

ARE SIGNALIZED INTERSECTIONS WITH CROSSWALKS SAFER IN INDIA? A STUDY BASED ON SAFETY ANALYSIS USING VIDEO DATA

By

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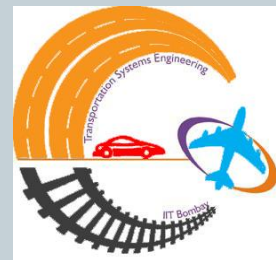
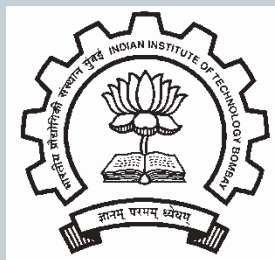
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Outline

1. Introduction
2. Methodology
3. Data Collection & Extraction
4. PET Values for Pedestrian at Signalized Intersections
5. Cumulative Logistic Regression Model
6. Application and Conclusions

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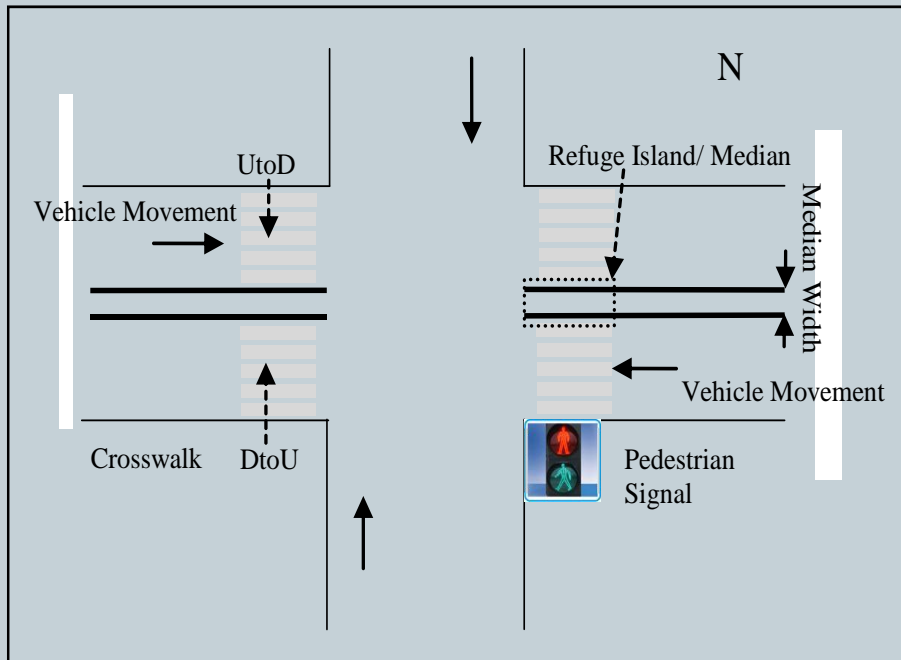
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Background

Pedestrian facilities at signalized intersections



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Motivation

❖ 16 people die on every hour in Indian roads and **65% of** accidents happened near **intersections** and **58% of pedestrians** deaths (during 2008-2012) were reported in *Mumbai* (NCRB 2015).

How to reduce pedestrian fatalities? How to encourage walking?

To provide safer pedestrian facilities

To measure operational conditions of crosswalk

How to provide safer pedestrian crosswalk at signalized intersections?

How to estimate operational conditions of existing facilities?

To develop empirical models with field data by considering pedestrian and traffic characteristics

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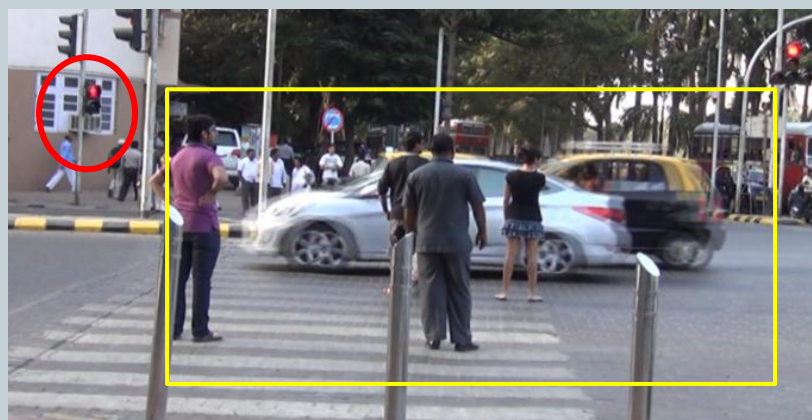
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Problem Statement

User's behaviour in crosswalks at signalized intersections in India



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Problem Statement

- Modelling pedestrian-vehicular interaction is a complex task due to the effect of various influencing factors.
- Post-encroachment time (PET) values for pedestrian is missing with respect to each vehicle type in India.
- It is difficult to evaluate existing conditions of pedestrian at crosswalk with respect to safety.

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Objectives

- 1) To *define the PET values* for pedestrian severities in crosswalk based on collected video data
- 2) To develop the cumulative logistic regression model *to estimate pedestrian severity categories* at crosswalk
- 3) To *evaluate the safety level of existing crosswalk* at selected signalized intersections based on proposed PET values and developed model.

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Research Frame Work

Are signalized intersections with crosswalks safer in India? A study based on safety analysis using video data

Identification of Study Locations

Data Collection and Extraction

PET Values for Pedestrian at Signalized Intersections in India (CDF and Raff's Method)

Develop cumulative logistic regression model for pedestrian PET category

To evaluate the safety level at selected new crosswalk

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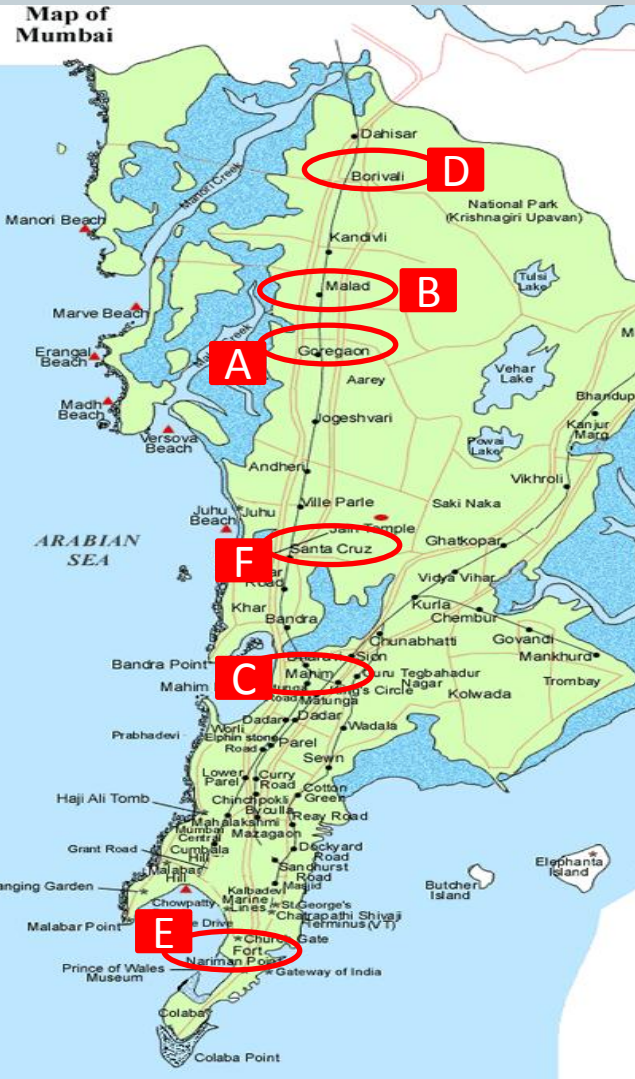
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Site Selection

MUMBAI



Location Name	Identity
Link Road Junction	A
Malad Junction	B
Mahim Junction	C
Mahatmagandhi Road Junction	D
Holkar Junction	E
Santacruz Junction	F

- ✓ Pedestrian flow low, medium and high
- ✓ Bi-directional pedestrian flow
- ✓ Two way traffic
- ✓ Fixed cycle time
- ✓ Typical four arm



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Data Collection

Video graphic survey

The diagram illustrates the video graphic survey setup at a pedestrian crossing. It shows two cameras, Camera-1 and Camera-2, positioned on opposite sides of the crossing. Camera-1 is labeled 'D2U' and Camera-2 is labeled 'U2D'. The diagram illustrates the camera fields of view and the resulting video frames. To the right, images show the equipment used: two Sony camcorders, a SanDisk Extreme Pro 64GB SDXC UHS-I memory card, two Sony batteries, and two tripods. At the bottom, images show a bicycle wheel, a bicycle, and a digital stopwatch.

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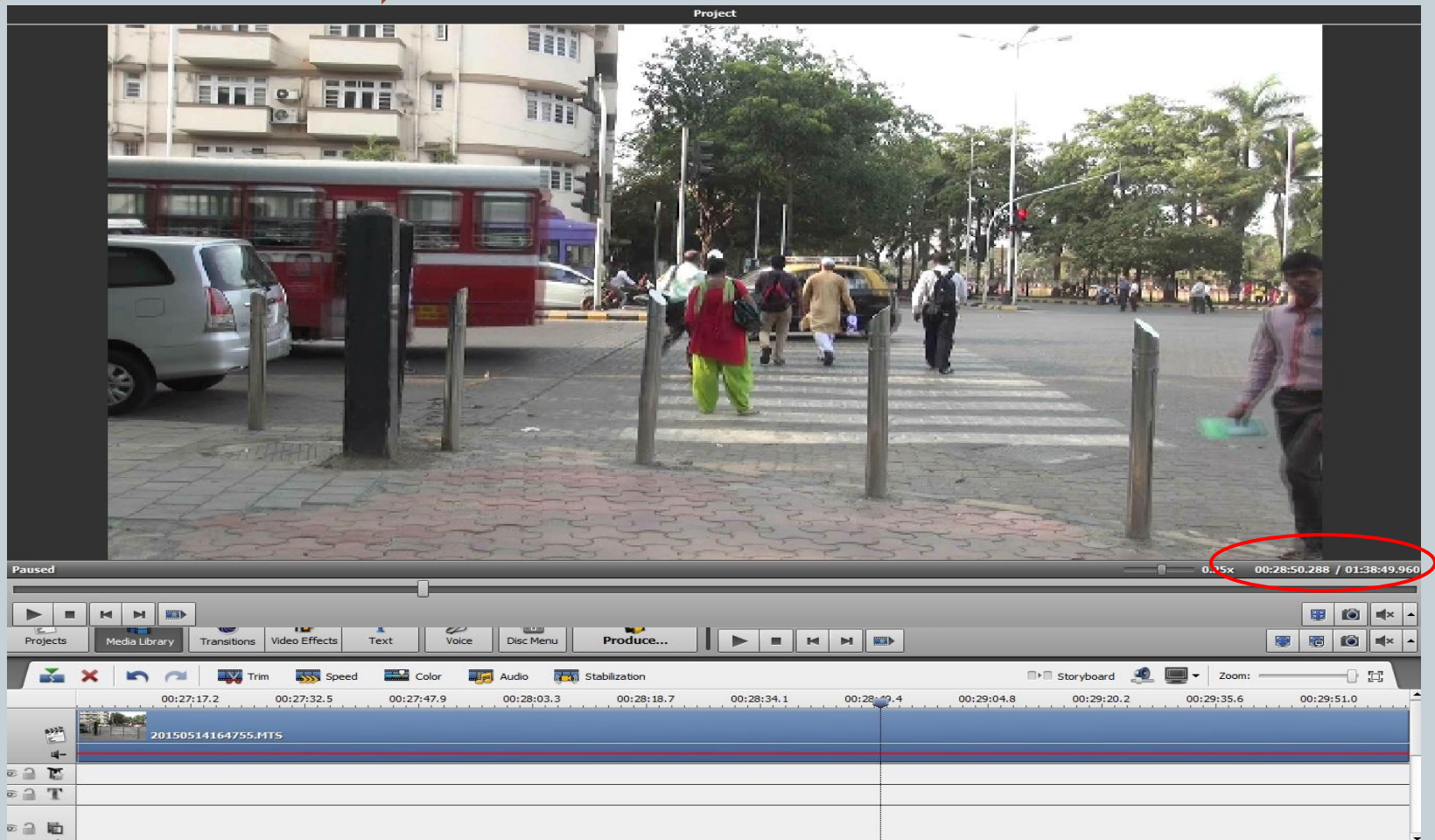
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Data Extraction

AVS Video Editor Software



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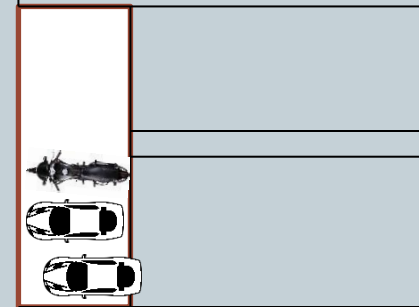
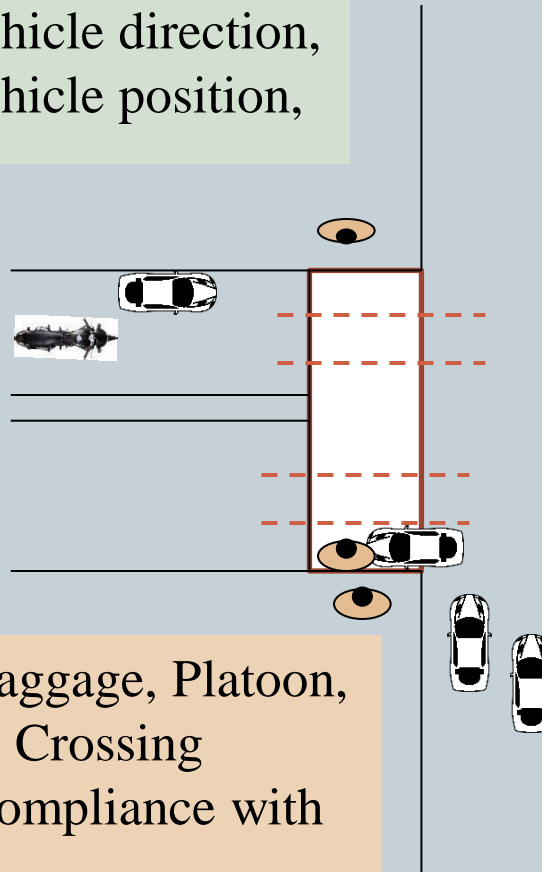
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Extracted Data

Approaching vehicle type,
Approaching vehicle direction,
Approaching vehicle position,

Crosswalk length,
width, Crosswalk
marking, Signage,
Median width,
connection between
sidewalk and
crosswalk, Signal time

Gender, Age, Baggage, Platoon,
Crossing speed, Crossing
direction, Noncompliance with
signal



A total of
1158 pedestrian
samples

PET Values

- Surrogate measure of safety (Proactive method): Traffic Conflicts Techniques (TCT) and Post-encroachment time (PET).
- PET: The time gap between two road users arriving and leaving the crossing area.
- Smaller PET – High probabilities of Interaction and Larger PET – Less probabilities of Interaction
- 115 pedestrian-vehicle interactions were identified.
- Three categories: Highly dangerous, Dangerous or Conflict and Safe or No conflict.

PET Values for Pedestrian

- Cumulative frequency distribution (CDF) plot used to calculate the threshold value for each interaction severity.
- Defined with respect to 15th and 50th percentile PET values from cdf plot.
- Threshold value was validated with Raff's method.
- PET Values are 5.5s (cdf method) and 5.6s (Raff's method)
- PET values for pedestrians calculated for each vehicle type (TW, Car, Auto, HCV and LCV) using both methods.

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PET Values for Pedestrian

Pedestrian PET values based on vehicle types

Vehicle Type	PET Category (Sec)		
	1 (Highly Dangerous)	2 (Dangerous or Conflict)	3 (Safe or No Conflict)
All data	≤ 2.00	> 2.00 and ≤ 5.5	> 5.5
Car	≤ 2.50	> 2.50 and ≤ 10.80	> 10.80
TW	≤ 3.06	> 3.06 and ≤ 11.00	> 11.00
LCV	≤ 3.83	> 3.83 and ≤ 6.50	> 6.50
HCV	≤ 2.37	> 2.37 and ≤ 5.25	> 5.25
Auto	≤ 2.25	> 2.25 and ≤ 7.50	> 7.50

Model for Pedestrian PET Category

- Pearson's correlation test was performed at 95% CI in SPSS 16.0 software.
- Significant factors: Approaching vehicle direction, Approaching vehicle position, Approaching vehicle type, Pedestrian age and Speed type
- Cumulative logistic regression (CLR) model developed to estimate the PET category.

Parameters	Types	Estimates	Std. Error	Wald
Threshold	1 (PET≤2.5)	-0.213	0.494	3.185
	2 (2.5<PET≤5.6)	1.312	0.498	6.941
Variables	Approaching Vehicle Direction (X_1)	0.482	0.119	16.323
	Approaching Vehicle Position (X_2)	-0.536	0.115	21.687
	Approaching Vehicle Type (X_3)	0.055	0.071	6.593
	Pedestrian Age (X_4)	0.395	0.243	2.634
	Pedestrian Speed Category (X_5)	0.682	0.682	25.429

Model validation: MAPE, RMSE, R and R-Square:
7.64%, 1.998, 0.7087 and 0.5022

Findings

- PET value of adult pedestrians is less than other age group (child and elder) pedestrians.
- Pedestrian crossing speed has significant influence in PET assuming that crossing speed is same or higher throughout the crosswalk.
- Reduction or increases in speed would result in interaction.
- PET values for turning vehicles are higher than through movement vehicles.
- Lane of approaching vehicle closer to the pedestrian (first strips) then the possibilities of interaction between pedestrian and vehicle are less.

Application

➤ **Problem:**

- Are signalized intersections with crosswalk safer in Chembur Nakka Junction?

➤ **Extracted Data:**

- Field PET Value is 2.67 and Category is 2.
- Approaching vehicle direction, Approaching vehicle position, Approaching vehicle type, Pedestrian age and Speed type extracted from video.

➤ **Analysis:**

- The Calculated Mean PET Values is 2.38 and Category is 2.

➤ **Result: NOT SAFE**

Conclusions

- The video data were collected at selected six signalized intersections in Mumbai, India.
- PET values for pedestrian were defined and CLR model was developed to estimate the PET category.
- The proposed model and results are appropriate for Indian traffic conditions.
- Study useful to rank the severity level of pedestrian in crosswalk and improve the facilities.
- Useful to revise PET values in simulation software's.
- Increase the data set and compare the results with different cities data in future work.

THANK YOU

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