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Study On Pedestrian Crossing Behavior at Unsignalized Intersections In Sambalpur Region

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ABSTRACT:

Pedestrian safety remains a critical issue in numerous developing countries, despite the alarming number of pedestrian fatalities each year. Regrettably, road design often neglects pedestrian safety, perpetuating the problem. Understanding pedestrian behaviour is key to addressing this issue, yet it remains a complex phenomenon despite extensive research efforts. In this study, the focus lies on pedestrian behaviour, particularly at unsignalized junctions in densely populated areas. Video graphic surveys conducted at these intersections provided data for analysis. Variables such as waiting time, crossing time, gender, and age were extracted from the surveys, with crossing speed serving as the dependent parameter. To determine the relationship between these independent and dependent parameters, a multiple linear regression model was employed with a 95% confidence level. This statistical approach allows for a deeper understanding of how factors such as waiting time, gender, and age influence pedestrian crossing behaviour, particularly in crowded urban settings.

Keywords: Pedestrian behavior, built-up density, SPSS software, age, gender, waiting time, crossing time

INTRODUCTION

Pedestrian safety is a pressing global issue, particularly in developing nations where factors like dense population, urbanization, and disregard for traffic regulations contribute to a significant number of accidents involving pedestrians. One common problem arises when drivers ignore traffic rules at crosswalks, often accelerating to assert their right-of-way, thus endangering pedestrians. Conversely, pedestrians sometimes contribute to traffic delays by crossing streets during busy periods, disrupting vehicle flow. Pedestrian accidents constitute a substantial portion of urban traffic incidents, with pedestrians accounting for a significant percentage of fatalities, particularly in countries like India where pedestrians comprise 65% of accidental deaths, with 35% being children. The shared space on roads between pedestrians and vehicles heightens the risk, especially for pedestrians who lack protective measures. Given this scenario, there's a critical need for a thorough examination of pedestrian crossing behaviour to enhance road safety. Understanding how pedestrians navigate roadways can provide insights into improving safety measures and reducing accidents.

NEED FOR PEDESTRIAN SAFETY ANALYSIS

Pedestrian safety is a paramount concern in transportation worldwide, as walking is a fundamental mode of travel in all communities, marking the beginning and end of every journey. Numerous studies underscore the urgent need for analyzing pedestrian safety, given the complexity of the pedestrian population across gender, age, and socio-economic parameters. Age is a crucial factor in safety analysis, as it can influence an individual's perception and decision-making abilities. Some studies have identified age as a significant determinant of pedestrian behavior. Gender also plays a role, as research indicates notable differences in the behavior of male and female road users. In developing countries like India, the predominance of male drivers underscores the importance of considering gender in safety assessments. Pedestrian fatalities in road accidents continue to rise annually, with pedestrians facing significant risks when crossing city streets. The World Health Organization (WHO) emphasizes the need to prioritize pedestrian safety in street design. Safety rating which assess a vehicle's ability to protect occupants and pedestrians in collisions, are crucial. These ratings evaluate a vehicle's technology and capacity to mitigate crash consequences.

This research focuses on safety measures through rating-based models, aiming to develop an index that predicts safety ratings effectively. The framework for developing safety indices relies on both rating-based and behavior-based models, combining various approaches to enhance safety assessments.

OBJECTIVES

- Explore pedestrian crossing behavior at uncontrolled intersections.
- Analyze the influence of various factors including pedestrian attributes, movements, traffic patterns, road conditions, walking environments, and intersection layouts.
- Develop a pedestrian safety index that incorporates both road infrastructure and pedestrian behavior.

After evaluating various methods for this study, it has been determined that the chosen methodology revolves around collecting data on collisions and conducting road safety analysis. While each method has its significance and merits, the preference is for a simpler approach that offers greater benefits. Therefore, the analysis criterion prioritizes simplicity alongside effectiveness.

METHODOLOGY

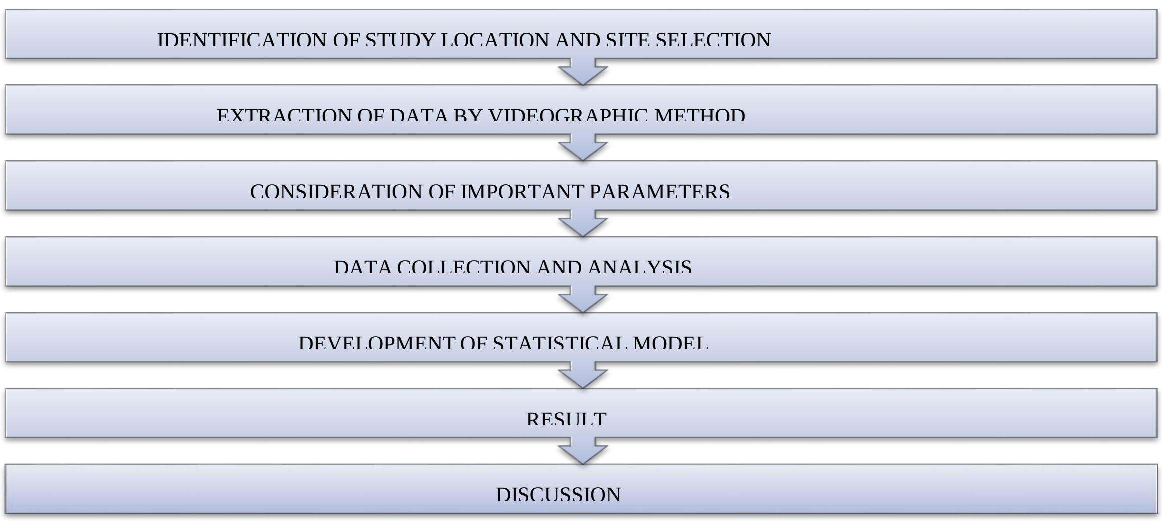

Figure.1 Methodology

SELECTION OF THE GROUP OF STUDY SITES

STUDY AREA

BALANGIR- Balangir is the 3rd biggest town in Odisha and one of the most famous town connecting districts with Western The study area chosen for this research is located in Odisha, covering a total area of 303 km² with a population of approximately 1,648,997 as per the 2011 census. Sambalpur, situated between 20º11'40" - 21º05'08" north latitude and 82º41'15" - 83º40'22" east latitude, boasts an average altitude of 383 meters (800 ft) above sea level. This site was selected due to the inadequate pedestrian facilities and transportation infrastructure present. Many intersections within the city lack proper markings, necessitating field analysis related to pedestrian safety. Moreover, the study aims to understand pedestrian behavior in this newly urbanized area. The specific location chosen for the study is Haatpaada Para market, situated in Titilagarh, which serves as a vital hub connecting various parts of the city. This market caters to a wide range of needs, including groceries, ready-made garments, and vegetables, making it a prominent destination for locals and visitors alike. The study area encompasses residential, commercial, and institutional zones, witnessing a high volume of pedestrian traffic. Key factors driving the selection of this area include its traffic infrastructure, pedestrian behavior patterns, street infrastructure, and pedestrian flow dynamics.

DATA ON BUILT-UP DENSITY FOR THE CHOSEN SITES

A land cover map and land use analysis were conducted for the Haatpaada Para Market area using high-resolution satellite data spanning two decades, specifically for the years 2002, 2012, and 2022. The analysis focused on categorizing land into two primary layers: built areas and unbuilt areas, resulting in the creation of a built density map. This density map, representing changes in construction density over time, guided the selection of the research intersection. By examining the evolution of built-up areas from 2002 to 2022, the intersection was identified based on the model of construction density, ensuring relevance to the study's objectives and focus on urban development dynamics.

DATA ON PEDESTRIAN BEHAVIOUR

Pedestrian movement at intersections is inherently uncertain, as it's shaped by both physical and operational factors. Factors like age, gender, and group size influence pedestrian behavior, impacting parameters such as crossing time, waiting time, location of crossing, and crossing pattern. To understand these dynamics, statistical tests such as ANOVA and Pearson's correlation coefficient were employed at a 95% confidence level, revealing the interconnectedness of these components.

In ANOVA tests, randomized experiments are utilized within normal linear models to analyze the mean effect. Human psychology, being highly unpredictable, is a crucial factor in transportation research, particularly evident in behaviors during commuting. The physical and operational environment significantly influence human movement, with pedestrian behavior being further shaped by variables such as location, unauthorized road use, smartphone distractions, risk perception, and alcohol consumption.

Data on pedestrian behavior, including crossing speed, waiting time, interaction with vehicles, crossing patterns, and vehicle approach, were collected through high-definition video cameras installed at intersections. Analysis of this data was facilitated using tools like VLC media player and Kinovea Software, revealing the complexity and uncertainty inherent in pedestrian movements.

Overall, pedestrian behavior is deeply influenced by various physical and psychological parameters, making it a multifaceted and challenging area of study within transportation research.

VARIABLES LIST WITH THEIR DEFINITIONS & PARAMETERS

SL NO.	VARIABLE	DEFINITIONS AND PARAMETERS
1	**GENDER**	**0 (male pedestrians) and 1 (female pedestrian)**
2	**AGE**	**0 - (> 15)** **1 - (20-30)** **2- (30-40)** **3- (40-50)** **4- (50-60)** **5- (>60)**
3	**GROUP/PLATOON**	**0 for single road users 1 for multiple road users**
4	**CROSSING SPEED (m/s)**	**Crossing speed of the pedestrian in (m/s)**
5	**WAITING TIME (s)**	**Pedestrians waiting to enter the intersection**
6	**CROSSING TIME (s)**	**for pedestrians traveling the intersection by walking and** **for pedestrians traveling the intersection by running**
7	**TYPE OF CROSSING**	**Straight or oblique path**
8	**DIRECTION**	**Upward or downward**
9	**BAGGAGE**	**Carried by the pedestrian(yes/no)**

All the parameters mentioned will be carefully considered when assessing behaviors at the intersection, and data will be collected with these aspects in mind. During video analysis, close attention will be paid to each of these parameters to ensure a comprehensive understanding of pedestrian behavior.

DEVELOPMENT OF SAFETY INDEX AND MODELLING

The Pedestrian Safety Index was formulated by amalgamating data from three distinct categories: building density, intersection accidents, and pedestrian behavior. Specifically, the study delved into pedestrian crossing dynamics at a selected intersection, scrutinizing variables like crossing duration, speed, patterns, waiting times near vehicles, and adherence to signals. Gender, age, and group size were analyzed as independent factors influencing these behaviors.

Employing SPSS software, statistical analyses were carried out at a 95% confidence interval, utilizing techniques such as ANOVA and Pearson correlation coefficient to unravel interdependencies among factors. The findings underscored the significance of various parameters in shaping pedestrian behavior.

Despite incorporating street infrastructure and accident data, the analysis underscored the limited impact of street-related factors. Notably, accidents involving pedestrians were relatively rare, prompting the exclusion of accident data from the index. Building density data, however, was aggregated over time to inform the index's formulation.

DATABASE AND ANALYSIS

The study location chosen for analysis is the city of Balangir in the Odisha State of India. This location was selected because the state has a higher proportion of unsignalized intersections compared to signalized ones. Specifically, the Haatpaada Para market area in Titilagarh, Balangir, was selected to study unsignalized intersections. This area offers a substantial amount of traffic infrastructure, pedestrian behavior data, street infrastructure, and pedestrian flow, making it ideal for the analysis.

VIDEO GRAPHIC SURVEY

To gather data on pedestrian characteristics and traffic conditions at unsignalized intersections, a video survey was conducted. Cameras were strategically installed to capture pedestrian movement in both downstream to upstream and upstream to downstream directions at the selected study area. The survey covered designated crosswalks and recorded pedestrian activity across the entire research zone. Data extraction was performed manually, a process that takes longer but yields more precise data compared to continuous and permanent event recording methods. Below is a depiction of the camera's positioning for reference

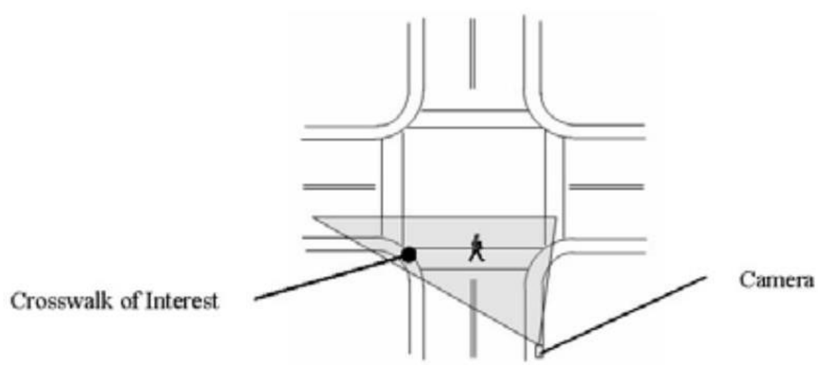

Fig 2 Framework for Fixing Video Camera

DATA OF BALANGIR LOCATION (UNSIGNALIZED INTERSECTION)

VARIATION OF WAITING TIME WITH RESPECT TO PEDESTRIAN AGE

NO OF DAYS/DATE	TIME OF SURVEY	AGE GROUP	AVERAGE WAITING TIME IN S
7 DAYS (25.01.2024 TO 02.02.2024)	10:00 AM TO 11:00AM	BELOW 15	4.23
		20-30	3.45
		30-40	3.57
		40-50	3.107
		50-60	5.7
		ABOVE 60	7.69

The study uncovered that adult pedestrians are more inclined to choose unsafe crossings because of their shorter waiting times compared to children and older pedestrians. Furthermore, it revealed that children take longer to cross the street than adults due to their apprehension about crossing safely. However, teenagers and young adults were found to take less time to cross the road in both locations when they are in a hurry.

VARIATION OF WAITING TIME WITH RESPECT TO PEDESTRIAN GENDER

NO. OF DAYS/DATE	TIME OF SURVEY	GENDER	AVG WAITING TIME
7 DAYS (25.02.2024 TO 02.02.2024)	10:00 AM TO 11:00 AM	FEMALE	5.714
		MALE	2.603

The video survey revealed that female pedestrians tend to wait longer and take more time to complete their crossings compared to their male counterparts. On the other hand, male pedestrians were observed to be more prone to breaking traffic laws and exhibiting unsafe crossing behavior

VARIATION OF CROSSING TIME WITH RESPECT TO PEDESTRIAN AGE

NO. OF DAYS/DATE	TIME OF SURVEY	AGE GROUP	AVERAGE CROSSING TIME IN S
7 DAYS (25.01.2024 TO 02.02.2024)	10:00 AM TO 11:00 AM	BELOW 15	6
		20-30	10.36
		30-40	15.2
		40-50	14.5
		50-60	17.26
		ABOVE 60	17.27

According to the video survey results, it appears that older individuals tend to take more time to cross the road compared to both adults and children. Furthermore, adults seem more inclined to choose unsafe crossing methods, likely due to their tendency to minimize both waiting and crossing durations, which contrasts with the behavior of elderly pedestrians.

VARIATION OF CROSSING TIME WITH RESPECT TO PEDESTRIAN AGE

According to the video survey findings, older individuals generally take longer to complete road crossings compared to both adults and children. On the contrary, adults exhibit a greater tendency than elderly pedestrians to choose unsafe crossing methods, prioritizing the reduction of both waiting and crossing durations.

NO.OF DAYS/DATE	TIME OF SURVEY	AGE GROUP	AVERAGE CROSSING TIME IN S
7 DAYS (25.01.2024 TO 02.02.2024)	10:00 AM TO 11:00 AM	BELOW 15	6
		20-30	10.36
		30-40	15.2
		40-50	14.5
		50-60	17.26
		ABOVE 60	17.27

VARIATION OF CROSSING TIME WITH RESPECT TO PEDESTRIAN GENDER

NO. OF DAYS/DATE	TIME OF SURVEY	GENDER	AVERAGE CROSSING TIME IN S
7 DAYS (25.01.2024 TO 02.02.2024)	9:00 AM TO 10:00 AM	FEMALE	15.23
		MALE	14.87

Male pedestrians frequently exhibit riskier behavior and tend to be in a hurry when crossing the road, unlike their female counterparts. Conversely, female pedestrians typically take longer to complete their crossings compared to males. Despite this, female pedestrians experience fewer collisions, attributed to their heightened awareness while crossing the street.

DATA RELATED TO PEDESTRIAN CROSSING SPEED WITH RESPECT TO AGE

NO. OF DAYS / /DATE	TIME OF SURVEY	AGE GROUP	AVERAGE SPEED IN (m/s)
7 DAYS (25.01.2024 TO 02.02.2024)	10:00 AM TO 11:00AM	BELOW 15	0.945
		20-30	0.823
		30-40	0.863
		40-50	1.02
		50-60	1.5
		ABOVE 60	1.15

Observational statistics reveal that during rush hour, a higher percentage of men are observed walking compared to women, and adults are more prevalent than children and the elderly. The analysis indicated that pedestrians tend to opt for walking rather than jogging through the intersection, with most individuals crossing at speeds between 1.2 m/s and 1 m/s. Upon analyzing survey responses from 308 men and 172 women representing various demographics, several key findings emerged. Notably, the average crossing speed of children and the elderly is lower compared to that of adults..

DATA RELATED TO PEDESTRIAN CROSSING SPEED WITH RESPECT TO GENDER

NO. OF DAYS/ DATE	TIME OF SURVEY	GENDER	AVERAGE SPEED IN (m/s)
7 DAYS (25.01.2024 TO 02.02.2024)	10:00 AM TO 11:00AM	FEMALE	0.963
		MALE	1.15

The research findings indicate that male pedestrians tend to cross at a faster average speed compared to their female counterparts. Moreover, male pedestrians exhibit a higher inclination to take risks by accelerating their crossing speed and reducing both waiting and crossing times when compared to female pedestrians.

DATA RELATED TO CROSSING PATTERN OF PEDESTRIANS WITH RESPECT TO AGE

AGE GROUP	BELOW 15	20-30	30-40	40-50	50-60	ABOVE 60
POINT AT 0	7	6.185	8.796	10.07	3.5	2.67
POINT AT 3.66	7.5	5.907	3	3.117	3	3
POINT AT 7.32	7.5	6.6	8.906	9.984	9.625	1.33
POINT AT 11	6.5	10.523	9.268	9.66	10.578	2.933

DATA RELATED TO PEDESTRIAN CROSSINGPATTERNSN WITH RESPECT TO GENDER

NO.OF DAYS/DATE	TIME OF SURVEY	GENDER	FEMALE	MALE
7 DAYS (22.01.2024 TO 29.01.2024)	9:00 AM TO 10:00 AM	POINT AT 0	6.97	9.29
		POINT AT3.66	5.74	3.015
		POINT AT 7.32	7.07	9.246
		POINT AT 11	7.72	9.558

Male pedestrians walk obliquely, but female pedestrians walk in a nearly straight pattern, as shown below.

BUILT-UP DENSITY DATA

Built-up density refers to the usable density of an area, which evolves over time and plays a crucial role in indirectly defining pedestrian volume and the significance of a location. In this context, built-up density is specifically considered for the junction rather than the entire city, as the focus is on density changes within that area.

To gather data on built-up density, land use maps were created using Google Earth software spanning two decades: 2004, 2014, and 2024. The land use map categorized areas into two classes: (a) built-up areas and (b) non-built-up areas, forming the built-up density map.

Utilizing a pedestrian walking speed of 1.2 m/s (as per IRC 1985) and assuming a 30-minute walking duration, nonlinear changes in the built-up area were calculated at the intersection within a 2 km radius between 2004 and 2014..

TITLAGARH MARKET COMPLEX (BALANGIR, ODISHA) BUILT-UP DENSITY MAP

THE YEAR 2024 (Fig.3)

STREET INFRASTRUCTURE AT TITLAGARH MARKET COMPLEX INTERSECTION

LOCATIO N NAME	PROPE R ROAD MARKI NG	SIGN BOAR DS	STREE T ROAD MARKI NG	STREE T LIGHTI NG	OPERATI ON TRAFFIC SIGNAL	ROAD INTERSEC TION	CONDITI ON OF PEDESTR IAN PATHWA Y
TITLAGARH MARKET COMPLEX	5	4	4	8	0	3	5

DEVELOPMENT OF PEDESTRIAN SAFETY INDEX (PSI) MODEL

The development of the PSI model comprised three stages. Multiple linear regression methods were employed to establish numerous linear relationships capable of evaluating the mean rating for each respondent in the field survey, which involved video-graphic data collection.

- Calibration of PSSISCORE

- Description of PedISI
- validation of the PedISI
- The multiple linear regression framework is presented in its entirety. $Y=\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots + \beta_n X_n$
- Where β_{1-n} = estimated parameter from PSI model
- β_0 = constant parameter
- X_{1-n}= independent variable / explanatory variables for PSI model Y = dependent variable

Details of ANOVA[a,b] ANOVAa,b

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	467.958	4	116.989	200.804	.000[c]
1 Residual	277.320	476	.583		
Total	745.278[d]	480			

a. Dependent Variable: SPEED
b. Linear Regression through the Origin
c. Predictors: AGE, WAITING TIME, GENDER, CROSSING TIME
d. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

Descriptive Statistics

	Mean[b]	Root Mean Square	N
SPEED	1.066434241	1.2460585764	480
WAITING TIME	4.7727	11.20331	480
CROSSING TIME	13.3180	14.59884	480
GENDER	.4542	.93541	480
AGE	2.2146	2.46179	480

a. Coefficients have been calculated through the origin.
b. The observed mean is printed

Correlationsa

	SPEED	WAITING TIME	CROSSING TIME	GENDE R	AGE
SPEED	0.980	.267	.625	.422	.776
WAITINGTIM E Std. Cross- CROSSINGTI	.267	1.000	.498	.247	.340
product ME GENDER AGE SPEED	.605	.516	1.000	.452	.700
WAITINGTIM E	.422	.247	.432	1.000	.366
Sig. (1-tailed) CROSSINGTI	.776	.340	.789	.366	1.000

ME GENDER AGE SPEED	**.**	**.000**	**.000**	**.000**	**.000**
WAITING TIME N CROSSING	**.000**	**.**	**.000**	**.000**	**.000**
TIME GENDER AGE	**.000**	**.000**	**.**	**.000**	**.000**
	.000	**.000**	**.000**	**.**	**.000**
	.000	**.000**	**.000**	**.000**	**.**
	480	**480**	**398**	**480**	**480**
	480	**480**	**480**	**480**	**480**
	480	**480**	**480**	**480**	**480**
	480	**480**	**480**	**480**	**480**
	480	**480**	**480**	**480**	**480**

RESULT AND DISCUSSION

PEDESTRIAN CROSSING BEHAVIOUR ANALYSIS AND TABULATION

Few studies have comprehensively examined pedestrian crossing behavior at both signalized and unsignalized intersections amidst mixed traffic conditions. Drawing from field-observed data, this research endeavors to analyze various aspects of pedestrian crossing behavior. These include crossing speed, potential non-compliance behaviors exhibited by pedestrians, waiting times, types of approaching vehicles, and the dynamics of pedestrian-vehicle interactions at crosswalks.

PEDESTRIAN CROSSING SPEED

At unsignalized junctions, the analysis zeroes in on variations in pedestrian crossing speeds and the factors influencing them. The study involved 480 pedestrians, with the observed average crossing speed ranging between 1 and 1.2 meters per second. Field observations in China, a densely populated area, recorded an average crossing speed of 1.2 m/s, aligning with a field value of 1.24 m/s reported in previous literature (Li et al., 2005).

The crossing speed variation, calculated as the difference between the 85th and 15th percentile speeds (0.078 for the chosen location in Balangir), serves as a crucial metric. An ANOVA test was conducted to explore the primary factors impacting pedestrian crossing speed at unsignalized junctions, employing SPSS 16 software. Based on insights gathered from existing literature, parameters such as gender, age group, crossing time, waiting time, and crossing speed were all evaluated in the ANOVA test.

MODEL ANALYSIS FOR PEDESTRIAN SAFETY INDEX

In the realm of transportation engineering, a variety of deterministic and stochastic models have historically been developed to tackle complex problems. However, assessing qualitative data, such as user reaction scores to gauge safety or service levels of current facilities, presents a challenge due to its inherent difficulty to quantify.

Linear regression emerges as a method for modeling dependent variables with one or more independent variables to predict or forecast outcomes, while also quantifying the strength of these variables. Traditional linear regression methods have been widely utilized by researchers to establish ordered data, such as pedestrian and bicycle service levels.

Utilizing SPSS Software, a regression model was constructed, with significant values from ANOVA and Pearson's coefficient serving as dependent factors, and other factors as independent parameters.

For instance, in modeling an unsignalized intersection, crossing speed is considered a dependent parameter, while crossing time, waiting time, gender, and age are independent parameters. Linear regression is favored due to its simplicity and widespread use, making it accessible and practical for field applications.

Coefficients a,b

Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
WAITINGTIME	**.001**	**.004**	**.007**	**.213**	**.831**
CROSSING TIME	**-.009**	**.004**	**-.102**	**-1.965**	**.050**
GENDER	**.236**	**.042**	**.177**	**5.656**	**.000**
AGE	**.400**	**.023**	**.790**	**17.202**	**.000**

a. Dependent Variable: SPEED
b. Linear Regression through the Origin

The β value for the factor selected is shown in column B of the preceding table, and the equationcan be plotted using these values.

PSI model equation $Y=\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots + \beta_n X_n$

Where β_{1-n} = estimated parameter from PSI model

β_0 = constant parameter

X1-n= independent variable / explanatory variables for PSI model Y = dependent variable

To ensure that the equation formed from these data sets was valid, pedestrian safety ratings were assigned to this site.

[Y= 0.001(X1)-0.009(X2) +0.236(X3) +0.400(X4)]

Y=speed

X1 = waiting time X2 =crossing time X3 =gender

X4 =age

CALIBRATION AND VALIDATION OF PSSISCORE MODEL

CALIBRATION OF PSSISCORE

The equation for the pedestrian safety score index model is expressed in the following mathematical expression: -

PSSISCORE = β0+β1(APV)+ β2(PCWS)+β3(CWM)+β4(CWL)

Where,

PSSISCORE = Pedestrian safety score index through video graphic survey (rating 1 to 5) and where the corresponding ratings define the following values

1= Highly safe (excellent) 2- safe(normal)

3= average

4 = risk (danger)

5- high Risk (high danger)

PSSISCORE VARIABLES

Variables	Description	Value for Study
APV	**Average pedestrian volume (i.e., pedestrian/hour)**	**68.57**
PCWS	**Pedestrian cross walking speed (in meter/second)**	**1.08 m/sec**
CWM	**Crosswalk Marking (Values vary where 0 represents the absence of pedestrian crosswalk marking and 1 represents the presence of pedestrian crosswalk marking)**	**0**
CWL	**Crosswalk Length (meter)**	**10 meters**

Details of Multiple linear regression

Parameters	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	Model coefficients	Std. Error	Beta		
Constant	**0**	**0**	**0**	**0**	**0**
APV	**.001**	**.004**	**.007**	**.213**	**.831**
PCWS	**-.009**	**.004**	**-.102**	**-1.965**	**.050**
CWM	**.236**	**.042**	**.177**	**5.656**	**.000**
CWL	**.400**	**.023**	**.790**	**17.202**	**.000**

PSSISCORE = 0+ 0.001(APV) – 0.009(PCWS) + 0.236(CWM) + 0.400(CWL) PSSISCORE = 0+ 0.001(68.57) – 0.009(1.08) + 0.236(0) + 0.400(10)
PSSISCORE = 4.059

Description for Pedestrian Safety Index Model (Ped ISI)

The PED ISI model consists of one equation that determines the safety index score for a single pedestrian crossing.
The Ped ISI Score is calculated using the following equation
Ped ISI = 2.372 – 1.867SIGNAL – 1.807STOP +0.335THRULNS +0.018SPEED+ 0.006(MAINDT*SIGNAL) + 0.238COMM

Ped ISI Variables

Ped ISI	Descriptions	Safety index value (pedestrian)
SIGNAL	**Signal-controlled crossing**	**0 = no** **1 = yes**
STOP	**Stop-sign controlled crossing**	**0 = no** **1 = yes**
THRULNS	**Number of through lanes on the street being crossed (both directions)**	**1, 2, 3, …**
SPEED	**Eighty-fifth percentile speed of street being crossed**	**Speed in Km per hour**
MAINADT	**Main street traffic volume**	**ADT in thousands**
COMM	**Predominant land use on the surrounding area is commercial development (i.e., retail, restaurants)**	**0 = not predominantly commercial area** **1 = predominantly commercial area**

Validation Pedestrian Safety Index Score at Titlagarh Market

TABLE 4.15.4
Ped ISI Scores at Titlagarh Market

Ped ISI	Safety index value (pedestrian)
SIGNAL	**0**
STOP	**0**
THRULNS	**3**
SPEED	**6**
MAINADT	**1646**
COMM	**1**

Ped ISI = 2.372 – 1.867S*0– 1.807*0 +0.335*3 +0.018*6+ 0.006(1646*0) + 0.238*1
Ped ISI Titlgarh Market = 3.723
Using the pedestrian safety score index & safety index Model, the safety level rating for Burla Market is derived at Risk.

Residuals Statisticsa,b

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	**.062417805**	**3.276979923**	**.879888712**	**.4484715139**	**480**
Residual	**-2.4912655354**	**3.4565839767**	**.1865455294**	**.7376207840**	**480**
Std. Predicted Value	**-1.823**	**5.345**	**.000**	**1.000**	**480**
Std. Residual	**-3.264**	**4.529**	**.244**	**.966**	**480**

a. Dependent Variable: SPEED

b. Linear Regression through the Origin

Coefficient Correlationsa,b

Model			AGE	WAITING TIME	GENDER	CROSSING TIME
1	**Correlations**	**AGE**	**1.000**	**.127**	**-.020**	**-.732**
		WAITING TIME	**.127**	**1.000**	**-.021**	**-.409**
		GENDER	**-.020**	**-.021**	**1.000**	**-.252**
		CROSSING TIME	**-.732** **.001 1.084E-005**	**-.409 1.084E-005** **1.340E-005**	**-.252**	**1.000**
	Covariances	**AGE**	**-1.937E-005**	**-3.203E-006**	**-1.937E-005**	**-7.558E-005**
		WAITING TIME	**-7.558E-005**	**-6.656E-006**	**-3.203E-006**	**-6.656E-006** **-4.671E-005 1.974E-005**
		GENDER			**.002** **-4.671E-005**	
		CROSSING TIME				

a. Dependent Variable: SPEED

b. Linear Regression through the Origin

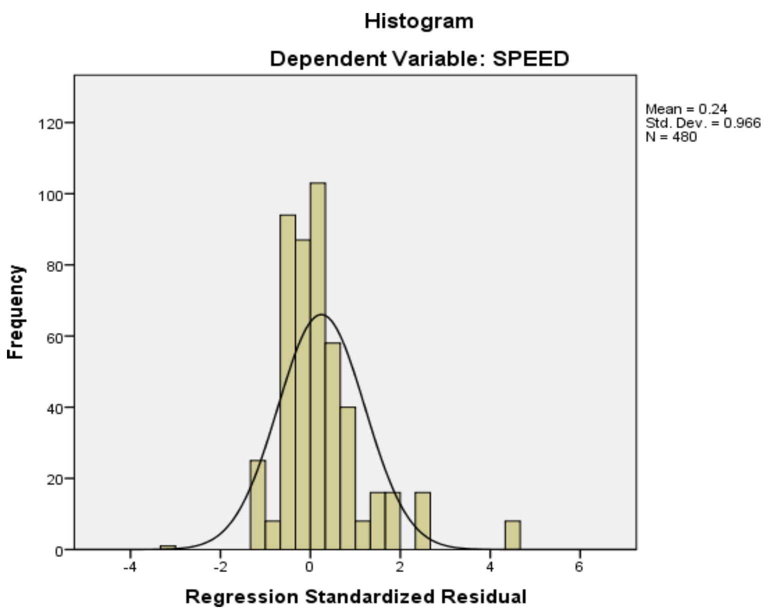
Histogram
Dependent Variable: SPEED
Mean = 0.24
Std. Dev. = 0.966
N = 480
Frequency
0
20
40
60
80
100
120
-4
-2
0
2
4
6
Regression Standardized Residual

Fig. 4

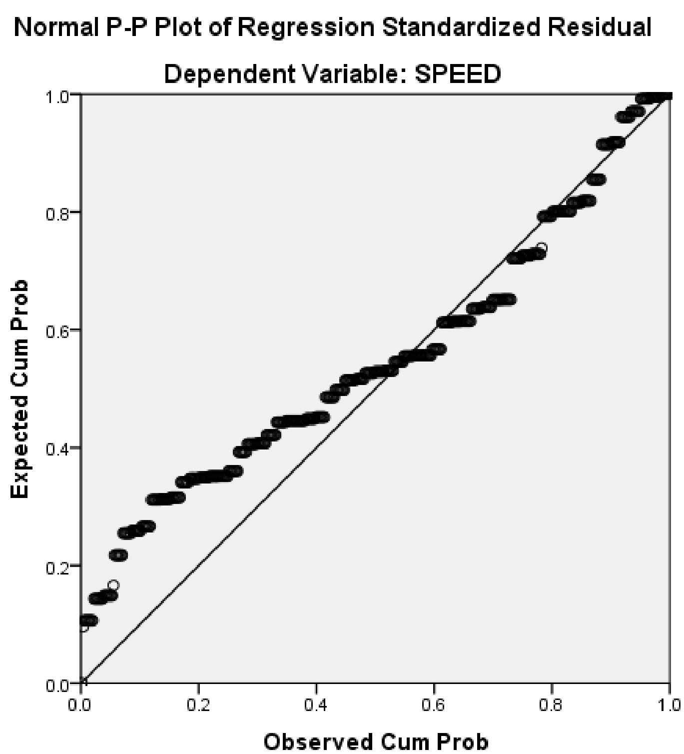
Normal P-P Plot of Regression Standardized Residual
Dependent Variable: SPEED
Expected Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob

Fig .5

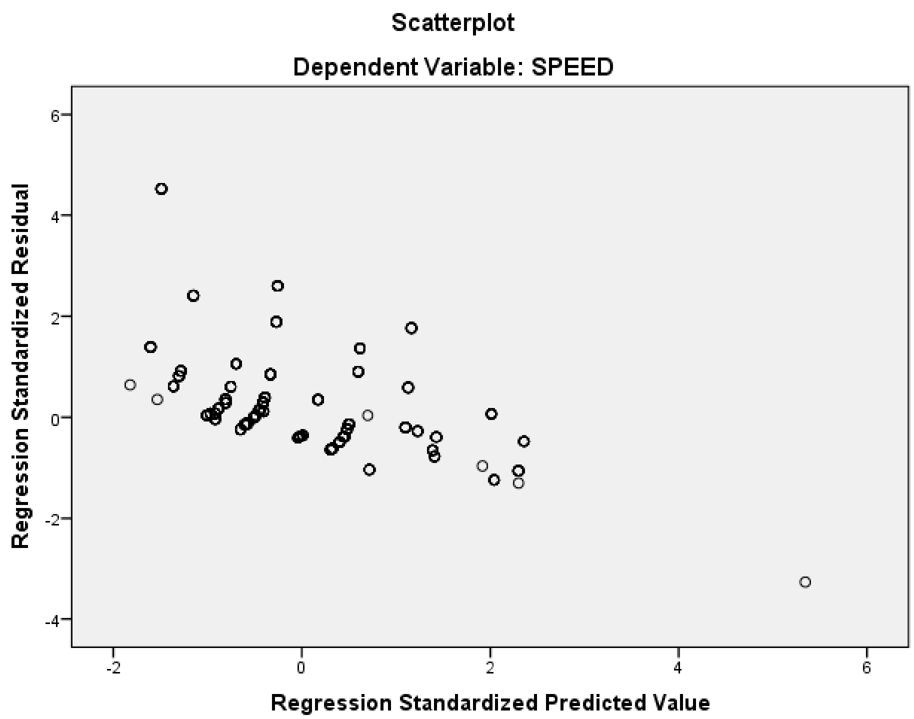

Fig .6

FOR TITLAGARH MARKET COMPLEX BALANGIR

Using SPSS 16.0 software and employing linear regression analysis with a 95% confidence interval, the results revealed an adjusted R^2 value of 0.628. This suggests that the explanatory variables explain approximately 62.8% of the variation in the predicted dependent variable. Hence, the proposed model demonstrates a reasonably accurate prediction level..

CONCLUSIONS

This study delves into pedestrian crossing behaviors at intersections using data gathered from camera observations. It identifies various factors influencing how pedestrians cross roads, notably noting that male pedestrians tend to walk faster than females. Gender, age, and the sense of urgency also impact pedestrians' crossing speeds. Interestingly, despite pedestrians committing more traffic violations, they tend to be less attentive to road safety.

Employing a linear regression model, the study effectively models pedestrian behavior, emphasizing the importance of such analysis in ensuring pedestrian safety at crosswalks. Additionally, it suggests that pedestrian waiting times could indicate the need for safety measures at specific junctions.

In developing countries like India, where numerous variables affect pedestrian safety decisions, comprehensive models like PSSI and PedISI prove invaluable. The successful application of these models at the Titlagarh market intersection underscores their utility. Such models can be applied universally to urban intersections by identifying the variables perceived by pedestrians that affect their safety, thus aiding in the improvement of pedestrian behavior and safety measures in areas with mixed traffic conditions

MAJOR FINDINGS

The following conclusion can be reached based on the work completed:

- Pedestrian crossing behavior varies among individuals, with factors beyond gender playing a significant role.
- Similarly, the speed of pedestrian crossings is influenced by both age group and gender.
- Pedestrian compliance is affected by factors such as vehicle direction and pedestrian movement.
- Changes in built-up areas occur gradually over time, thereby exerting a relatively minor impact on pedestrian safety at intersections.
- While crash data can provide valuable insights, pedestrian-vehicle accident data may be limited due to pedestrians avoiding walking amidst increasing vehicular traffic.
- Analysis of pedestrian crossing behavior could offer valuable insights for traffic and urban planners involved in intersection construction.

FUTURE SCOPE

- An appropriate model could be formulated with enhanced data quality and a refined study site.
- By ensuring precise availability of crash and infrastructure data, a highly accurate index could be developed.
- This could involve comparing pedestrian safety perception with actual safety performance, utilizing surrogate safety measures to enhance overall pedestrian safety at unsignalized crossings..

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