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Analysis of Pedestrians Behavior and Remedial Measures at Major Intersections

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Abstract: ***One of the biggest issues facing the entire globe today is accidents involving pedestrians. In India, a developing and highly populated nation, some of the causes of these accidents include pedestrians who are not following traffic regulations. Scientists have occasionally shown an interest in pedestrian behavior and the variables that influence it. Researchers have tried a variety of methods to increase safety, but a workable strategy must be developed for the comfort of pedestrians. The primary motivation for this research was to use questionnaire surveys and video recording techniques to examine pedestrians according to their age, gender, and crossing behavior at 3 of the busiest intersections in Lucknow, the capital of Uttar Pradesh. Pedestrians were questioned and were video graphed. Some remedial measures we adopted at the intersections are pedestrian refuge island, foot over bridge sidewalks , pedestrian ramps and crosswalk. This will provide a version for raising pedestrian awareness of the rules and regulations to help them avoid conflicts with drivers.***

Keywords: ***Intersections, Pedestrian Behavior, Remedial Measures, Questionnaire survey, Video graphic method , Refuge island, sidewalk , foot over bridge, crosswalks.***

I. INTRODUCTION

The behavior of pedestrians is a significant and intricate occurrence. A pedestrian is someone who moves forward on foot, particularly in a location where moving vehicles are present. India has a large walking population. According to studies, 45 million people every day walk to work. Despite the hierarchy of roadways in India, millions of pedestrians put their lives in danger every day as they travel along unsafe roads, where they are vulnerable to accidents and fatalities from motor vehicles. Inadequate infrastructure forces people to cross streets illegally, stroll along the edges of roads, and deal with many other issues. Due to the increase in traffic, this issue became more serious at junctions. Therefore, it became essential to examine pedestrian behavior and implement corrective measures at intersections. Gender, age, the way they cross the street, how much luggage they are hauling, and other factors all affect how they behave as pedestrians.

A. Objectives

The main goals of this study are as follows:

1) To comprehend pedestrian behavior at important intersections in Lucknow, Uttar Pradesh, with regard to age, gender, crossing time, crossing pace with or without luggage, etc.
2) To comprehend the issue junctions are currently facing.
3) To ascertain the cause of illegal behavior, such as failing to use a crosswalk, traversing the street while wearing headphones, running across the street without looking both ways, etc.
4) Look for some corrective actions to take, such as installing or improving crosswalks, signal design, sidewalks, road safety instruction programs, etc.

B. Background

Due to their outdated construction, the roads and intersections could not accommodate the growing number of vehicles and pedestrians. Traffic movements are hampered by a lack of traffic consciousness, disregard for traffic laws, an increase in the number of vehicles, and feelings of "superiority complex." For both comfort and safety, pedestrians at intersections require vigilance and some changes.

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II. LITRATURE REVIEW

2012, Athanasios Galanis et.al suggested a behavioral trend for pedestrian crossing at signalized crosswalks. In the Greek city of Volos, over 1300 pedestrians were captured on camera during the summer. The Captiv L2100, a cutting-edge instrument, was used to analyze the footage. (TEA). This research criticizes pedestrians' lack of access to road safety education and their unsafe crossing habits. It suggests implementing a senior citizen traffic safety training program.

2015, Marisamynathan Sankaran et.al examined the variables affecting human behavior at signalized intersections. In Mumbai, India, 8 signalized intersections were video graphed, and 2476 pedestrians were photographed. The research was organized into four stages. Long crosswalks, a lack of refuge islands, and a lack of crosswalk signs were all noted as contributing factors to non-compliance. Crosswalk markings with exquisite green timing and distinct lanes for turning vehicles would aid in reducing pedestrian disobedience.

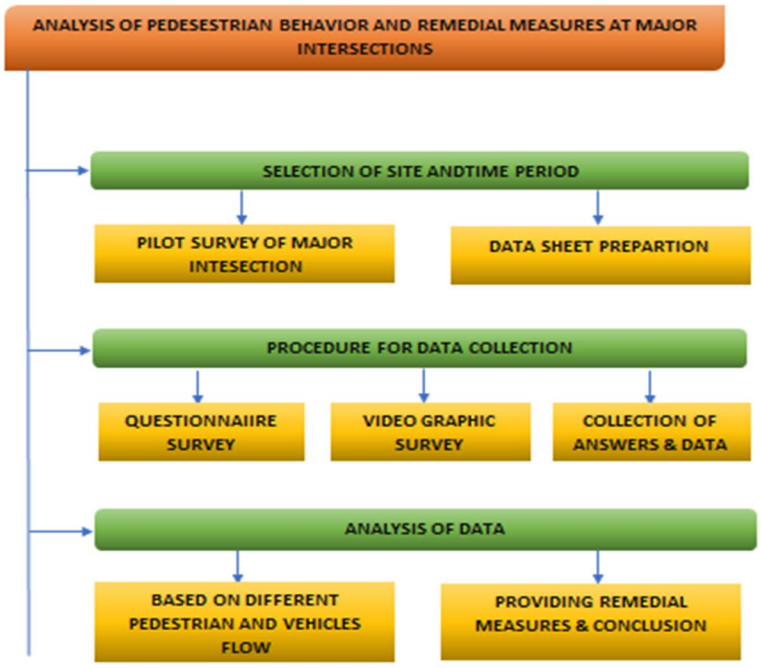
2016, Aseem Anand et.al In order to develop a strategy to make pedestrians more comfortable, questionnaire surveys have been carried out at some of Lucknow's busiest crossroads. In order to capture the current activity of pedestrians and interview them, 10 significant intersections were video graphed first. The influence of a pedestrian's age, level of awareness, and wealth was investigated.

2019, Huseyin Onur Tezcan et.al Two hours of video were taken at each midblock intersection to examine how pedestrians cross the street. For individual crossover behavior and platooning, two multinomial logit models were assessed. It was observed that as platoon size and traffic volume grow, so does the likelihood of platooning. Platoon formation must be avoided using push-to-walk buttons and other devices.

2022, Sadie Boyer et.al identified the variables influencing pedestrian behavior and lawbreaking at some intersections. Cameras were installed at a UDOT intersection, and UG students at Utah State University used Google forms to gather video data and information after analyzing the footage with logistic regression models, t-tests, and chi-squared tests. pedestrian violation in both space and time was investigated. Gender, age, time of day, rush hour, workday, and holiday did not appear to have any appreciable influence on pedestrian behavior.

III. METHDOLOGY

A questionnaire survey and video recording will be used for analysis of pedestrian behaviour at some of the major intersections in Lucknow. Lucknow is the largest city, capital of Uttar Pradesh with a population of over 4 billion. Considering this, 3 major intersections were chosen for examining the behaviour of pedestrians and provide some remedial measures at the respective intersection. The pedestrian characteristics like age, gender , crossing pattern , income , carrying luggage , zebra crossing used or not etc. will be taken into consideration will analysing their behaviour.



A. Selection of site and Time period

As we know that Lucknow , Capital of Uttar Pradesh is a big city , comprising a remarkable percentage of population of the state .In context of this Seven major intersections were chosen for analysing the behaviour of pedestrians and providing remedial measures at these intersections .

1) Engineering college Intersection.
2) Polytechnic Intersection.
3) Kamta Intersection.

B. Procedure for Data Collection

Questionnaire survey and Video observation method is used for pedestrian survey, to analyse their behaviour , their crossing behaviour based on different pedestrian characteristics like age ,gender etc. , problem faced by them at the intersections and so on.

As we know that Questionnaire Survey has significant importance in transportation studies. It is a relatively cheap method which helps to record the reason for pedestrian illegal crossing behaviour, the problem faced by them to help them increase their awareness and safety .

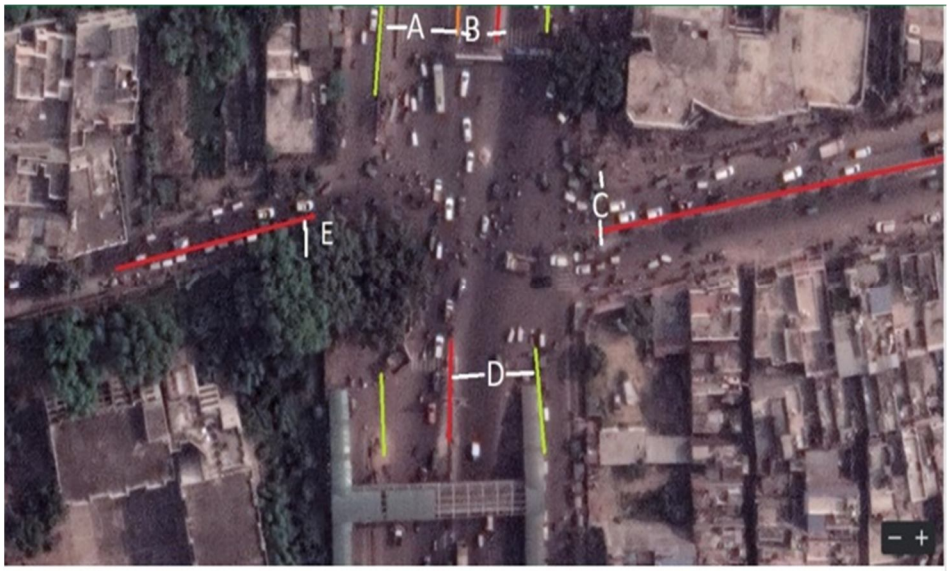
Questions and Answers from pedestrian based on their behaviour both in Hindi and English

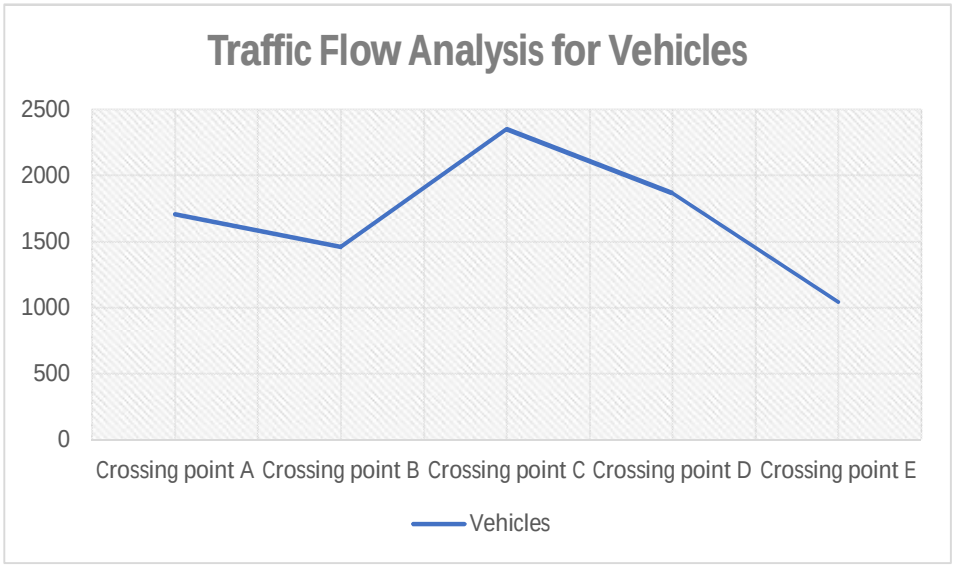
Q.No.	Question
a.	Sir/Madam , why did you cross the road while green light is on? महोदय/महोदया , हरी बत्ती होने पर भी आपने सड़क क्यों पार की? Sir/Madam, Actually I am in hurry and is getting late. Also here crossing is not built properly neither the traffic system runs properly here.
b.	Sir/Madam , what do you think of safety while walking on road? महोदय/महोदया , सड़क पर चलते समय आप अपनी सुरक्षा के बारे में क्या सोचते हैं? Sir/Madam, Worst ! Many a times vehicles comes from the wrong side. Vehicles speed are so fast even after reaching crossing. At night it gets even more difficult to walk or cross when the signal is off vehicles speed are much more faster than in day time.
c.	Sir/Madam ,why you ran to cross the road ? महोदय/महोदया , आप सड़क पार करने के लिए क्यों भागे? Sir/Madam, It only happens when either I'm in hurry or crossing the road while the signal is green due to fear. Sir/Madam, I came late to cross and If don't run the signal will turn green again and I won't be able to cross the road.
d.	Sir/Madam ,why didn't you use crosswalk to cross the road ? महोदय/महोदया , आपने सड़क पार करने के लिए क्रॉसवॉक का इस्तेमाल क्यों नहीं किया? At Kamta Intersection : Sir/Madam, At Kamta you can see there is no crosswalk made. At different Intersections : Sir/Madam, Here the crosswalks are notproperly visible. Sir/Madam, Many a times I use but sometimes to take shortcut I just skip it.
e.	Sir/Madam , why did you use mid block area for crossing road? महोदय/महोदया , आपने सड़क पार करने के लिए मध्य ब्लॉक क्षेत्र का उपयोग क्यों किया? Sir/Madam, the intersections is far from here and thus It'll take more time to go there and cross, so I crossed the road using mid block Sir/Madam, It seems a shortcut to cross the road and it saves time.
f.	Sir/Madam ,why you don't obey traffic rules ? महोदय/महोदया , आप ट्रैफिक नियमों का पालन क्यों नहीं करते? Sir/Madam , the rules that I'm aware of I always try to follow those but there are many rules that we don't even know. There is must be a hoarding to guide us. Sir/Madam, What's the point if only pedestrian obey the rules of traffic when vehicle also don't obey them. Sir/Madam, There are many rules that consumes time to follow them.
g.	Sir/Madam ,why you wore earphones while crossing road ? महोदय/महोदया , आप सड़क पार करते समय ईयरफोन क्यों लगाते हैं? Sir /Madam , Does it matter ? I take care of my safety even while wearing it. Sir/Madam, I forget to put off the earphones. Sir/Madam, Sometimes I've to be on call due to some really urgent work.
h.	Sir/Madam ,what facility do you want for your safety on road in summer? महोदय/महोदया , गर्मियों में सड़क पर अपनी सुरक्षा के लिए आप क्या सुविधा चाहते हैं? Sir /Madam ,There must be rule that don't allow Pedestrians not to wait too long on crossings as during summer it's really frustrating to wait. Sir/Madam, During summer even traffic police doesn't do their job properly.

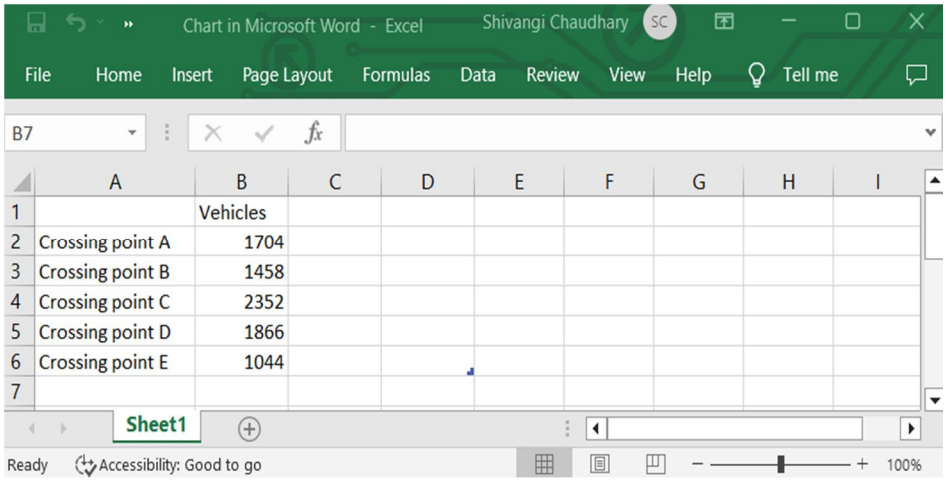
i.	Sir/Madam ,what facility do you want for your safety on road in monsoon? महोदय/महोदया , आप मानसून में सड़क पर अपनी सुरक्षा के लिए क्या सुविधा चाहते हैं? Sir/Madam , the biggest facility would be repairing of road and it's holes so that vehicle don't splash mud over us. Sir/Madam, There must be a properly built shed waiting area provided.
j.	Sir/Madam ,what facility do you want for your safety on road in winter? महोदय/महोदया ,सर्दियों में सड़क पर अपनी सुरक्षा के लिए आप क्या सुविधा चाहते हैं? Sir/Madam , there are many vehicles whose lights are not visible due to fog. Sir/Madam, the signals lights doesn't seem to bright enough to see from a considerable distance , so they need maintenance. Sir/Madam , Extra care must be taken to ensure that vehicles should slow down at Intersections for pedestrians crossing the road.
k.	Sir/Madam, why don't you wait for traffic light to cross road ? महोदय/महोदया आप सड़क पार करने के लिए ट्रैफिक लाइट का इंतजार क्यों नहीं करते? Sir/Madam , I was in hurry . Sir/Madam , This is busy road many vehicle doesn't follow the rules and also traffic signals falls after the crossing and I can't even see it. Sir/Madam, here no one follow the traffic signals ,and even if I tried to follow , the other persons make me not to follow through traffic light.
l.	Sir/Madam ,what do you think of your children safety on road ? महोदय/महोदयाआप सड़क पर अपने बच्चों की सुरक्षा के बारे में क्या सोचते हैं? Sir/Madam , I feel fear while crossing the road with children , so there should be some system like traffic barrier must be made to be designed for children's safety. Sir/Madam, Police must also should take care of the safety of children whilethey cross.
m.	Sir/Madam , what do you want from driver while crossing road? महोदय/महोदयाआप सड़क पार करते समय ड्राइवर से क्या चाहते हैं? Sir/Madam , the driver should follow the traffic signals. Also the driver should slow down for pedestrians walking and crossing the road. Sir/Madam , the driver should drive in his/her desired lane . Sir/Madam , the driver should not drive while drinking, speaking on phone etc.
n.	Sir/Madam , what main issue you are facing while using road? महोदय/महोदया , सड़क का उपयोग करते समय आप किस मुख्य समस्या का सामना कर रहे हैं? Sir/Madam , here there is no facility for pedestrians. Sir/Madam , here is no crosswalk and where there is the crosswalk is not visible enough. Sir/Madam , the intersection is not proper here also there is no sidewalks. Sir/Madam , there is no refuge island for pedestrian, even though the road width is large.
o.	Sir/Madam , what do you think of change so there is no traffic jam? महोदय/महोदयाआप बदलाव के बारे में क्या सोचते हैं ताकि कोई ट्रैफिक जाम न हो? Sir/Madam, here signal are accurate and followed by everyone . Sir/Madam , there is no proper direction for vehicles like rickshaw. , bike to turn vehicles. Sir/madam , due to lack of proper intersections ,the vehicles are forced to turn incorrectly.

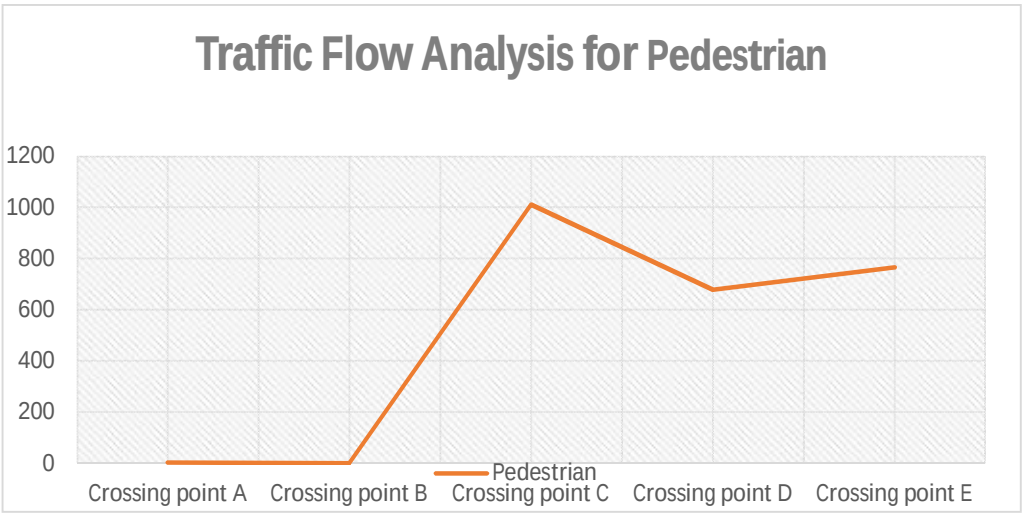
IV. ANALYSIS OF DATA

A. At Engineering College Intersection

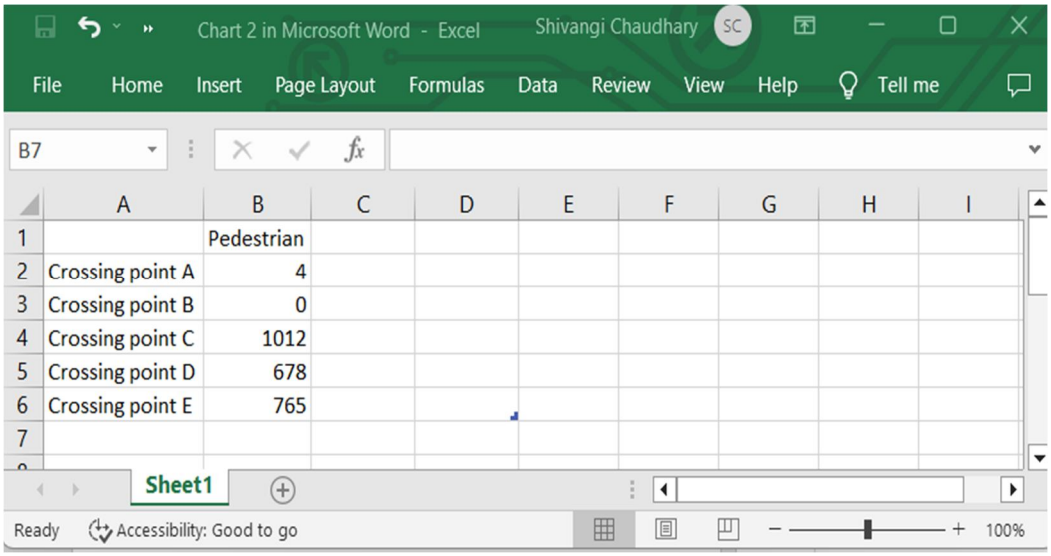








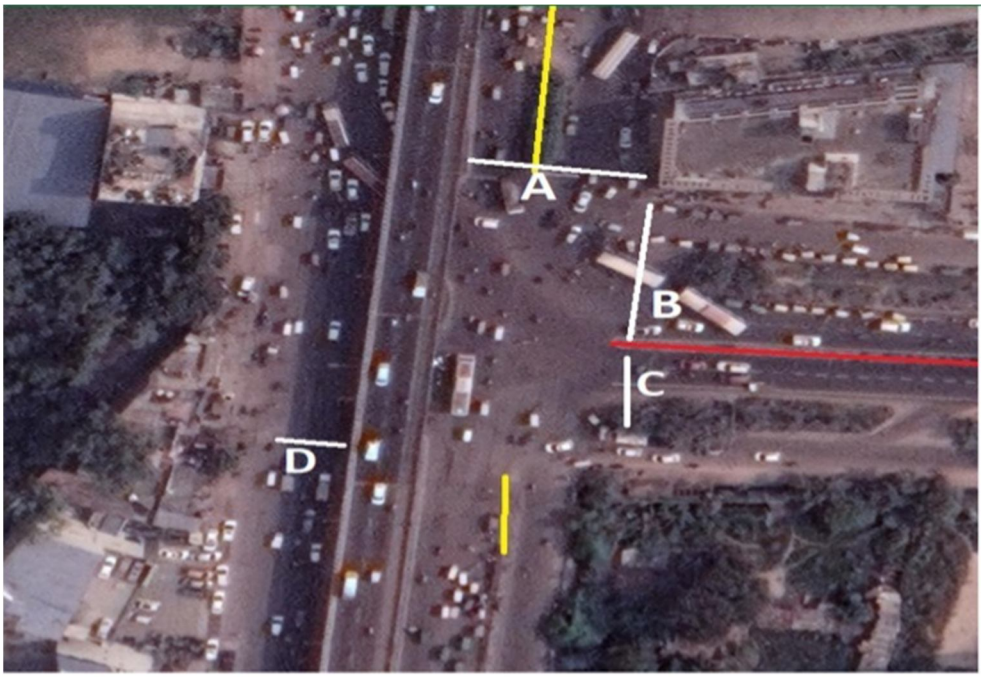
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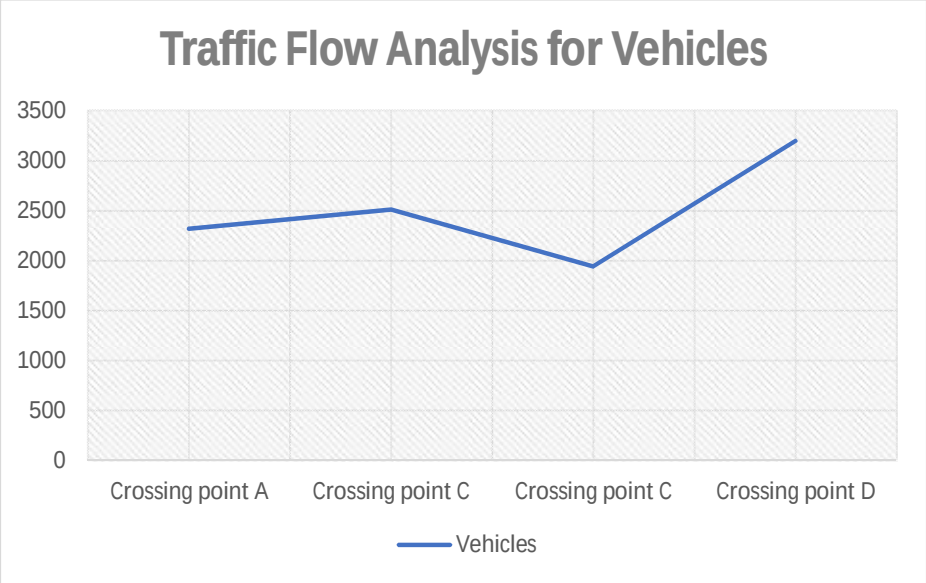
	A	B
1		Pedestrian
2	Crossing point A	4
3	Crossing point B	0
4	Crossing point C	1012
5	Crossing point D	678
6	Crossing point E	765
7		

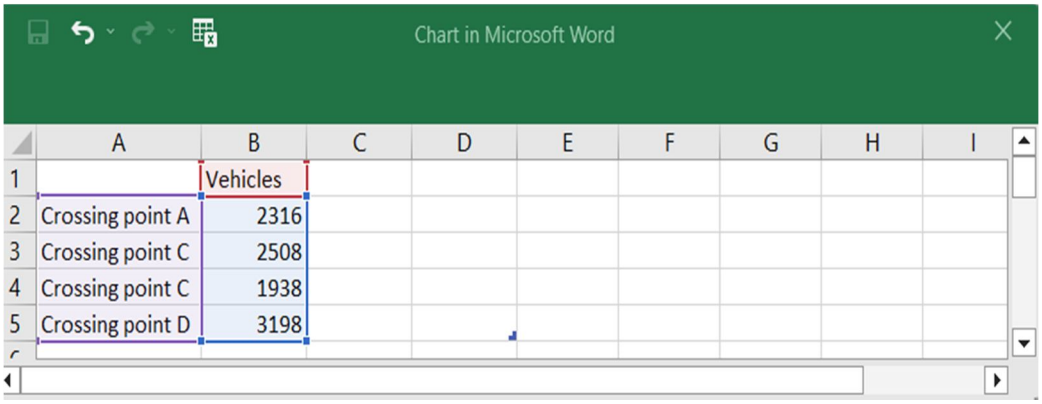
At the Engineering college Intersection , the number of Vehicles and Pedestrian Crossing a particular point has been determined by Video analysis. From the figure ,it can be seen that the pedestrians crossing point A are 4, point B - 0,point C -1012,point D - 678 ,point E – 765 and the vehicles crossing point A are 1704 ,point B - 1458 , point C – 2353 ,point D - 1866,point E – 1044 on hourly basis. These data has been recorded during rush hours. So, most vehicles and pedestrians are vehicles are crossing point C.Vehicles at point A,B are far greater than the pedestrian. At point D and E both pedestrians and vehicles are comparable. So remedial measures needed to be the most at point C,D,E. Need for modification in crosswalk to improve visibility by using thermoplastic material , Need of pedestrian refuge island at point C. Sidewalks are also desired at some points especially on the left side of point D Barricading before crosswalk is a proposed measures to help prevent vehicles on stopping at the crosswalk so that pedestrians can use it without worrying about their safety.

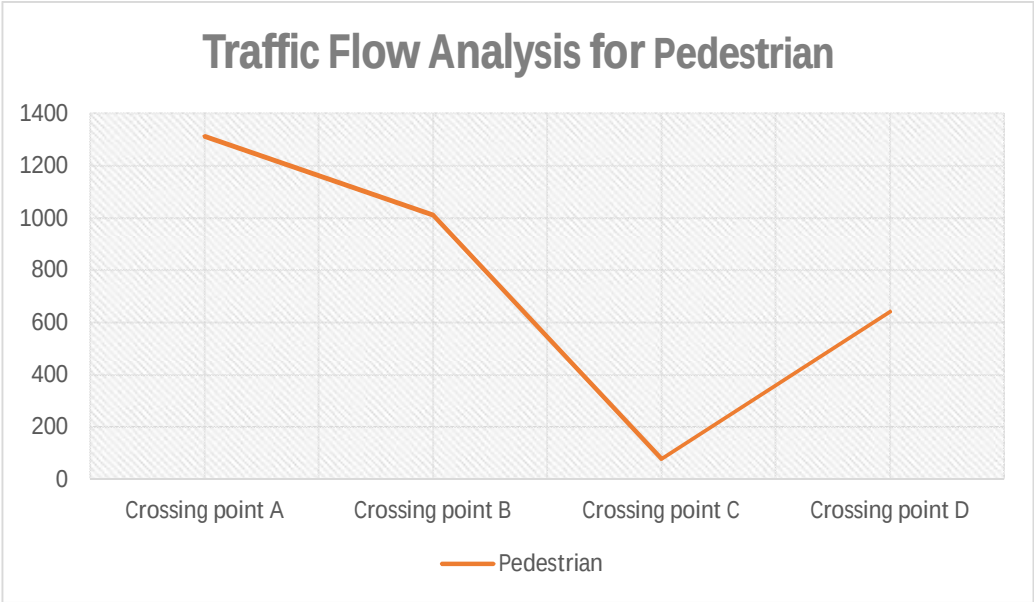
B. At Kamta Intersection



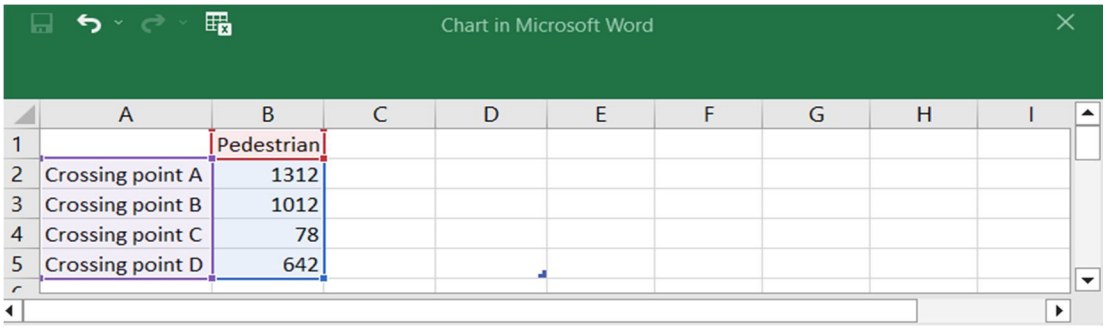
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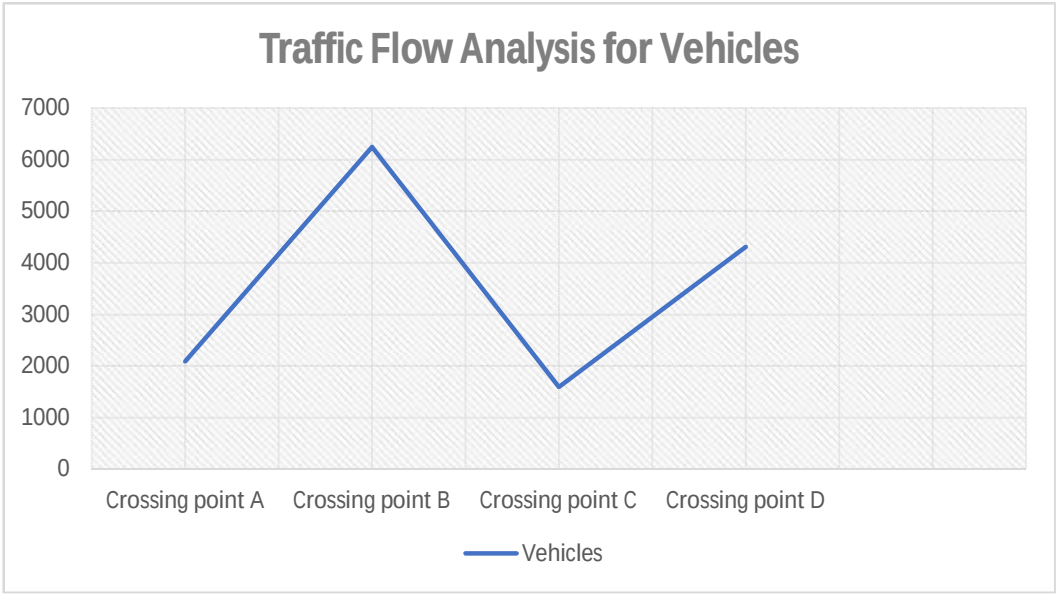


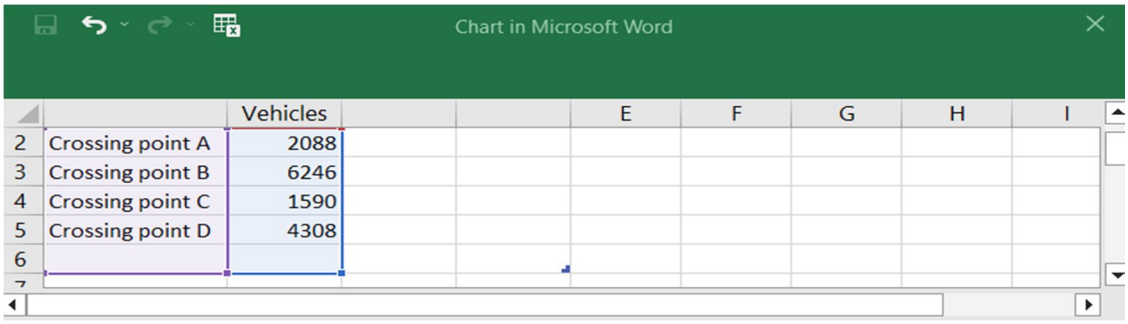
	A	B	C	D	E	F	G	H	I
1		Pedestrian							
2	Crossing point A	1312							
3	Crossing point B	1012							
4	Crossing point C	78							
5	Crossing point D	642							

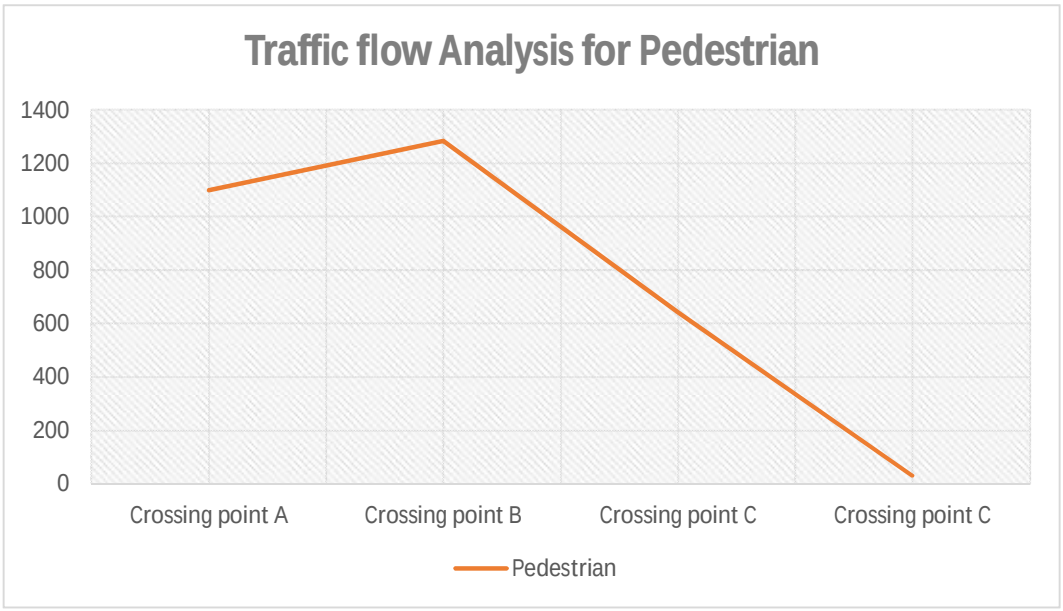
At the Kamta Intersection , the number of Vehicles and Pedestrian Crossing a particular point has been determined by Video analysis. From the figure ,it can be seen that the pedestrians crossing point A are 1312, point B - 1012,point C -78,point D - 642 , and the vehicles crossing point A are 2316 ,point B - 2508 , point C – 1938 ,point D - 3198,on hourly basis. These data has been recorded during rush hours .So, most vehicles are crossing at point D and pedestrians are crossing point A .Vehicles at point C are greater than the pedestrian. At point A and B both pedestrians and vehicles are comparable. So remedial measures needed to be the most at point A,B,D. Need for crosswalk , Need of pedestrian refuge island between point B and C. Pedestrian signals and signs needed both at point A and D.

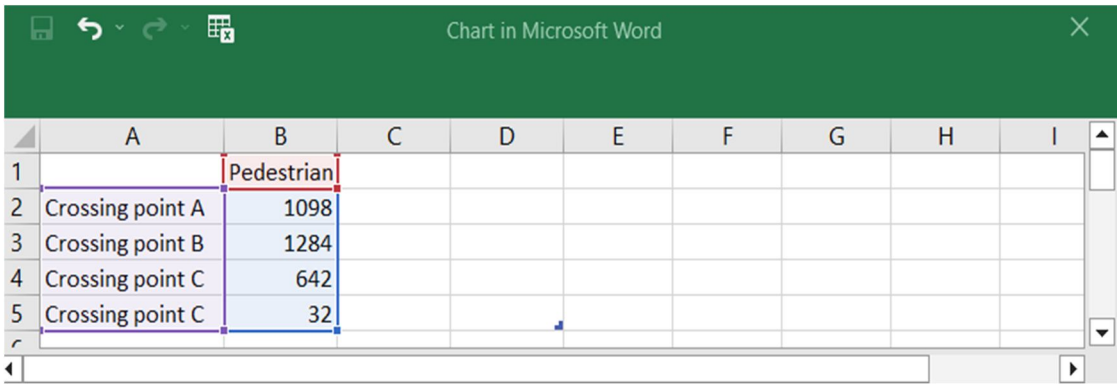
C. At Polytechnic Intersection











At the Polytechnic intersection , the number of Vehicles and Pedestrian Crossing a particular point has been determined by Video analysis. From the figure ,it can be seen that the pedestrians crossing point A are 1098, point B - 1284,point C -642,point D - 32 , and the vehicles crossing point A are 2088 ,point B - 6246, point C – 1590 ,point D - 4308,on hourly basis. These data has been recorded during rush hours .So, most vehicles are crossing at point D and pedestrians are crossing point B .Vehicles at point D are far greater than the pedestrian. At point A and C both pedestrians and vehicles are comparable. So remedial measures needed to be the most at point A,B,C. Need for crosswalk modification to improve visibility using thermoplastic material. Pedestrian signals and signs needed at point D. There is pedestrian refuge island for pedestrian. Barricading before crosswalk is a proposed measures to help prevent vehicles on stopping at the crosswalk so that pedestrians can use it without worrying about their safety.

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V. REMEDIAL MEASURES AT SELECTED MAJOR INTESECTIONS

A. Pedestrian Refuge Island

It is also called 'refuge island' or 'pedestrian island' or 'median refuge island'. It is a small section on the road where pedestrians can stop before finishing crossing the roads. Used mainly where the roads are wide and helps those pedestrian who finds to cross the roads in one traffic light cycle.

Design Guidance

1) The island should be at least 6 feet in width , desired width is 10 feet or more and should be of adequate length to allow enough number of pedestrian to wait and stand on it before crossing the road.
2) It can be made either of asphalt or concrete. Cost of concrete island is rather higher than asphalt island but the former has long life .
3) When it is constructed on a two way street, it should be placed long the centerline of the road .
4) The approaching edge of the raised median should be outlined in retroreflective yellow or white material.
5) The height of the refuge island should be curb level, 6 inches high.
6) Lighting can also be installed for improving visibility at night

B. Sidewalks

Sidewalk (North American English) is also called pavement in British English , footpath in Australia , India ,New Zealand. It is a path along the sides of roads street, highway. It is designed for pedestrian . It is made for pedestrians and is typically made of concrete, pavers, masonry, stone, or asphalt.

Design Guidance

1) *Width:* Depending on the neighboring land use, the footpath's width should change. The minimum clear width for residential areas is 1.8 meters, and the minimum clear width for business areas is 2.5 meters. (IRC:103-2012, 6.1.5.2). and at least 2.5 meters for commercial zones. (IRC:103-2012, 6.1.5.2).
2) *Height:* The kerb's height above the carriageway shouldn't be greater than 150 millimeters.(IRC:103-2012, 6.1.4).
3) *Surface:* Flat walking surfaces on footpaths enable for proper drainage and prevent puddles from developing. (IRC:SP:50 and IRC:103-2012, 6.1.6). To help those who are visually impaired, the footpath should have guide tiles installed along its length. (IRC: 103-2012, 6.1.4).
4) *Property Entrance:* For uninterrupted pedestrian movement, footpaths must run continuously, even at property entries. The footpath's elevation ought to stay constant. Each side of the property entryway needs to have warning tiles installed in order to alert people who are blind or visually impaired to potential vehicle activity (IRC 103-2012, 6.4.3). Bollards should be put in place to prevent cars from parking on the sidewalk, leaving at least 1.2 meters of space free. (IRC:103-2012, 6.12). Use the correct material at each property entrance to prevent damage from moving vehicles.

C. Pedestrian Safety Ramps

Ramps for pedestrians are a crucial part of offering accessible and secure modes of transportation. For all pedestrians, especially the elderly and those with ambulatory and vision impairments, pedestrian ramps provide entry onto and off of sidewalks and roadways.

Design Guidance

Wherever there is a change in level on pedestrian pathways or cross paths, curb ramps are used.

1) Curb ramps should be placed away from the normal path of pedestrian flow to avoid confusing blind pedestrians. The pathway's clear breadth must be at least 0.90 meters. (see Pathways).Curb stairs ought to be placed far from areas where water collects.

2) Width

Without including the sloping sides, a curb ramp should have a minimum breadth of 0.90 meters. The suggested breadth is 1.20 meters.

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3) Slope

*A curb incline should have a maximum slope of 1:12.
*Flares should have a maximum inclination of 1:12.
*Level transition between the curb ramp and a pathway's pavement is advised. Useful lips range from 15 millimeters and under.

4) Guide Strips

To help blind and partly sighted pedestrians find the curb ramp, a guide strip painted in a contrasting hue should be installed.

5) The hue and surface

*To be noticeable and slip-resistant, curb ramps, including flares, should have a rough texture or ground design.
*To help blind walkers, the surface colour should be distinctive and contrast with the nearby surfaces.

D. Crosswalks

A fundamental tool for guiding pedestrians securely across the street and alerting drivers to pedestrian crossings are crosswalk markings. Not every legal crosswalk needs to be marked, nor is it feasible to do so.

Design Guidance

The driver and the pedestrian must both be able to see the crosswalk signs. Because they are closer to the junction and approaching it from a different angle than drivers, pedestrians can generally see crosswalk markings much more readily than drivers.

1) *Standard (Transverse) Crosswalk Markings:* A typical crosswalk consists of two transverse (parallel) lines that are 15 feet apart in downtown and activity centers and 10 feet apart in other places, each measuring 6 inches in breadth. Instead of using a 6 inch line width, transverse lines can use a 12 inch line width to make them more visible.
2) *High – visibility (Longitudinal) Crosswalk Markings:* A high-visibility crosswalk is made up of longitudinal lines that are striped in the same way as the flow of traffic. The breadth and spacing of the longitudinal lines should be between 12 and 24 inches and 12 and 60 inches, respectively. In order to minimize maintenance requirements, the markings may be striped to avoid the routes taken by moving vehicles.

The materials that can be used to designate crosswalks include thermoplastic, epoxy, inlay tape, and latex paint. Both inlay tape and thermoplastic offer superior performance over the course of the crosswalk markings, despite being initially more expensive than paint.

E. Foot Over Bridge

Narrow bridges called "foot over bridges" are typically constructed so that people can traverse them safely. Two sides of a major road are connected by a foot overbridge, which enables pedestrians to travel without holding up traffic. They ought to be constructed across congested streets to permit pedestrians to cross securely without impeding or impeding the flow of traffic.

F. Traffic Signals and Signs

The traffic signs, which are typically mounted on the side of a road and have an eye-catching design, warn or teach drivers and pedestrians by displaying symbols or words. The placement of such traffic signs would notify drivers of motor vehicles of the presence of pedestrian crossings as well as walkers of the presence of crosswalks.

VI. CONCLUSION

The conducted research at the 3 major intersections in Lucknow helps to analyze the behavior of pedestrians of pedestrians using the method of Questionnaire survey and video graphic method. This will help to formulate and recommend the remedial measures which add to the safety of the pedestrians. Pedestrians were questioned and approximately were video recorded. Some of the major findings of the paper are as follows.

1) Pedestrian and vehicles are counted at each intersections to know the flow and the remedial measures for pedestrian needed at which point the most .
2) There are facilities but people are not using these ,because of infrastructure problem.
3) Females are seen to involve more in illegal crossing behavior than males.
4) Most vehicles stop at the crosswalk leaving no space or little space for pedestrians to use the crosswalk.

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From these data , the remedial measures proposed at the selected 3 major intersections of Lucknow are as :

a) Pedestrian Refuge Island.
b) Sidewalks
c) Pedestrian safety Ramps
d) Foot Over Bridge
e) Crosswalks
f) Barricading before signals during red light.

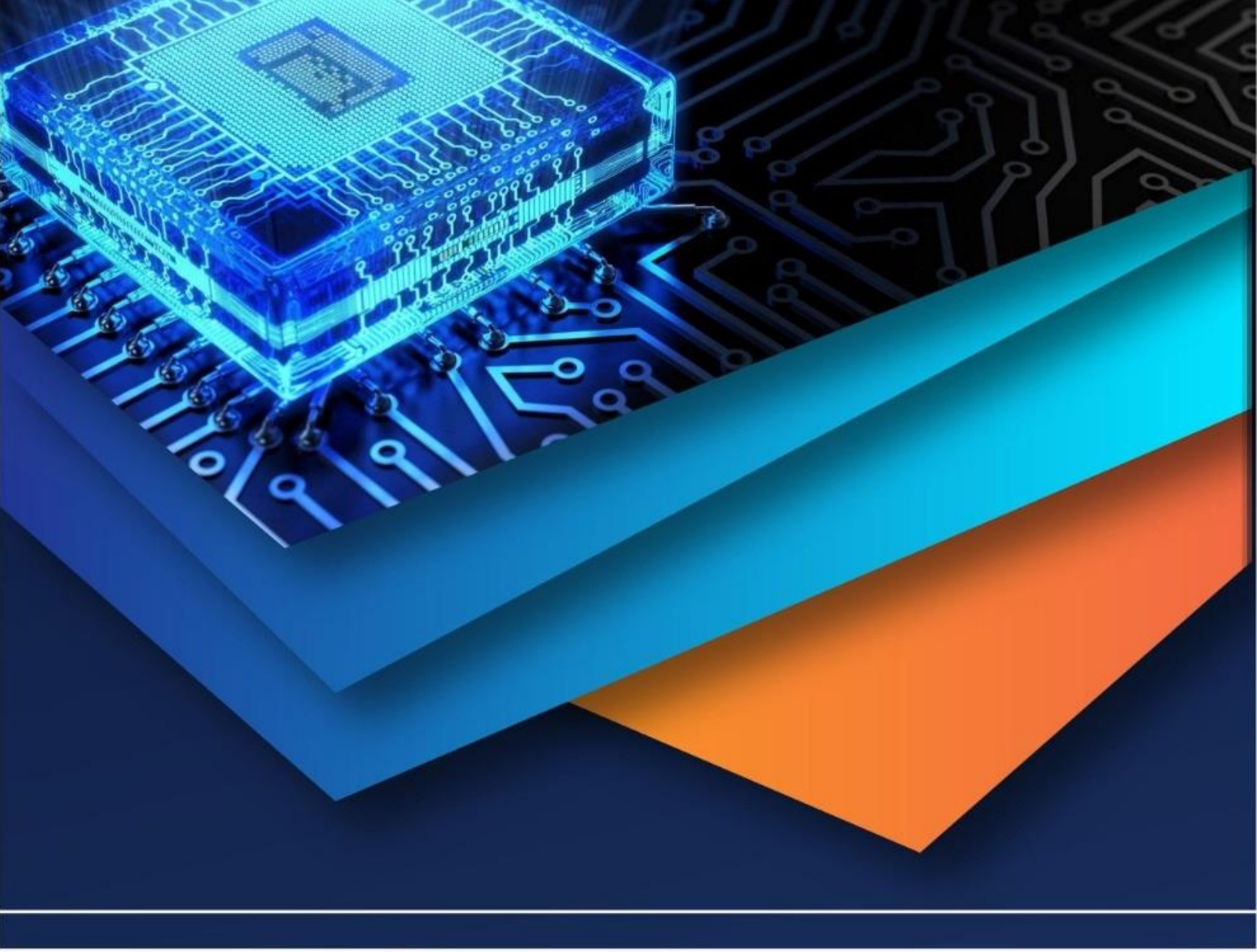
VII. FUTURE SCOPE OF STUDY

The data collected and proposed remedial measures of this study will help the engineers , local authorities , researchers to better analyze the pedestrian behavior at the intersections. This study will also help to formulate another new and innovative remedial measures that will improve the safety of pedestrian and also reduce the congestion arising due to strife between vehicles and vehicles.

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