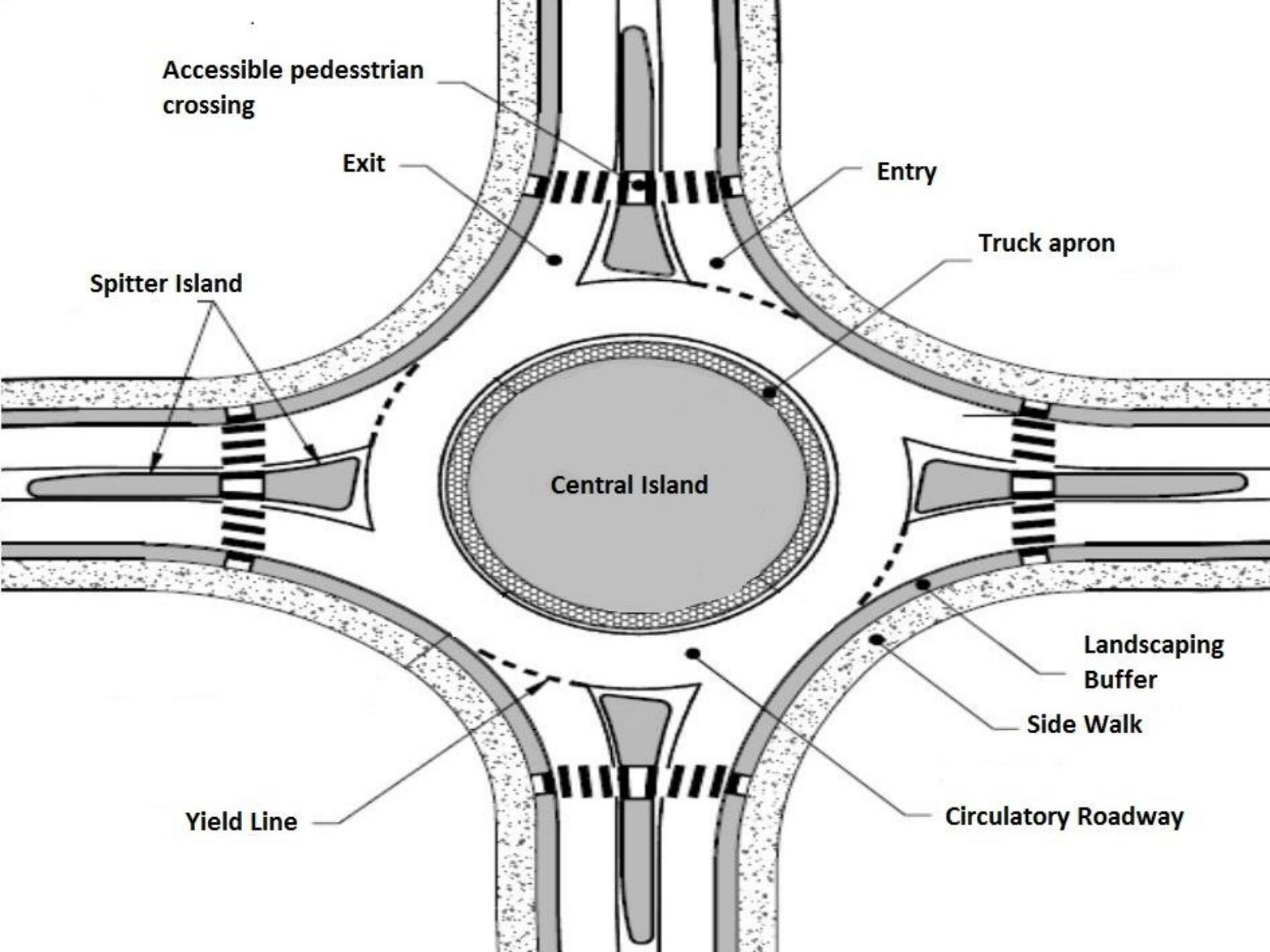
OVERVIEW

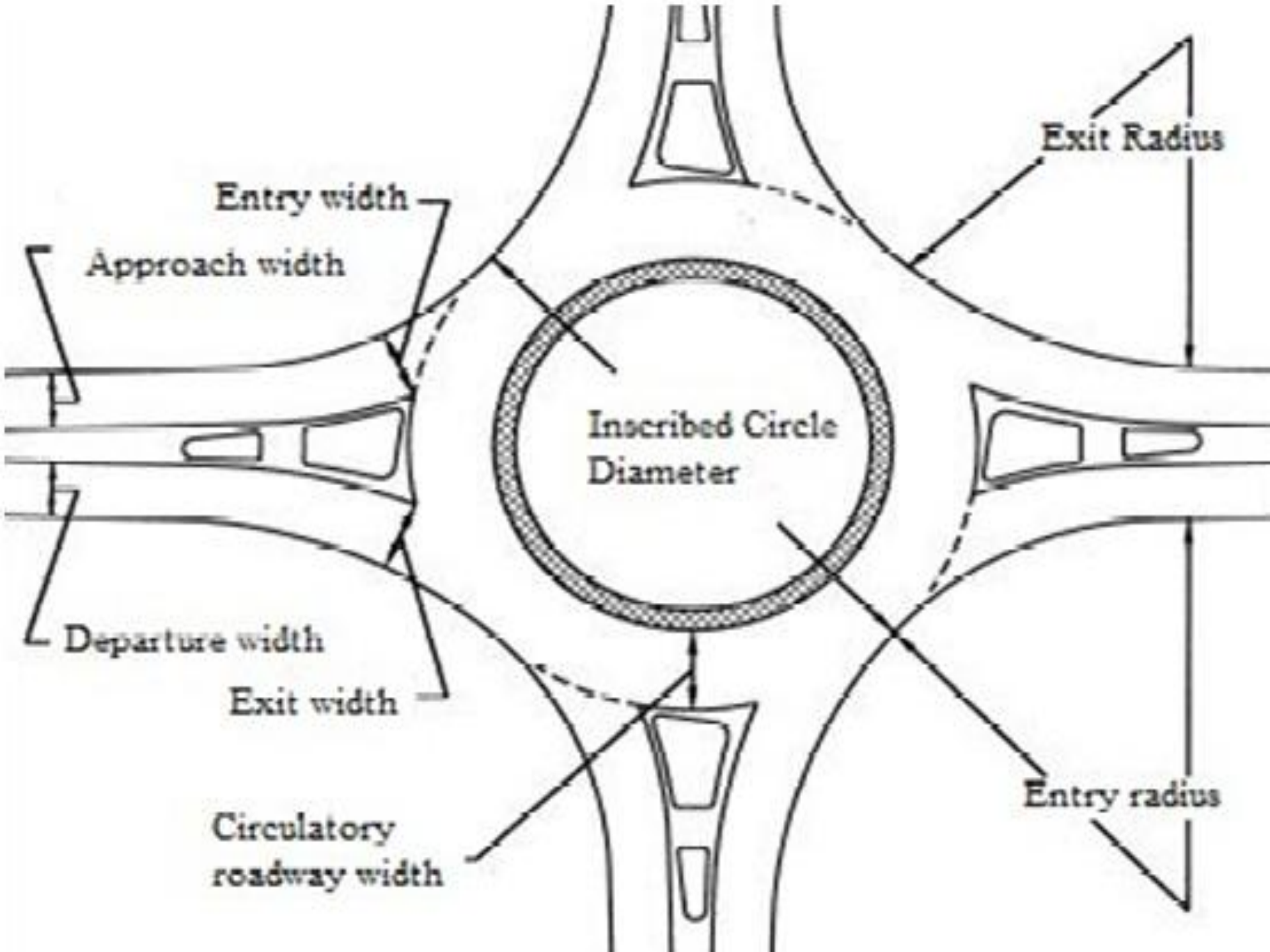
- Introduction
- Objectives
- Methodology
- Data Collection
- Data Exploration
- Model Development
- Estimation of AMF
- Application of AMF
- Summary and Conclusions
- References

INTRODUCTION

- Need For Study
- Accident Modification Factor (AMF)
- Roundabout



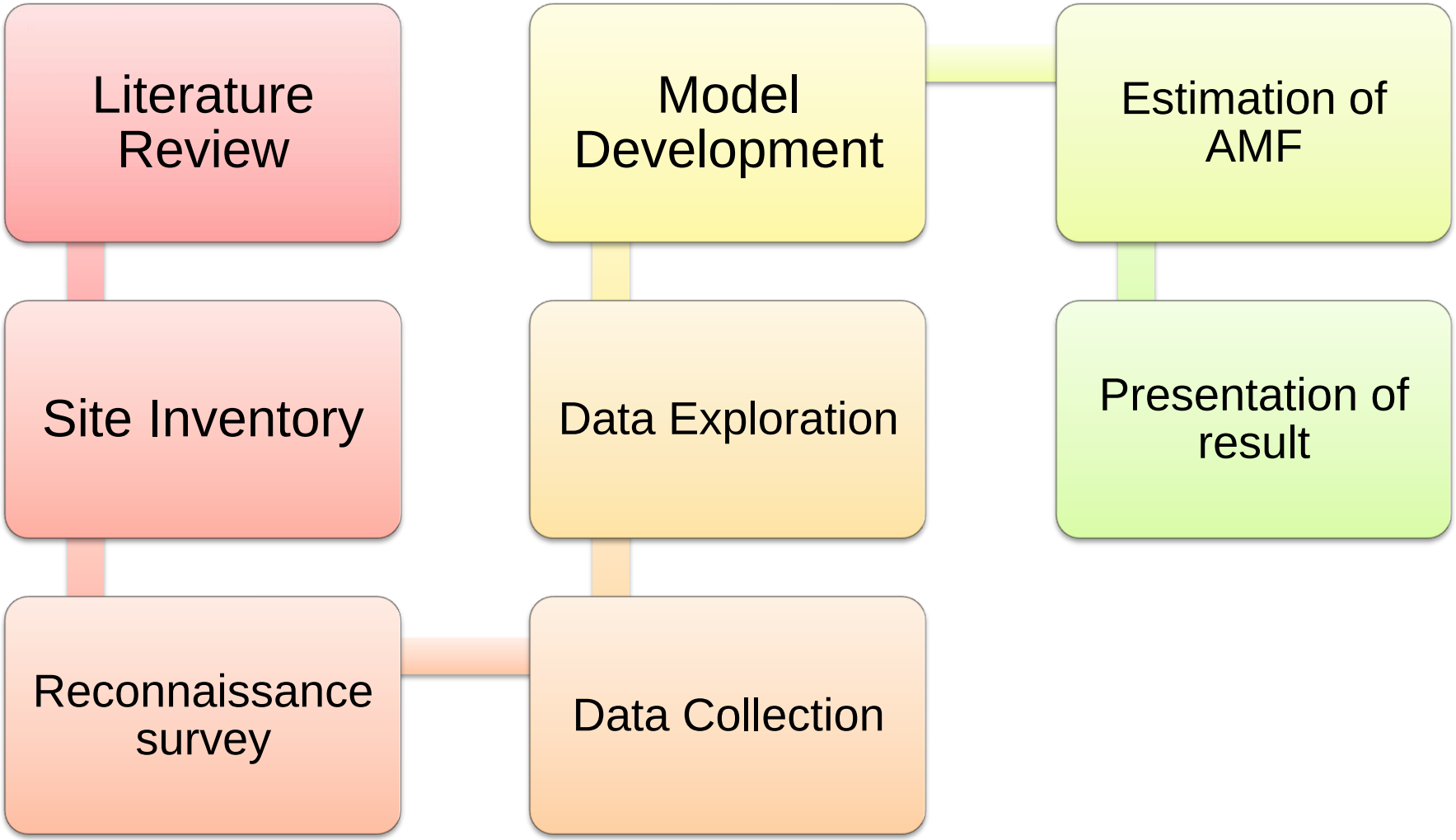

Accessible pedesstrian crossing
Exit
Entry
Truck apron
Spitter Island
Central Island
Landscaping Buffer
Side Walk
Yield Line
Circulatory Roadway


Exit Radius
Entry width
Approach width
Inscribed Circle
Diameter
Departure width
Exit width
Entry radius
Circulatory
roadway width

OBJECTIVE OF THE STUDY

- To identify the various geometric and traffic factors which affect safety at roundabout.
- To develop accident prediction model for Roundabout.
- To estimate AMFs for the various geometric variables of roundabout.

METHODOLOGY



LITERATURE REVIEW

- Inscribed circle diameter, Circulatory roadway width, Approach width,Departure width, Entry width, Exit width, Entry radius, Exit radius,Entry path radius, Angle to next leg, Entering traffic volume, Exiting traffic volume, Circulating traffic volume, Number of lanes, Number of legs

SITE INVENTORY

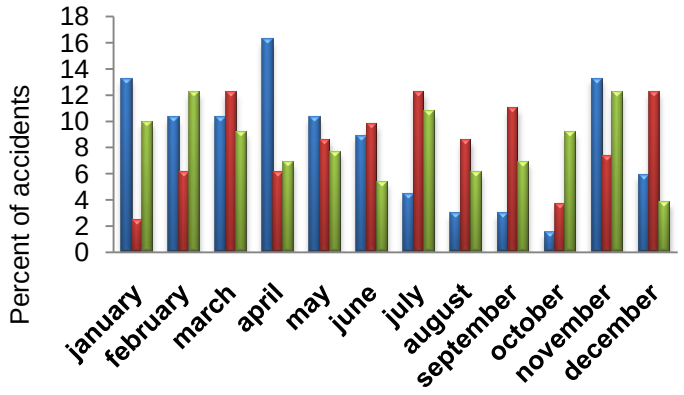
- 20 Roundabouts,75 approaches
- Three cities- Calicut, Trivandrum, Thrissur

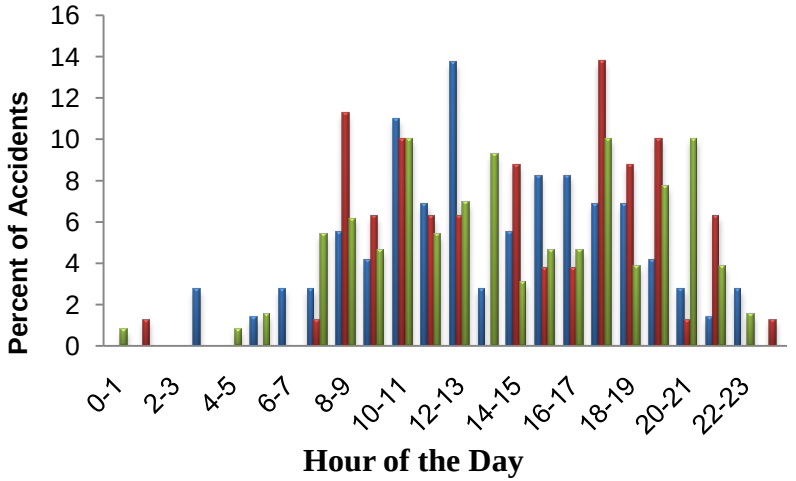
DATA COLLECTION

- Accident data-3 years
- Classified traffic volume count
- Speed data collection
- Intersection Geometrics

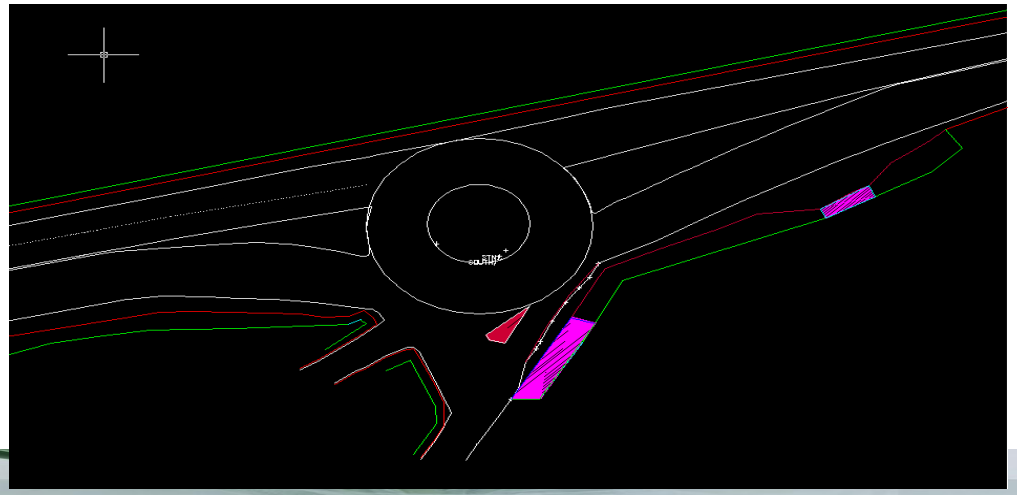
DATA EXPLORATION

Accident data analysis





Geometric data



MODEL DEVELOPMENT

- Intersection level and approach level safety prediction model .
- Modeling technique: Regression analysis

Step 1

- **Correlation matrix between accident frequency and independent variables were generated and candidate independent variables were identified**

Step 2

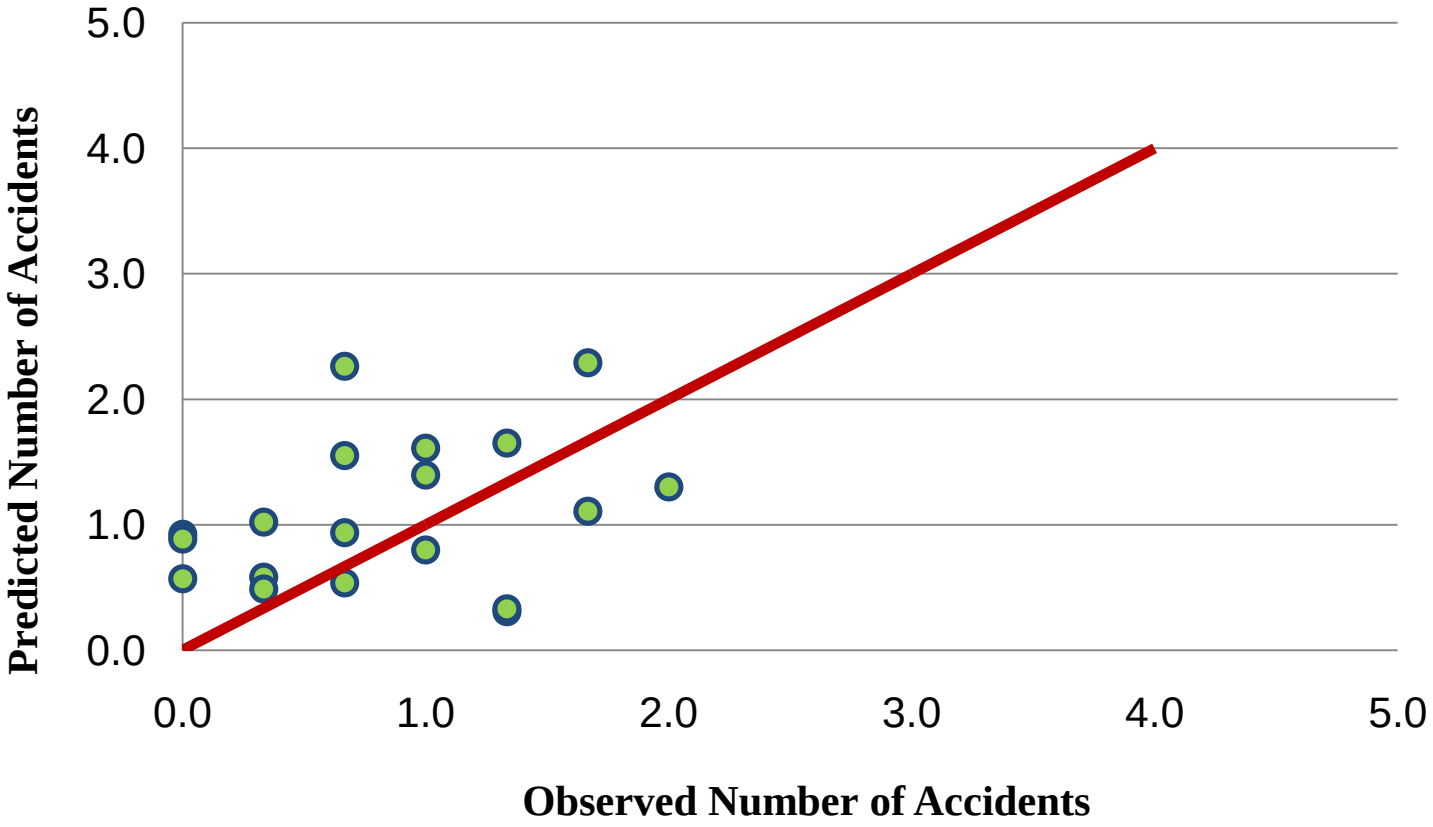
- **Model calibration with different combinations of independent variables & identifying the best fitting model.**

Multiple Linear Regression model
Generalized Linear Model
Poisson Regression Models
Negative Binomial Models
Zero Inflated Poisson Model

GENERALISED LINEAR REGRESSION MODEL

Accidents per year = EXP(-4.491) ×(EntADT^0.416) × EXP (0.014×CID - 0.112×CRW + 0.084×WW + 0.027×WL+ 0.002×EntPR - 0.007×AbL + 0.197×SIT - 0.01×SIL)

R^2	Adj. R^2	F
0.486	0.367	4.092



Model	Coefficients	t	Sig.
(Constant)	-4.491	-2.604	0.013
ENTRY ADT	0.416	2.585	0.014
Central Island Diameter	0.014	1.484	0.146
Circulatory Roadway Width	-0.112	-3.309	0.002
Weaving Width	0.084	2.659	0.011
Weaving Length	0.027	2.775	0.008
Entry Path Radius	0.002	1.731	0.091
Angle to the Next Leg	-0.007	-2.053	0.047
Splitter Island Type	0.197	2.278	0.028
Splitter Island Length	-0.01	-1.954	0.058
Dependent Variable: Accidents per year			

ESTIMATION OF AMF

Step 1

Assume base conditions,

develop base models and

determine crash frequency.

BASE CONDITIONS	
Central Island Diameter	20m
Circulating Roadway Width	7m
Entry Path Radius	23m
Length of Weaving Section	15m
Width of Weaving Section	7m
Splitter island Length	15m
Splitter island Type	Raised
Entry ADT	30000PCU
Angle to the next Leg	90degree

N_{base}	0.0164

Step 2

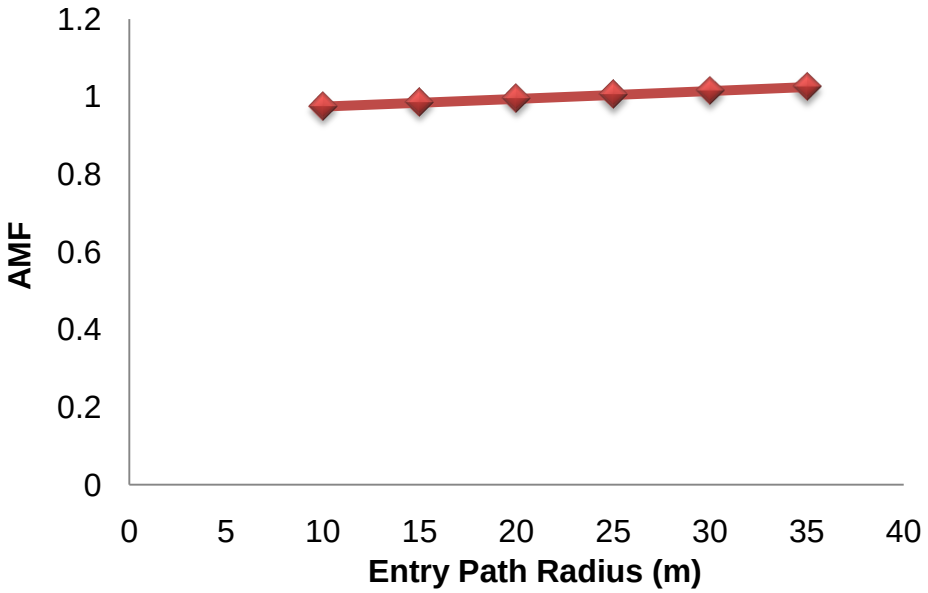
Determine crash frequency corresponding to different values of an independent variable keeping all others constant.

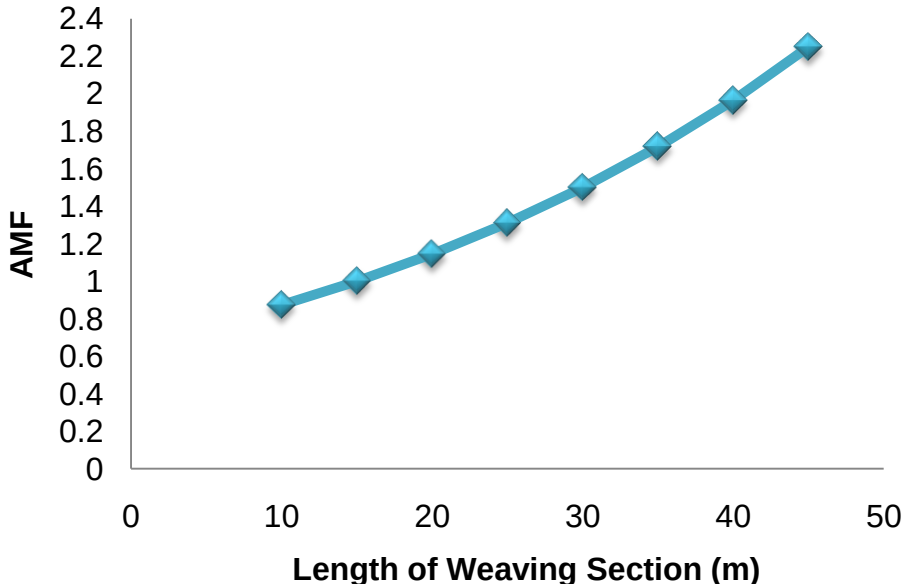
Step 3

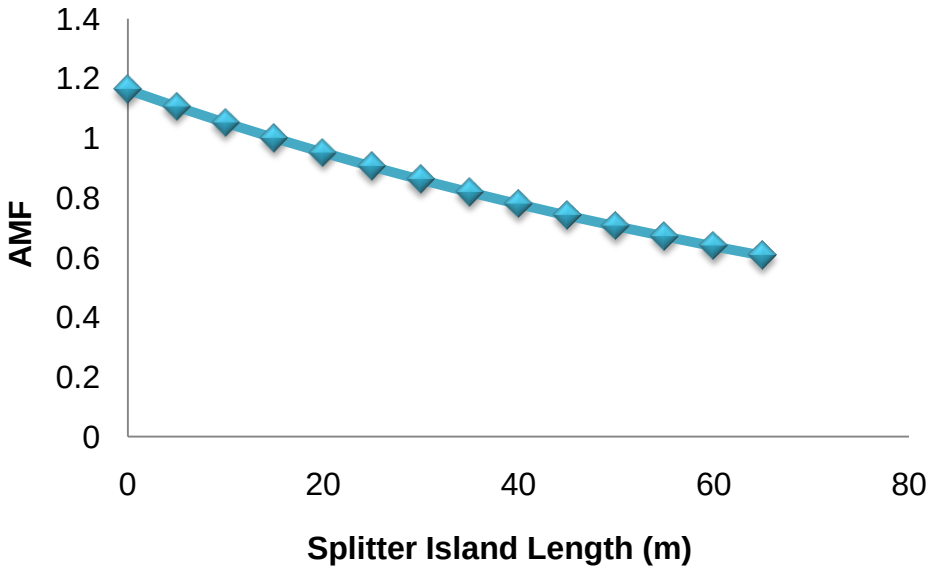
$AMF=N_w/N_{Base}$

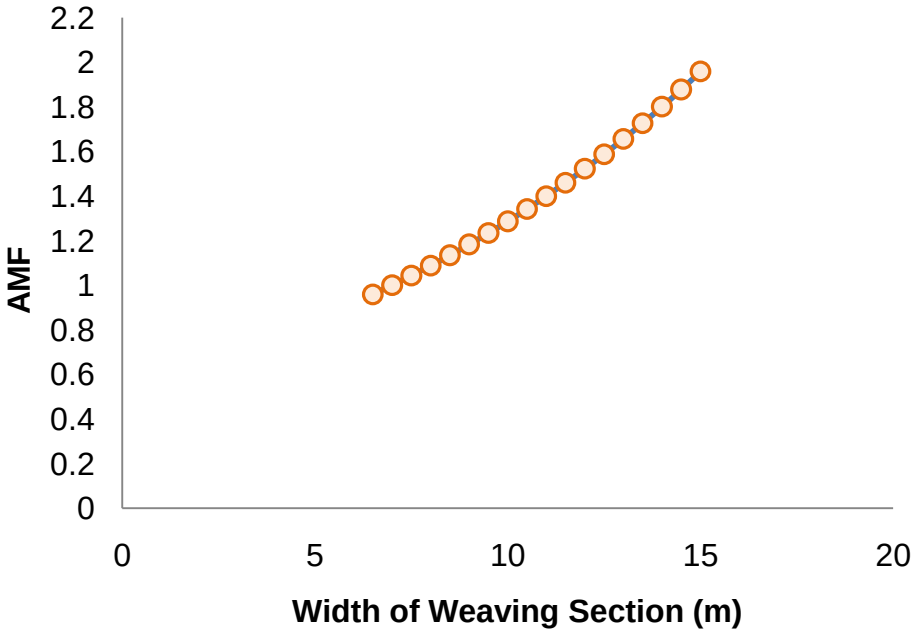
CRW	N_w	AMF
5	0.020524	1.251071
5.5	0.019406	1.182937
6	0.01835	1.118513
6.5	0.01735	1.057598
7	0.016405	1
7.5	0.015512	0.945539
8	0.014667	0.894044
8.5	0.013868	0.845354
9	0.013113	0.799315
9.5	0.012399	0.755784
10	0.011724	0.714623
10.5	0.011085	0.675704
11	0.010481	0.638905
11.5	0.009911	0.604109
12	0.009371	0.571209
12.5	0.008861	0.540101
13	0.008378	0.510686
13.5	0.007922	0.482874
14	0.00749	0.456576
14.5	0.007082	0.431711
15	0.006697	0.408199

ACCIDENT MODIFICATION FACTORS









APPLICATION OF AMF

- Safety Evaluation of Design Alternatives

Procedure for estimating the safety effects of changes in geometric design

Estimate N_{base}

$N_{before} = N_{base} \times (AMFc)$

Where,

N_{before} = Expected number of accidents before improvement.

AMFc = Combined AMF for all n changes.

$N_{after} = N_{base} \times (AMF_c)$

Where,

N_{before} = Expected number of accidents after improvement.

AMFc = Combined AMF for all n changes.

Calculate Percentage change in accidents

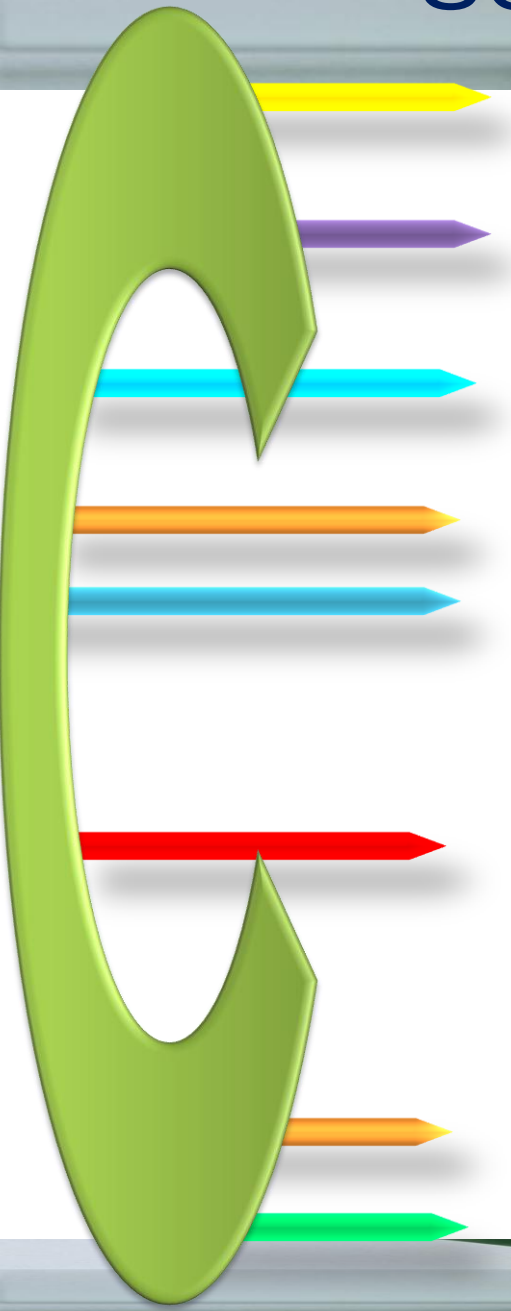
$=((N_{after} - N_{before}) / N_{before}) \times 100$

Or

$=(AMF_{after} / AMF_{before})-1)\times 100$

			Alternative								
Variable	Existing Condition	AMF_{before}	1	2	3	4	5	6	7	AMF_{after}	% change in Accidents
ADT	7006										Alternative 7=-68.79
Circulating Roadway Width (m)	11.26	0.620	15						15	0.408	-34.21
Weaving width (m)	23.88	4.127		15					15	1.958	-52.56
Weaving Length (m)	12.25	0.928			10					0.897	-3.31
Entry Path Radius (m)	301	1.743				60				1.034	-40.66
Angle to the next Leg (deg)	55	1.277					90			1	-21.72
Splitter island type	1	1									
Splitter island length (m)	8.4351	1.067						15		1	-6.354

SUMMARY AND CONCLUSIONS



The various factors which affect safety at roundabouts and the need for Accident Modification Factors were studied.

Accident data, traffic volume data, speed data and geometric details of 20 roundabouts in Kerala were collected.

Preliminary analysis was done for accident data and the general trend of accident variation was studied.

Scatter plot analysis and correlation analysis were done.

Models were developed using linear regression, generalised linear regression, Poisson regression, negative binomial regression and ZIP models. Generalised linear regression models were selected as the best fit model.

Significant variables - entry traffic volume, central island diameter, circulating roadway width, entry path radius, length of weaving section, width of weaving section, length of splitter island, type of splitter island and angle to the next leg as the explanatory variables.

AMFs were developed for explanatory variables in the model.

Application of AMF for safety evaluation was illustrated with an example.

- LIMITATIONS OF THE STUDY
  - AMFs for only a limited number of variables were generated.
  - Accident prediction models were developed for total accidents only.
- SCOPE FOR FUTURE WORK
  - Accident prediction models can be developed using some other advanced statistical techniques.
  - Accident modification factors can be generated for more number of geometric variables.
  - It would be desirable to incorporate other accident causative factors like driver behaviour, environmental factors etc into the model
  - Separate models can be developed for different accident severity and crash types.

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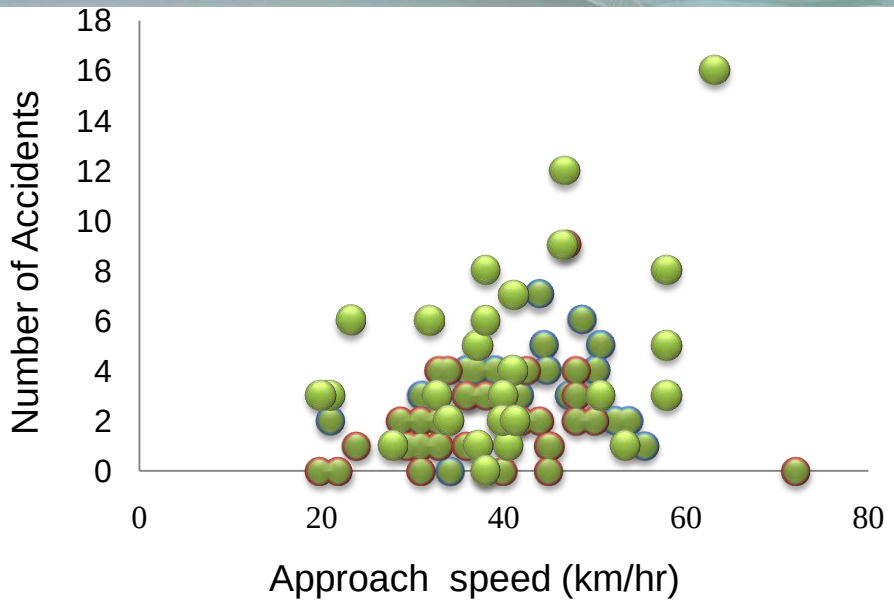
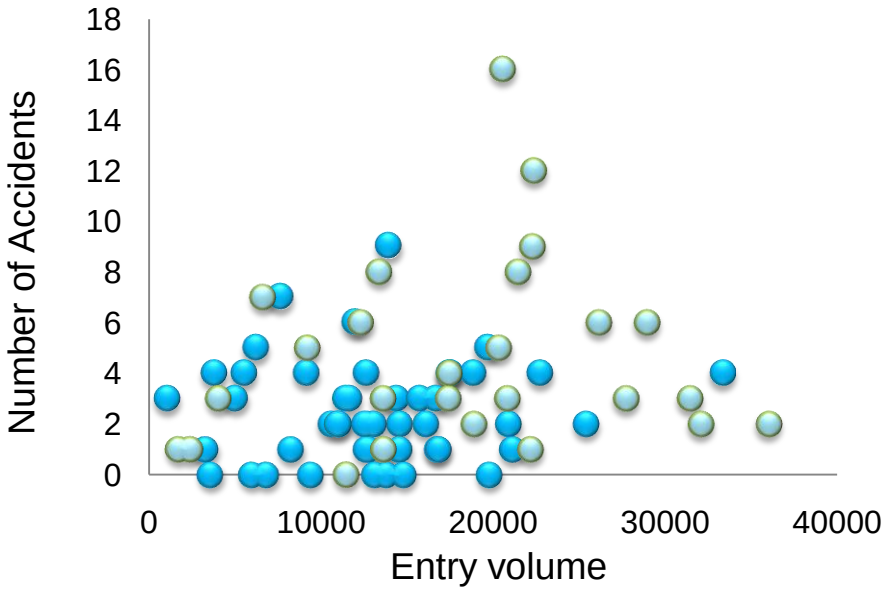
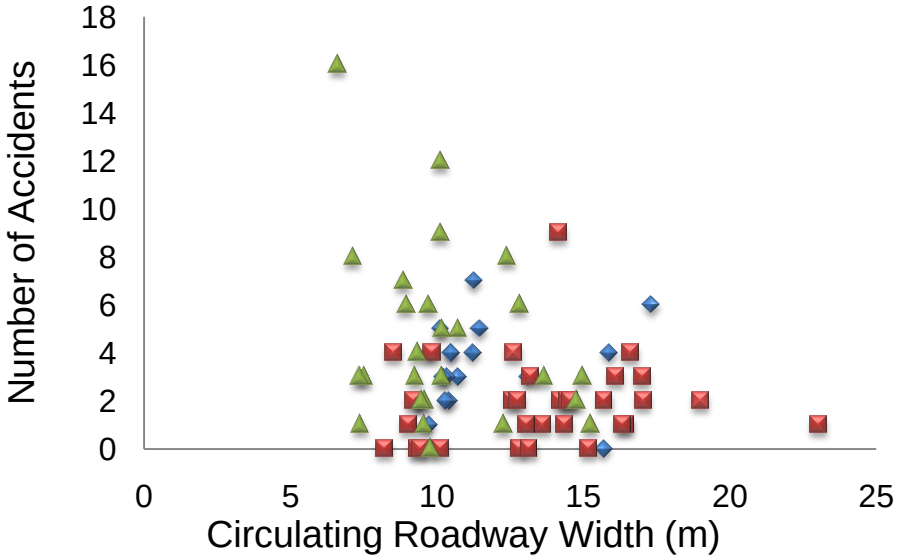
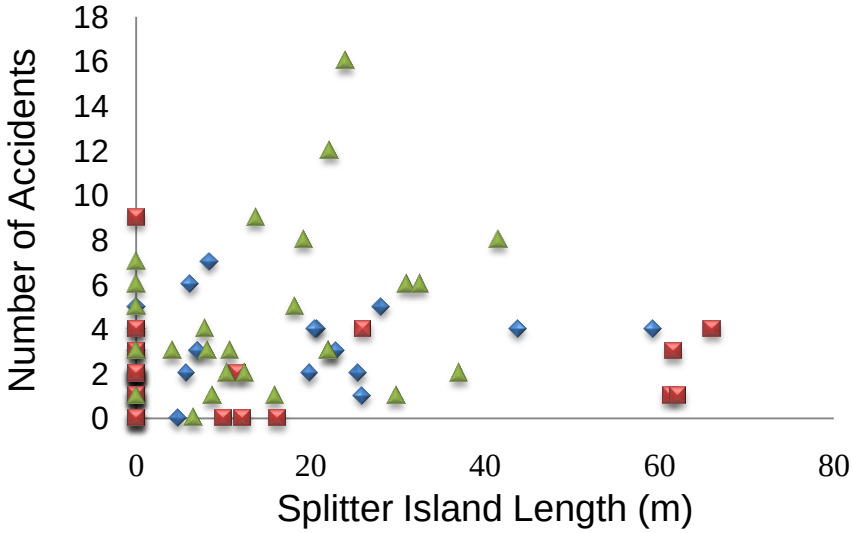
Thank
you!

Scatter plots

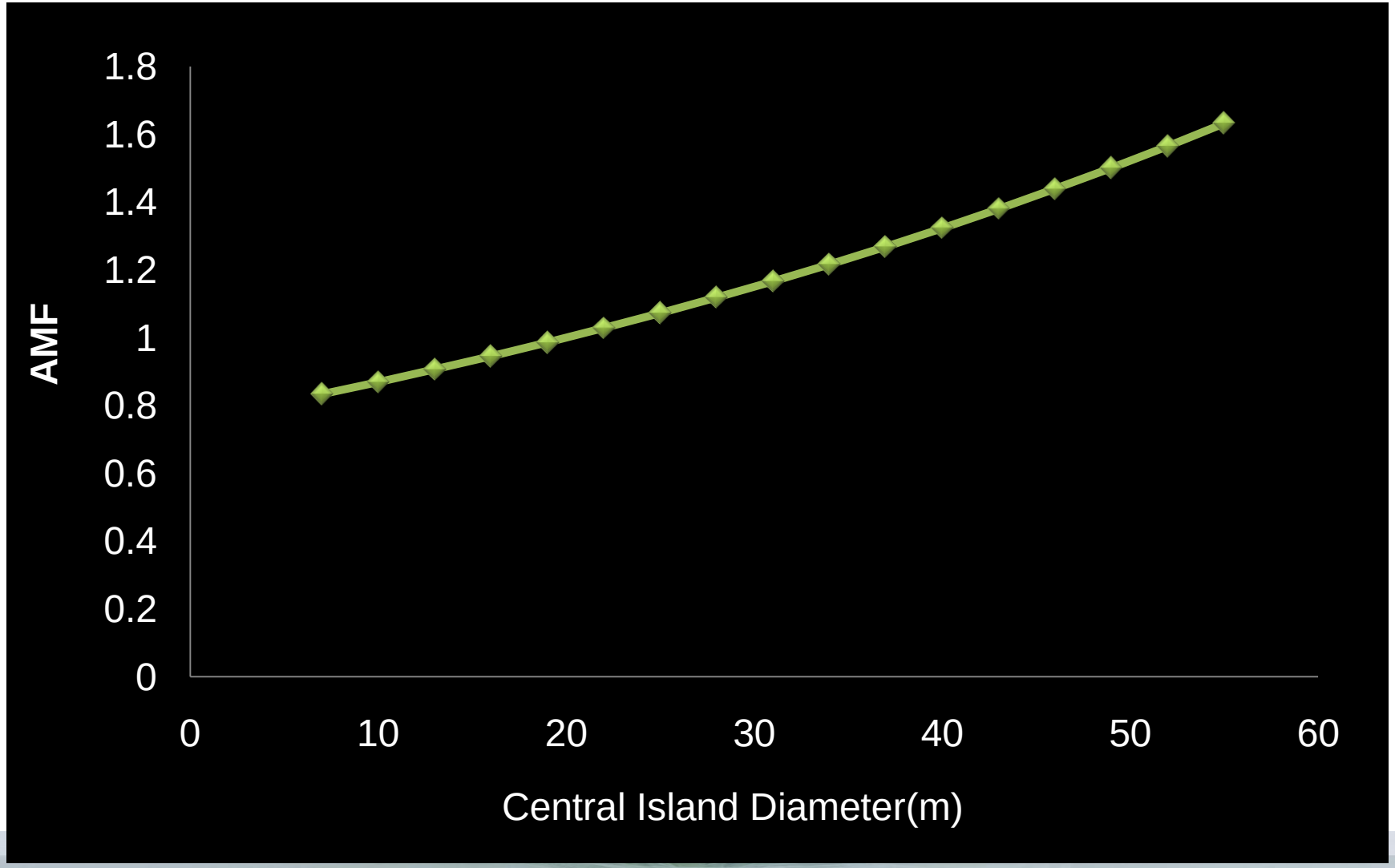




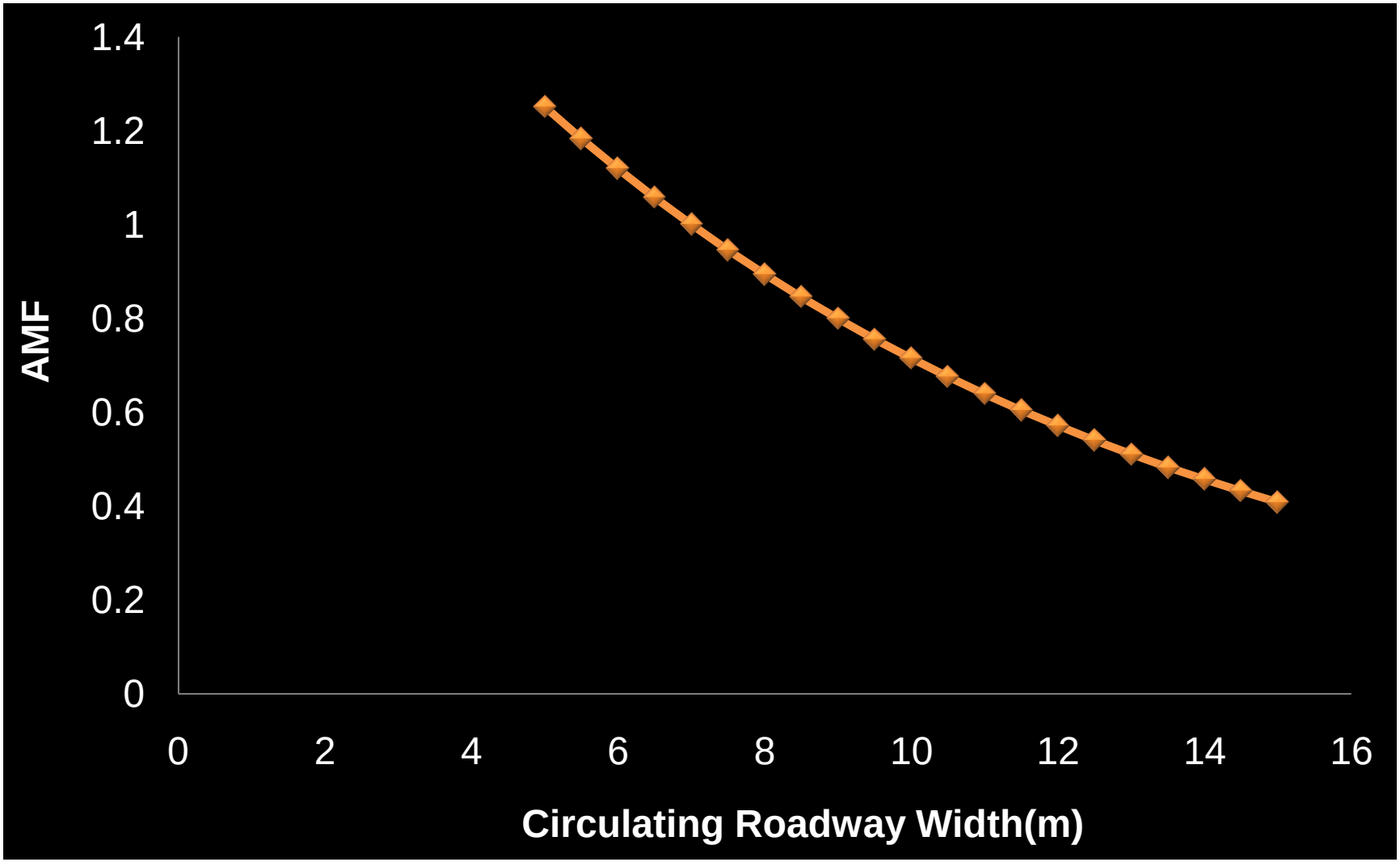




AMF for Central Island Diameter



AMF for Circulating Roadway Width



AMF for Angle to the next leg