Road Infrastructure Affecting Fatal Crashes : A Case-Control Study

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TRIP CENTRE

Introduction

- Transportation accounts for approximately **6-12%** of gross domestic product in developed countries and **6-8%** in developing countries (World Bank,2022).
- The budget allocation for Roads and Highways has increased from Rs 64,900 crore in 2017 to Rs 1.99 Lakh crore in 2022.
    - India is set to cross **1.8 lakh kilometers** of highway length by **2025**.
- However, there are **negative health impacts** associated with road transport :
    - Crashes
    - Air pollution
    - Noise pollution

Scale of the Problem

- Approximately **1.35 million** people lost their life to RTCs in a year (WHO,2022).
- **More than half** of these deaths are among **Vulnerable road users** (VRUs): pedestrians, cyclists and motorcyclists.
- Crash fatality rates in LMICs are **three times higher** than high-income countries.
- With only **1%** of the world's vehicles, **India** accounts for **11%** of the global deaths in RTCs, the highest in the world (World Bank,2021).

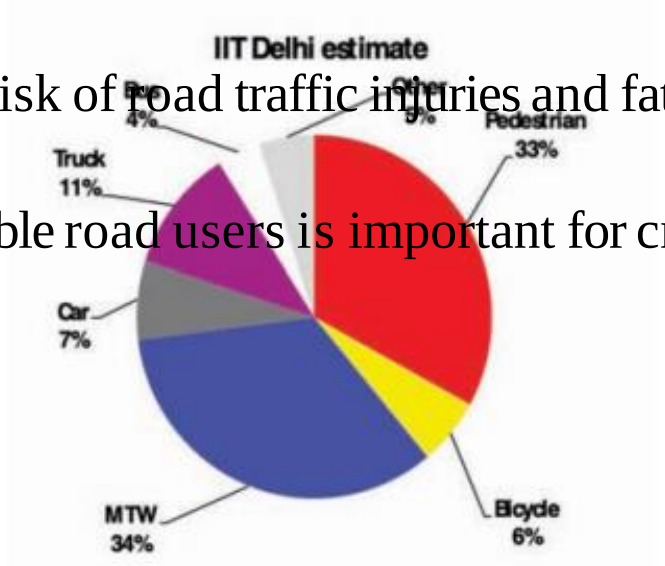
Who are vulnerable road users?

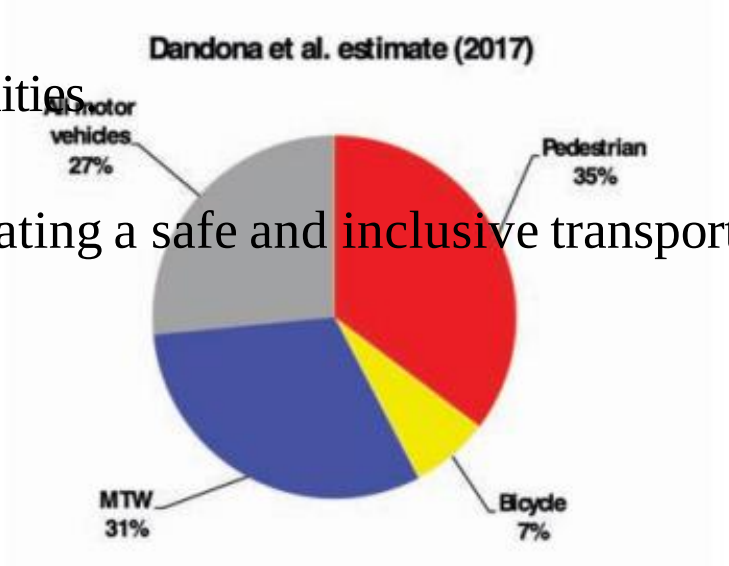
- VRUs are characterized by their comparatively low mass and lack of substantial external protective measures against collision forces.

- Vulnerable road users include pedestrians, cyclists, motorcyclists, and children.

- They are at a higher risk of road traffic injuries and fatalities.

- The safety of vulnerable road users is important for creating a safe and inclusive transportation system.





Research Gap and Objective

Goal: The study aims to fill this gap by conducting a comprehensive five-year study in Vadodara, India, to understand and identify the specific risk factors associated with VRU fatal crashes

Objectives

1. Analyze the percentage of Vulnerable Road Users (VRUs) in fatal road traffic crashes in Vadodara, India, over a five-year period (2017-2021)
2. Investigate the influence of various road infrastructure elements, such as street lighting, road design, and pedestrian facilities, on fatal crashes involving VRUs
3. Determine and define the specific risk factors associated with fatal crashes of VRUs in Vadodara, contributing to a deeper understanding of road safety challenges in this LMIC setting

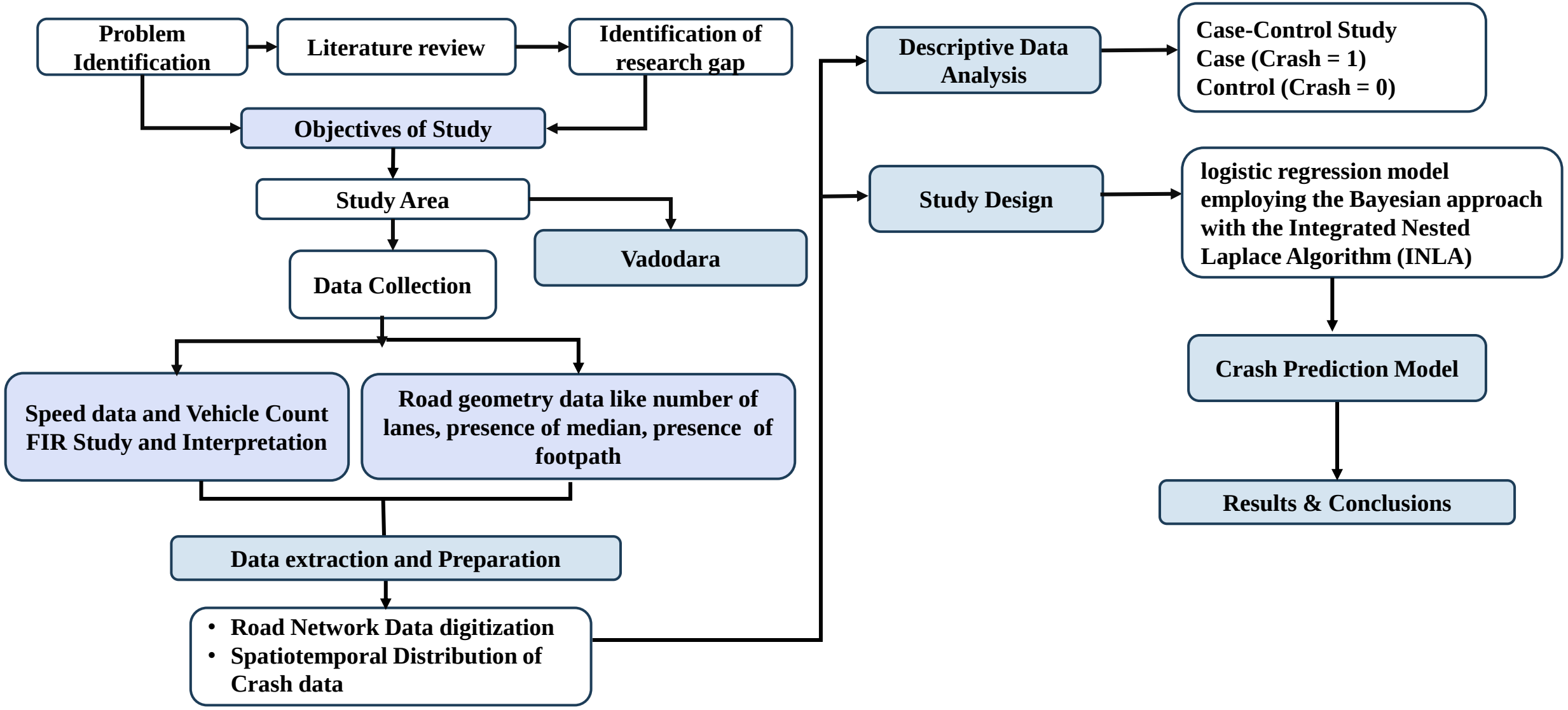
Literature Review

Author	Methodology	Result	Conclusion
Naci et al., 2009	Analyzed global motor vehicle crash fatality rates, with a focus on Vulnerable Road Users (VRUs), comparing Low- and Middle-Income Countries (LMICs) and High-Income Countries (HICs).	Found that VRU fatality proportions range from 55% to 80% in LMICs and 15% in HICs.	Economic development impacts motor vehicle crash rates, primarily due to changes in VRU crash rates.
Mohan	Conducted a comprehensive analysis of traffic-related injuries and fatalities in India, with a particular focus on cities like Delhi and Mumbai.	Discovered that nearly 80% of those losing their lives in these cities are VRUs.	Emphasized the significance of VRUs in India's road safety challenges and the need for tailored research.
Haddon et al., 1961	Employed the case-control approach, comparing pedestrians who suffered fatalities in traffic-related incidents (cases) with randomly selected pedestrians (controls) at similar geographic, temporal, and weekly intervals.	Focused on individual-level risk factors, including variables such as alcohol consumption, age, gender, and residential location.	The study aimed to discern risk factors at the individual level.
Solanki & Prajapati (2023); Suthar & Prajapati (2023)	Studies exploring crash scenarios and the involvement of different road users.	Provided specific insights into crash dynamics involving various road users, aiding in identifying vulnerable groups.	Highlighted the need for exploring exposure and built environment factors, essential for a comprehensive understanding of road safety risks.

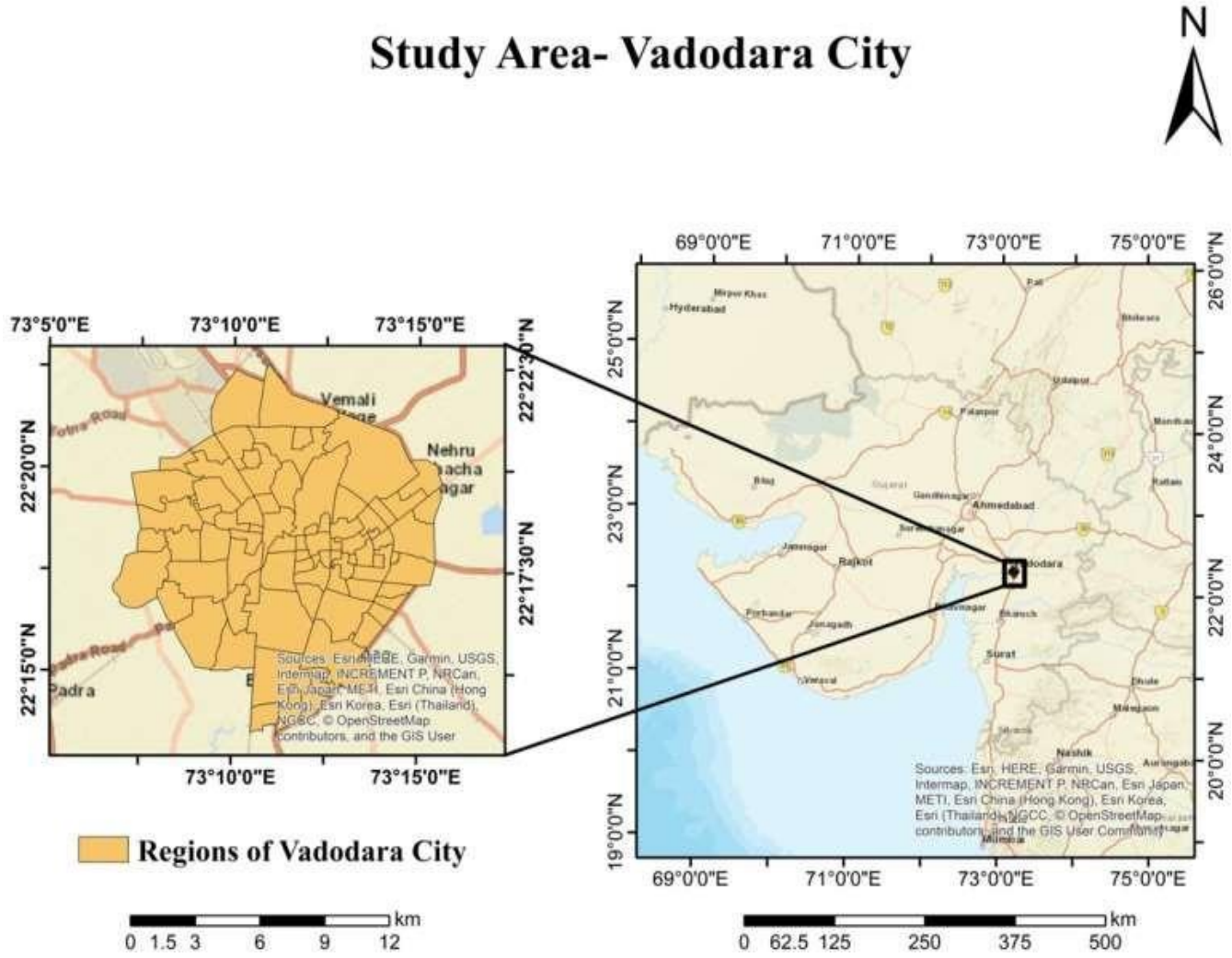
Research Gap

- Limited studies have focused to analyze the association of VRU crashes with road infrastructure.
- There is a lack of research focusing on road safety for Vulnerable Road Users (VRUs) in Low- and Middle-Income Countries (LMICs).
- Due to data constraint in LMICs various road infrastructure parameters have not been analyzed.

Research Methodology



Study Area

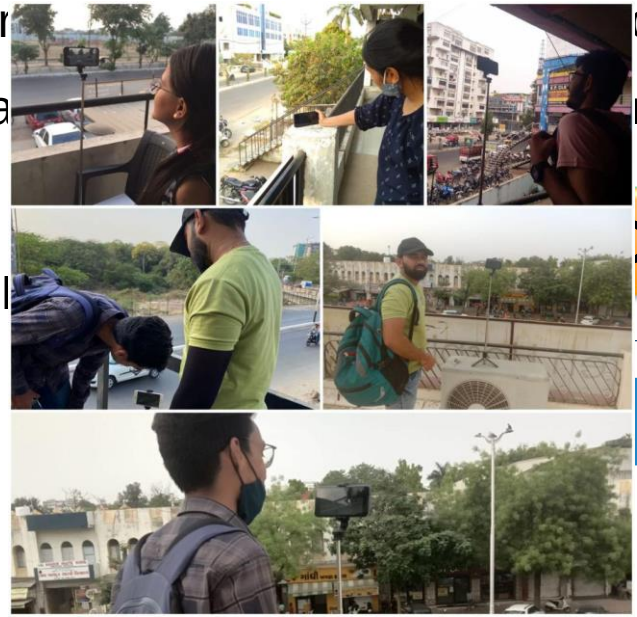


- **Location**: Vadodara, India
- **Study Period**: 2017-2021
- **Road Network**: 608 road links, 415 Km in total.
- **Data Collection**: Strategic selection of 62 diverse mid-block stretches. Combination of manual and video-based methods for precise traffic flow assessment
- **Land Use Data**: Gathered through extensive field visits. Comprehensive evaluation of land use on both sides of road links
- **Attributes**: Attribute with essential data, including road type, lanes, medians, road width, parking, footpaths, curvature, length, and traffic flow.
- Access density and intersection identification for understanding traffic dynamics.

Vehicle Data Collection

- Current road accident data collected in the form of the First Investigation Report (**F.I.R.**) by police department

1.Manual Method **2. Videography Method**

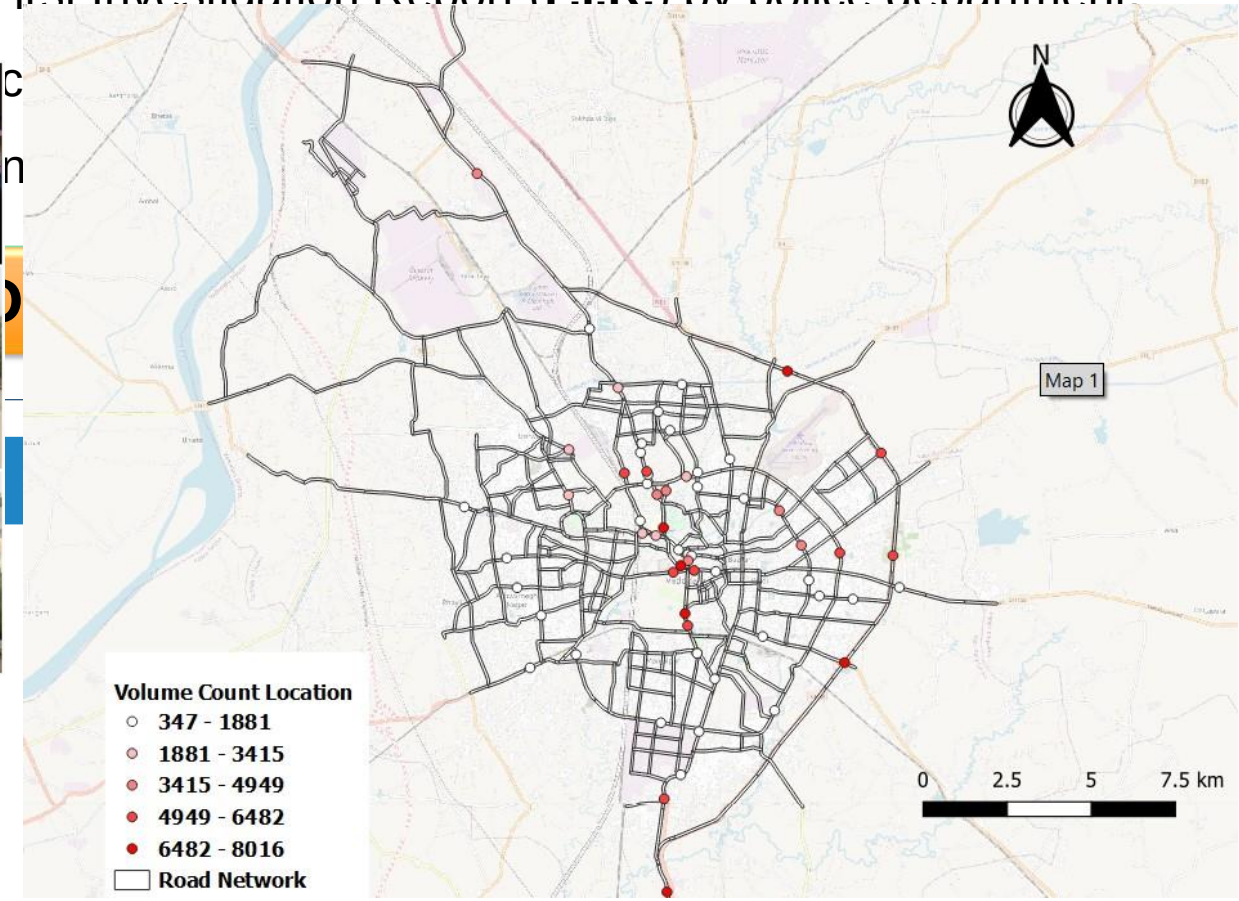


1765 FIRs

Urban

- A total of 42 sites covered for traffic flow data collection
- 12 Sites for manual data collection and 30 sites for videography data collection

- Police station
- Severity
- Vehicle involved
- Person injured
- Collison type
- Collison spot



Model Development

Variable/Models	Pedestrian		M2W	
	Fully adjusted model	Univariate model	Fully adjusted model	Univariate model
Total PCU	0.262 ***	0.397 ***	0.255	0.364 ***
Land Use characteristics				
Residential	-0.019	-0.013 **	0.0039	-0.008 ***
Commercial	-0.014	0	0.038	0.001
Mixed	-0.014	-0.006	0.035	-0.011
Vacant	-0.01	0.015 ***	0.045	0.012 *
Industrial	-0.025	-0.022	0.034	-0.016
Recreational	-0.011	0.002	0.058	0.012
Other	-0.019	0	0.034	0.008 *
Road Geometrics				
Type Of Carriageway	0.5	1.912 **	-0.17	1.398
No. of lanes	0.472 ***	1.94 ***	0.253**	1.773***
Width of Median	-0.008	1.559	-0.383***	-1.945**
Distance of light pole	-0.03	0.988	-0.019	1.001
Lux Level	0.02	1.007	0.024	1.016
Median Type	-0.123	1.416	0.001	1.512
Lane Markings 1	-0.316	1.469	-0.291	1.088
Lane Markings 2	-0.37	2.648	-0.313	1.798
Lane Markings (one way road)	-11.597	0	-12.54	0
Shoulder Marking	0.418	1.831	-0.024	1.398
Kerb marking	-0.325	1.223	0.041	1.341
On Street Parking	0.139	0.867	0.46	1.007
[a]Pseudo-r square	**0.476**			**0.578**

- Logistic regression is a statistical method used to analyze and model the relationship between one or more independent variables (predictors) and a binary outcome variable.
- It is especially useful when the outcome is binary, meaning it has only two possible values, such as "yes" or "no," "success" or "failure," or in this case, "case" or "control."

❑ Outcome Variable in the Study:

The outcome variable in this study is binary and represents the occurrence of a VRU fatal crash at a specific midblock location. It is used to categorize midblocks into two groups:

Cases (1): Midblocks with at least one VRU fatal crash.

Controls (0): Midblocks without any VRU fatal crashes.

Logistic regression was employed to model the factors influencing the likelihood of a midblock being classified as a "case" or a "control" based on the built road infrastructure variables, such as the number of lanes, road width, presence of medians, and more.

- * $P \leq 0.05$,
- ** $P \leq 0.01$,
- *** $P \leq 0.001$
- [a] McFadden's R^2.

Policy

- For safety of pedestrian, crossings should be provided in such a way that pedestrians need to walk as less as possible and the volume of the incoming traffic should also be less, the best way to achieve this can be a well-designed pedestrian under/ over pass and signals (Lalwani et al., 2023).
- Furthermore, raised crosswalks should be employed at places having considerable pedestrian movement to keep them safe from the perils of the road (Nazir et al., 2023).
- Width of median should be provided close to maximum allowable value, where possible to ensure reduced glare and better segregation of traffic (Tighe et al., 2000).

Limitation and Future Scope

- The present study excluded bicycle-related crashes.
- Subsequent research endeavours should encompass all Vulnerable Road User (VRU) crash classifications, while also examining the impact of road infrastructure on the entirety of VRU crash categories

Thank you!