Centre of Excellence (CoE) in Urban Transport
Department of Civil Engineering, IIT Madras

Title of the proposed project

Development of a Toolbox for Evaluation and Identification of Urban Road Safety Improvement Measures

Investigators

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Safe or unsafe?

Aim and Objectives

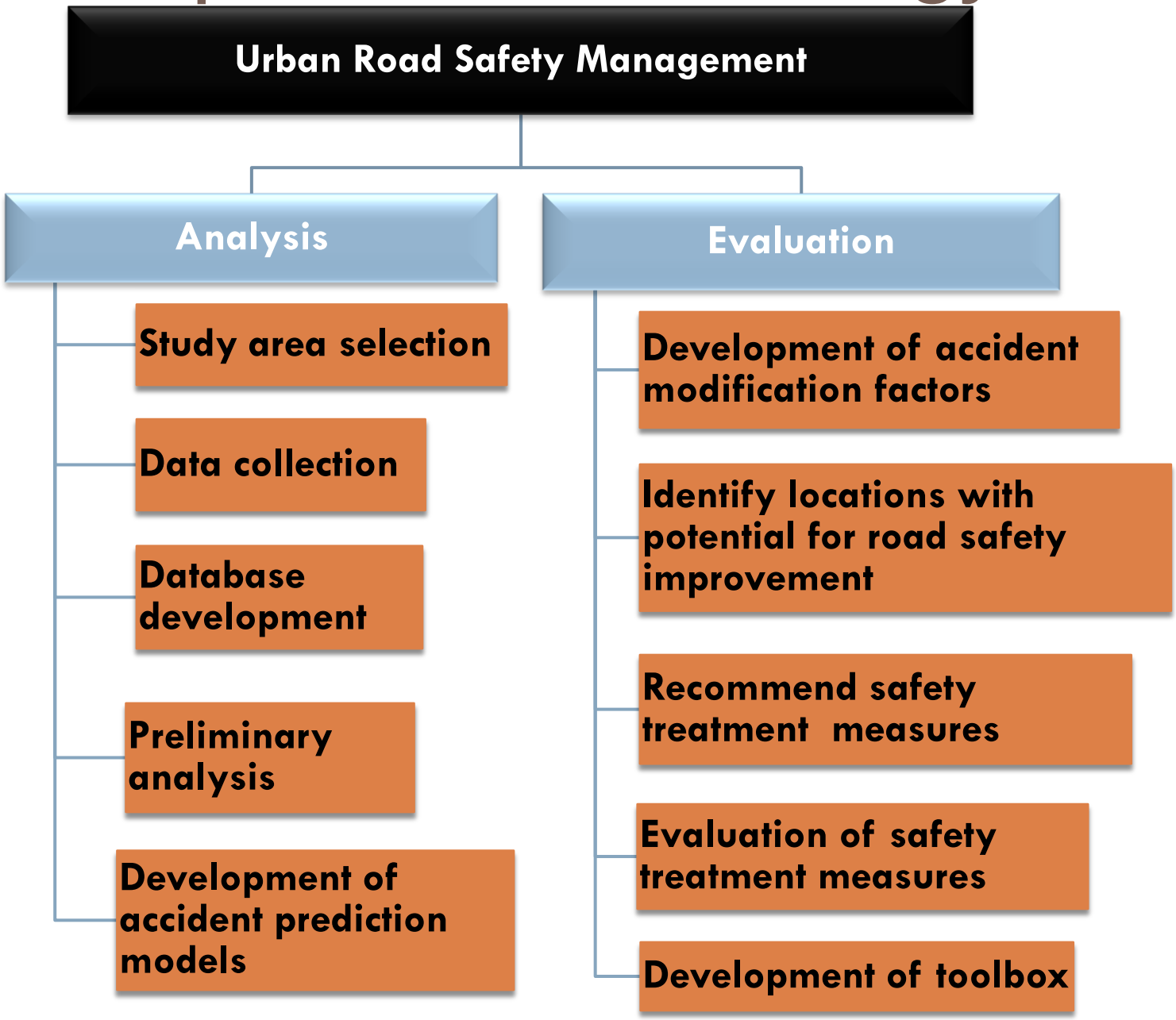
- **Aim**

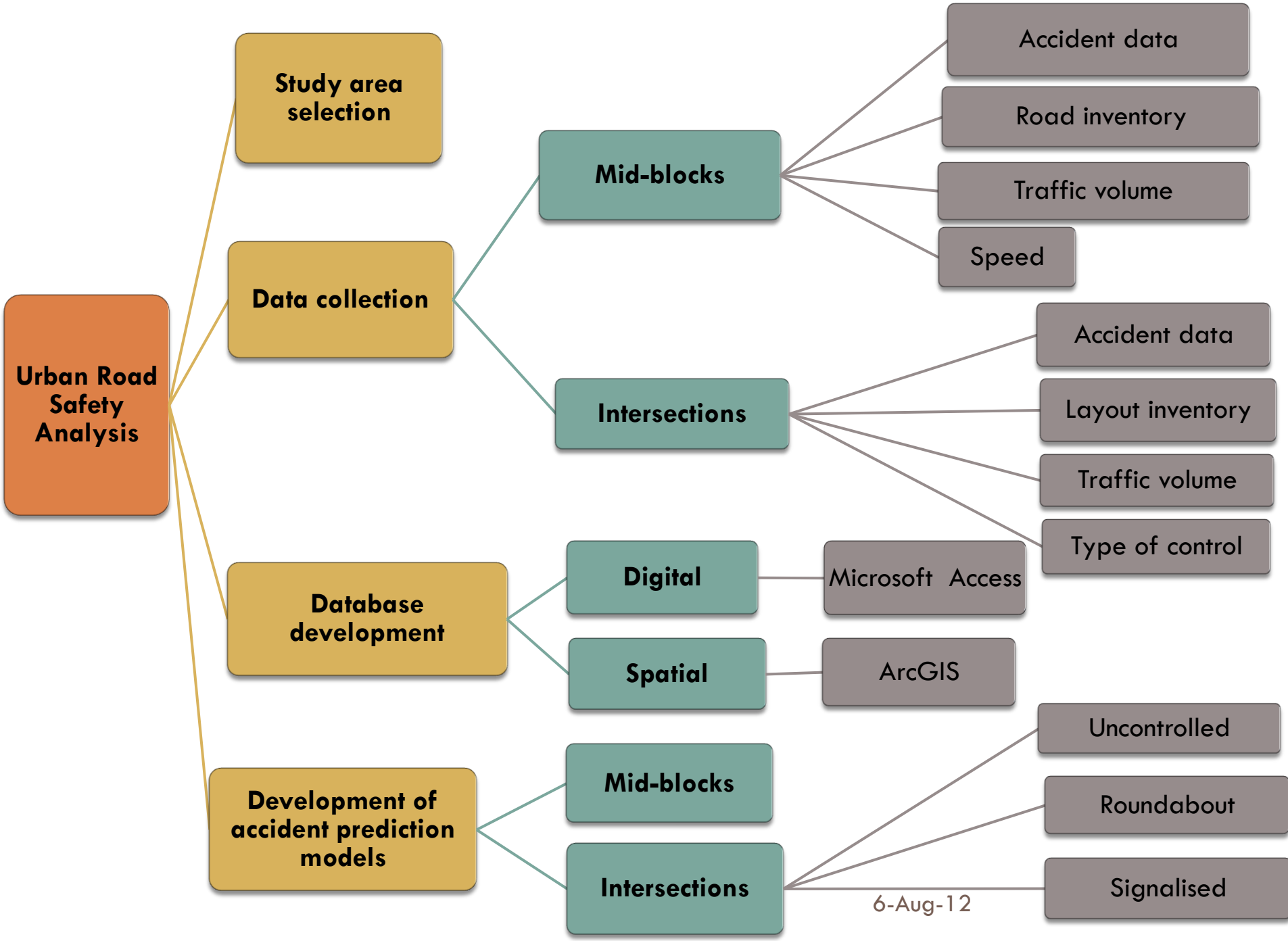
  Develop tools and techniques for analysing, evaluating and identifying road safety improvement measures in urban areas.

- **Objectives**

  - Design and develop a database of accidents, geometry and traffic for both midblocks and intersections.
  - Investigate the effect of various factors on road safety through a careful analysis and interpretation of data.
  - Develop accident prediction models to predict the accident occurrences at roadway sections and intersections.
  - Generate safety factors from the accident prediction models to act as tools for safety evaluation.
  - Consolidate the results of safety evaluation as a toolbox.

Proposed Methodology




Urban Road Safety Analysis
Study area selection
Data collection
Mid-blocks
Accident data
Road inventory
Traffic volume
Speed
Intersections
Accident data
Layout inventory
Traffic volume
Type of control
Database development
Digital
Microsoft Access
Spatial
ArcGIS
Development of accident prediction models
Mid-blocks
Intersections
Uncontrolled
Roundabout
Signalised

Accident Modification Factor(AMF)

- Accident Modification Factors
  - Estimates the change in safety following
    - the implementation of a countermeasure,
    - a significant change in geometric design and traffic characteristics of a roadway
    - up gradation of a highway section or intersection.
- AMF = N_w / N_{w0} where,
    - AMF = accident modification factor associated with a specific improvement;
    - N_w = expected number of crashes with the improvement, crashes/yr; and
    - N_{w0} = expected number of crashes without the improvement, crashes/yr.

Study area selection

Major urban centres in Kerala

- Trivandrum
- Ernakulam
- Thrissur
- Kozhikode

Core activities

Data collection and database development

- Accident data
- Road inventory data
- Intersection layout
- Signal controller settings
- Traffic data
- Traffic control measures

Data analysis and modeling

- Preliminary data analysis
- Dependant and independent variable determination
- Identification of suitable model form
- Accident prediction modeling

Development of AMF for geometric variables

- Selection of best model
- Midblocks
  - Single carriageway
  - Dual carriageway
- Intersections
  - Uncontrolled
  - Signal controlled
  - Roundabout
- Development of AMF

Works completed

- Literature review and preparation of synthesis report
- Preparation of data sheets for
  - Road inventory data
    - Single and dual carriageway
    - Uncontrolled intersections
    - Roundabouts
    - Signalised intersections
  - Classified volume count
  - Spot speed measurement
- Preparations of templates for data analysis

Data collection

Type of facility	Number of sites	Data collected
Midblocks	135	Accident data, Road inventory, speed, classified volume count
Uncontrolled intersections	60	Approach wise accident data, Intersection layout, approach speed, classified directional volume count
Roundabouts	20	Approach wise accident data, approach and circulating speed, classified directional volume count, intersection layout
Signalised intersections	24	Signal controller settings, approach wise accident data, classified directional volume count

Data analysis and modeling

- Preliminary data analysis
  - Scatter plots
  - Correlation matrices
- Identified explanatory variables
- Identified accident prediction model forms
  - Multiple linear regression
  - Generalised regression
  - Poisson regression
  - Negative binomial regression
  - Zero inflated poisson regression
- Development of prediction models for
  - Single carriageway
  - Dual carriageway
  - Roundabouts
  - Signalised intersections

Accident prediction models- midblocks

- Negative binomial regression model for total accidents -single carriageway roads
  - TA= EXP(1.261+ 0.048*Carriageway Width – 0.005*Shoulder Width – 0.078*Number of Sign Boards + 0.084*Minor Intersections + 0.0379*Exposure)
- Linear regression model for accident rate- dual carriageway
  - AR = 0.676 – 0.052*Carriageway Width+ 0.004*Shoulder Width - 0.082*Median Width – 2.123*Median Height + 0.036 Number of bus stops+ 0.066Minor intersections/km – 0.011Number of Signs/km + 0.343Carriageway condition Rating + 0.213Shoulder Condition rating – 0.461Pedestrian Facilities

Model summary

Negative binomial regression model - Single carriageway

Over dispersion	Chi-square	Significance level
2.864	76.94	0.000

Linear regression model - Dual carriageway

R	R Square	Adjusted R Square	F value
0.752	0.749	0.602	5.079

Accident prediction models - intersections

- Generalised linear regression model for roundabouts
  - Accidents per year = EXP(-4.491) × (Entering ADT)$^{0.416}$ x EXP(0.014× Central Island Diameter - 0.112×Circulatory Roadway Width + 0.084×Weaving Width + 0.027×Weaving Length + 0.002×Entry Path Radius - 0.007×Angle to the Next Leg + 0.197×Splitter Island Type - 0.01×Splitter Island Length
- Linear regression model for signalised intersections
  - Accidents per year= -11.796 + 4.166- 0.803Proportion of right turning traffic +0.055Total approach width – 0.640 Exclusive left turn lane +0.069V/C – 0.447g/C +0.015 Control Delay + 1.118 Approach grade

Model summary

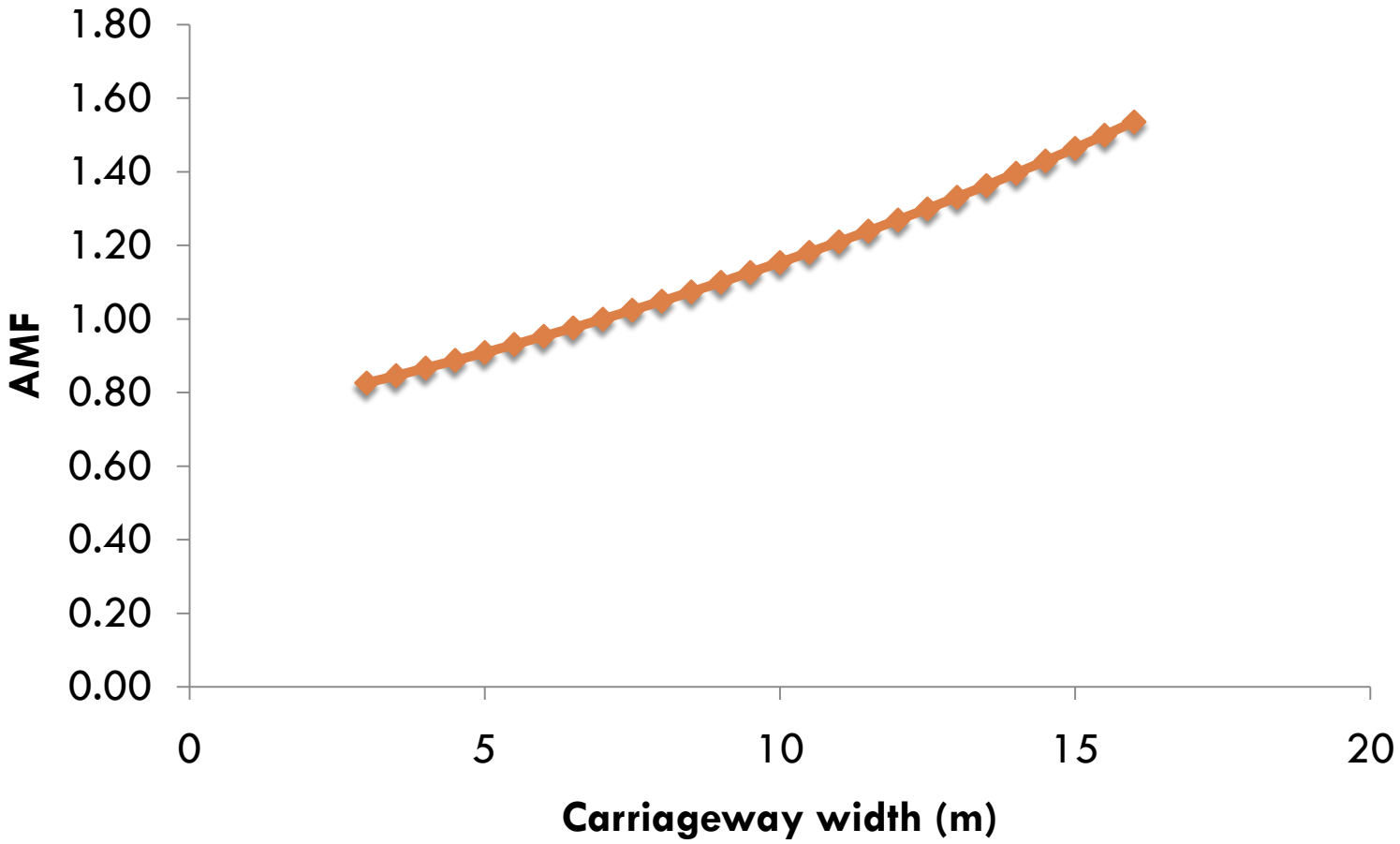
Generalised linear regression model - Roundabouts

R Square	Adjusted R Square	F value
0.486	0.367	4.092

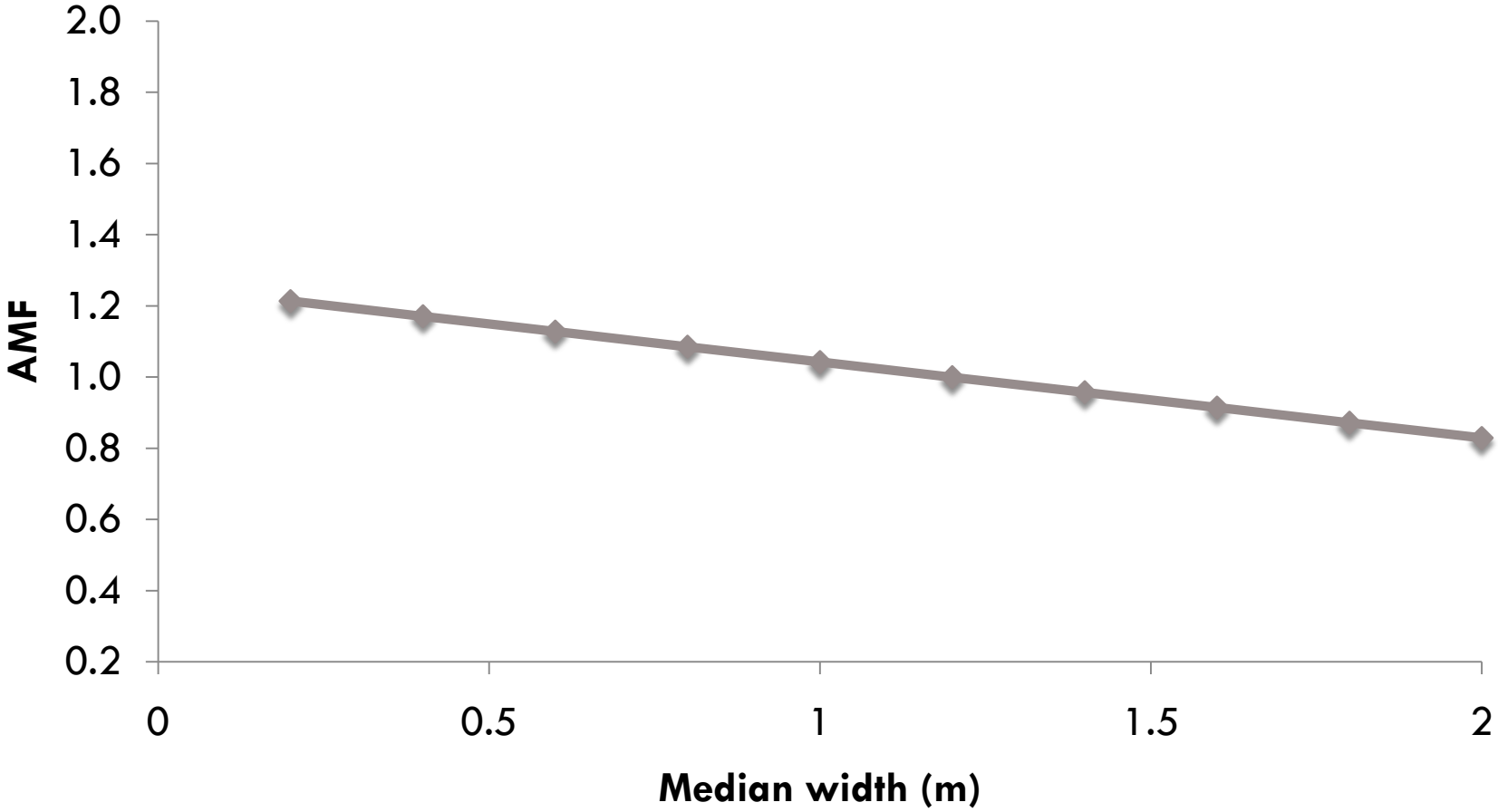
Linear regression model – Signalised intersections

R Square	Adjusted R Square	Std error	F
0.554	0.464	1.268	6.204

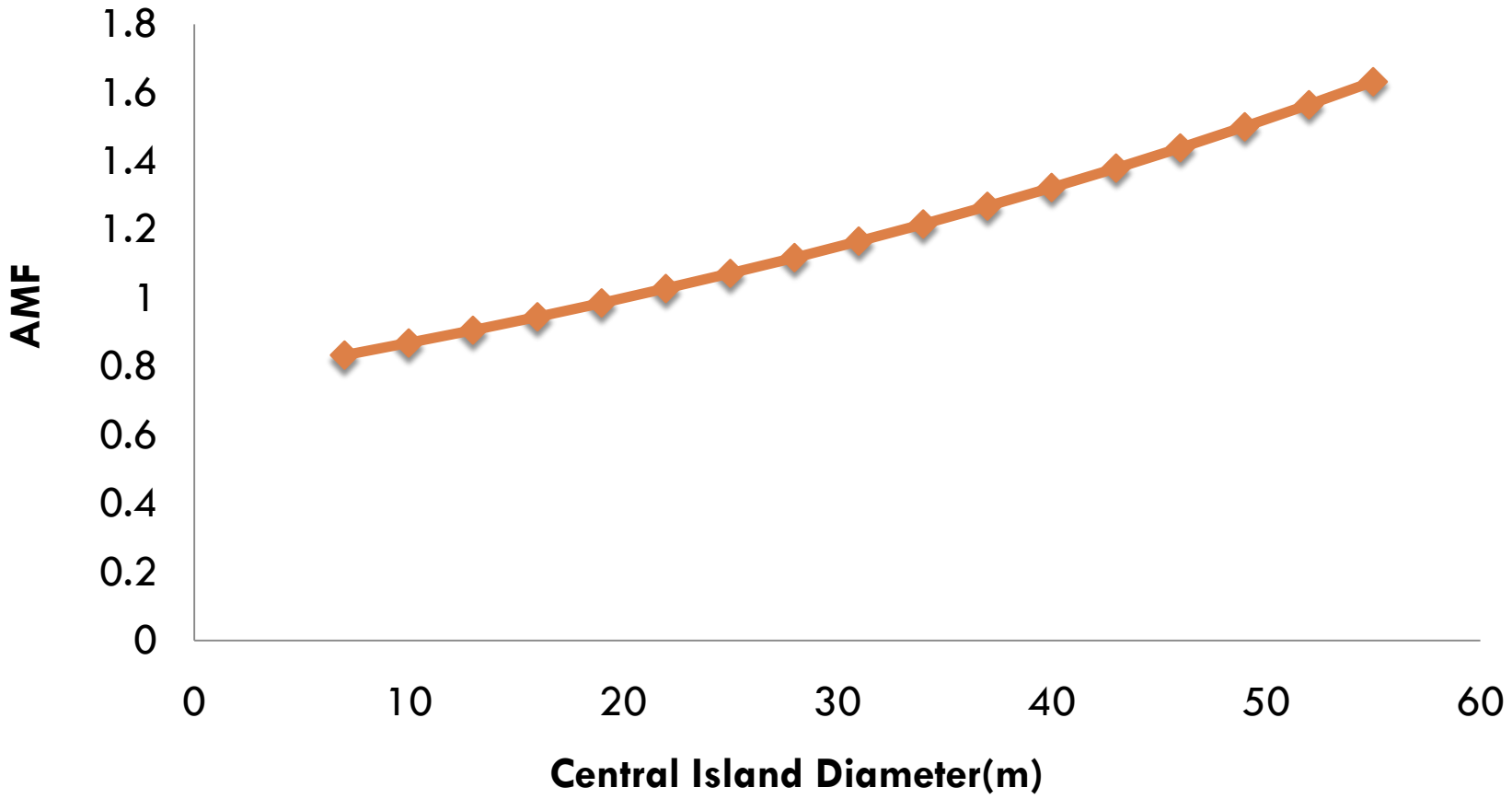
AMF for carriageway width



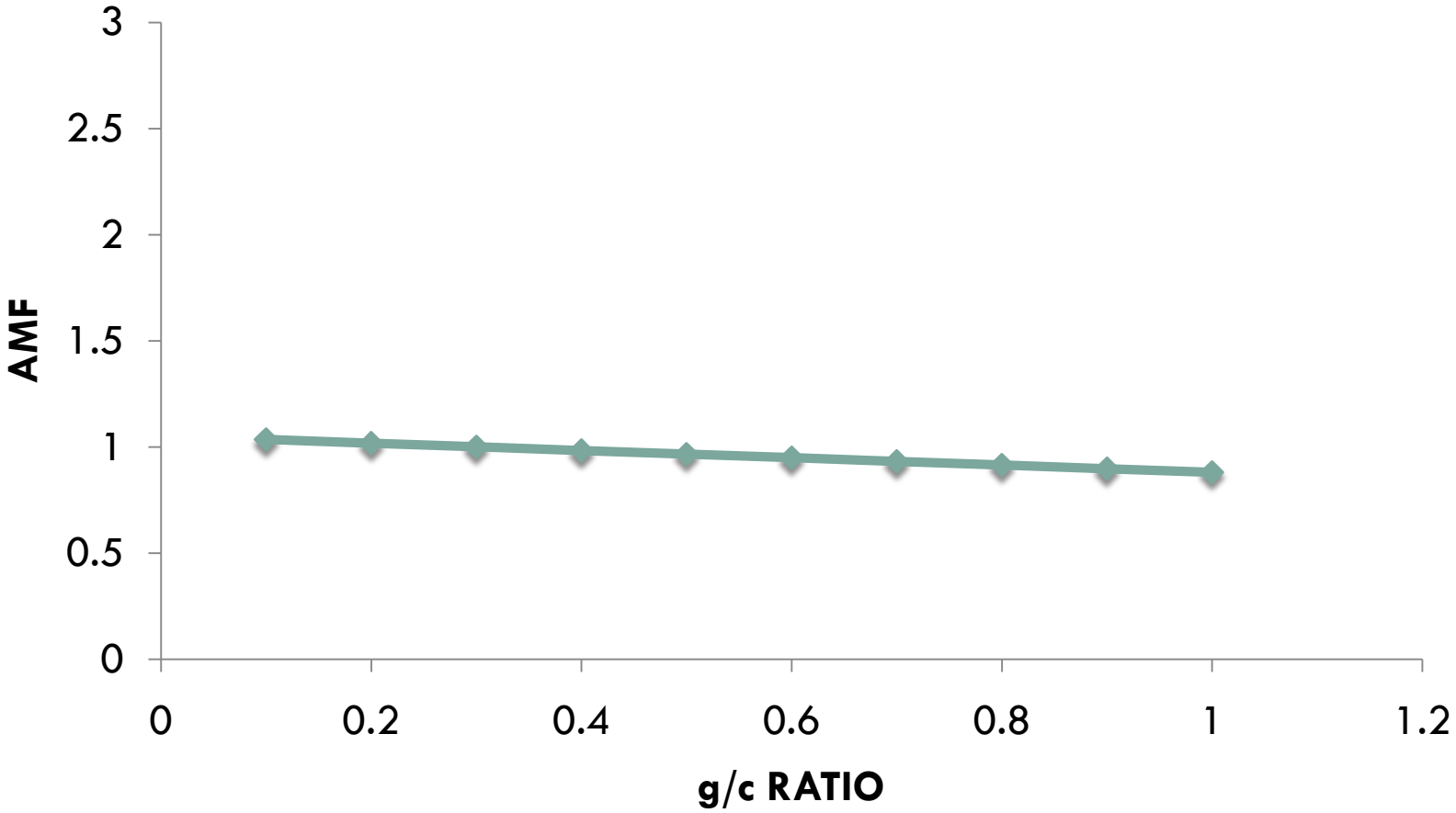
AMF for median width



AMF for central island diameter of roundabouts



AMF for g/c ratio of signalised intersections



Practical application- midblocks

- Safety evaluation of design alternatives

Variables	Existing condition	Existing AMF	Proposed change	Proposed AMF
Number of signs	1	0.925		
Minor Intersections	5	1.5239	4	1.257
Carriageway width	15	1.4643	14	1.396
Shoulder width	3.16	0.9967	4	0.990
Base accidents	2 accidents			Percentage change in accidents
Existing accidents	4.24 accidents			
Accidents after implementing safety treatment	3.1 accidents			(-)28.02%

Practical application - roundabouts

Variables	Existing Condition	AMF_{before}	Proposed change	AMF_{after}	% change in Accidents
Central island diameter	12.4 meters	1.063	10 meters	1.028	-3.29
Weaving width	23.88 meters	1.11	14 meters	1.05	-74.68
Weaving length	12.25meters	1.43	30 meters	1	42.85
Entry path radius	301 meters	2.35	30 meters	1.04	-41.81
Angle to next leg	55^0	1.18	90^0	1	-21.25

Conclusions

- Robust models developed to evaluate safety performance of facilities
- Safety factors (AMF) are generated from safety prediction models
- Effective tool for evaluation of alternate safety treatment measures
- AMF's used for safety evaluation of design alternatives

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THANK YOU