The safety of pedestrian roads in connection with the type of urban roads and traffic patterns.

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Abstract
The analysis of the connection between traffic flow for motor cars, urban roads type, and pedestrian road safety. We have studied six different kinds of urban streets in Jharkhand. For every road section of the streets under examination, we gathered information on the flow of pedestrian traffic and whether or not they were walking legally. Additionally, we gathered information on the flow of traffic for drivers in the same road segments of the streets inside the research area. When those statistics are combined with each road's administrative ranking, it is possible to determine the walk ability level of a street or a particular route under study as well as the mobility and safety concerns of pedestrians. This study confirms that different road types have different walking habits. Local streets had the lowest rate of law-abiding pedestrians, while major thoroughfares had the highest rate [1]. The low volume of motorized traffic combined with challenges with pedestrian infrastructure mobility and maintenance encourages people to walk on the street, which understates their safety concerns. Promoting pedestrian mobility with a focus on safety issues can improve the quality of life for local residents, raise an urban area's sustainability index, and shift the modal split in favor of vulnerable road users.

Keywords: Pedestrian, Safety, Accident, Sustainability, Urban.

1. Introduction: A high number of pedestrian fatalities in India are caused by inadequate infrastructure, such as sidewalks and pedestrian crossings, as well as lax traffic enforcement. Some important strategies to increase pedestrian safety include: always using designated crosswalks, walking on the sidewalk when possible, crossing roads only when there is a safe gap in traffic, being aware of turning vehicles, and dressing reflectively at night to be visible to drivers. To stay safe from traffic hazards, pedestrians should develop the practice of using road infrastructure appropriately. To cross the road, use foot over bridges, zebra crossings, or subways. Paying attention is the most crucial safety strategy to lower pedestrian fatalities and injuries. Following traffic laws can greatly lower your risk of getting involved in an accident with a motor vehicle. If at all possible, look drivers in the eye and make sure they can see you.

Everyone is a pedestrian at some point during the day. Sadly, there are still a lot of pedestrian fatalities and injuries. In 2023, 8,421 pedestrians were killed and more than 69,000 pedestrians were injured nationwide. Government raises awareness of the dangers to pedestrians and provides tips to keep pedestrians safe.

2. Literature review

In order to comprehend the peculiarities of pedestrians in mixed traffic situations, Oeding (1963) carried out a study. Older (1968) illustrates the walking habits of British consumers. Even though walkers move more slowly than cars, the flow diagrams for pedestrians and cars are similar in appearance. According to Moral (1991), pedestrian speeds in Asian nations are substantially slower than those in Western nations. When pedestrians encounter heavy or fast motorized traffic, they are exposed to a heightened risk level, making them vulnerable road users. Research on the severity of pedestrian accidents is extensive globally. The most frequent elements that affect pedestrian accidents are the kind of vehicle, age and gender, and alcohol consumption. To examine the impact of contributing factors on the likelihood of death and serious injury, Sze and Wong (2007) used logistic regression. Pedestrians under the age of 19 and those over 60 are more likely than other age groups to be involved in fatal pedestrian-vehicle collisions (Al-Ghamdi, 2002). The following factors have a major impact on the severity of pedestrian injuries: vehicle type; the presence of alcohol by drivers or pedestrians; and age (over 65) (Zajac and Ivan, 2003). Elderly people are more susceptible, accidents at signalized junctions are less serious, injuries are more severe in the dark, and speed limits increase the severity of injuries (Eluru et al., 2008). The severity of pedestrian-vehicle collisions is also influenced by environmental and personal factors. Urban design should take environmental circumstances into account and conduct a more thorough analysis of them (Clifton et al., 2009) [2]. The level of road safety can be raised by walking in a group and by having a high volume of pedestrian traffic on the roadway. According to Jacobsen (2003), doubling the number of pedestrians reduces traffic crashes that cause injuries by 32%. This can be explained by the fact that drivers modify their driving habits when they are aware of pedestrians. Increased vehicle speeds raise the risk of a pedestrian being hit by a car and the seriousness of the injuries sustained (Rosen and Sander, 2009). The majority of pedestrian fatalities happen at night, in metropolitan areas, and outside of intersections (NHTSA, 2015). In the United States, 4,735 pedestrians lost their lives in road accidents in 2013. This equates to one pedestrian fatality from a collision every two hours on average (NHTSA, 2015). Furthermore, in 2013, over 150.000 pedestrians received treatment in emergency rooms for injuries sustained in non-fatal collisions (CDC, 2015). According to Beck et al. (2007), pedestrians had a 1.5-fold higher risk of dying in an automobile accident on each journey than passengers in passenger vehicles. 5,712 pedestrians, or 22% of all fatalities, were killed in traffic accidents in the EU in 2013. Pedestrian fatalities decreased by 37% in the European Union during the past ten years, while overall fatalities decreased by nearly 45% (ERSO, 2015). People

want to live in a place where they can stroll around conveniently and safely. Road and personal safety, convenience, proximity to destinations, multimodal transit, and improved health are just a few advantages that residents of walkable cities enjoy. Although there is no universally accepted definition of walkability, it can be defined as the degree to which the urban road environment is suitable for pedestrians (Lund, 2003; Southworth,1997; Saelens et al., 2003).

3. Methodology

i. Pedestrian Traffic Flow: This describes how pedestrians move through a specific location and is impacted by things like walking speed, density, and the existence of impediments. Designing safe and effective pedestrian infrastructure requires an understanding of pedestrian traffic.

ii. Walking Behavior: This relates to the behaviors and patterns that pedestrians display when they are on the move, such as their reaction to environmental signals, group dynamics, and compliance with traffic laws. The safety of pedestrians and the general effectiveness of pedestrian infrastructure are greatly impacted by walking behavior.

iii. Motorized Traffic Flow: Metrics like speed, density, and traffic volume define this, which involves the movement of automobiles. Road capacity evaluation, congestion point identification, and traffic management strategy improvement are all aided by motorized traffic flow analysis.

By examining these factors, we want to obtain a thorough grasp of how cars and pedestrians interact, which is crucial for improving traffic control and road safety.

3.1. MAJOR PROBLEMS IDENTIFIED FROM FIELD SURVEY

A number of problems have been identified from the field investigation in study area regarding the pedestrians' convenience. Some of them are:

3.1.1. Ineffective Pedestrian Crossing Control Devices: According to field research, pedestrian traffic signals are present at 61% of signalized junctions in the DMP region (at least at one approach to the intersections). However, their use is ineffective. Consequently, pedestrians cross intersections at random. Once more, there are crosswalk markings at about 28% of signalized intersections. However, they lack advance crossing signs. With faded markings, the majority of the crosswalks are zebra crossings. As a result, the crossing marks are invisible to drivers at a distance.

3.1.2. Vehicles Occupied Crosswalks: Additionally, field research demonstrates that cars do not stop at intersections past the stop line. They try to occupy the crosswalks and travel as far as they can in the intersections' leg. The pedestrian's ability to cross the street is impeded by this circumstance.

3.1.3 Manual Operation of Intersections: The traffic police in Jharkhand manually run the majority of the signal-controlled crossings. Consequently, cars that arrive late frequently try to avoid the police and speed through intersections. This mindset raises the probability of pedestrian fatalities at junctions.

3.1.4. Raised Crosswalks at Exits: Despite the fact that raised crosswalks ought to be placed at intersection approaches, certain crossings (like Shahbag) have them placed at the exits. They are not functioning efficiently as a result of their failure to meet installation requirements.

3.1.5. Lack of Authorized Bus Stops: Because there aren't enough approved bus stations in Jharkhand , most buses stop close to intersections. Consequently, pedestrians are put in greater danger at junctions due to rivalry among automobiles for pedestrian loading and unloading.

3.1.6. Competition among Drivers: There is a greater chance of accidents due to chaotic intersection crossings caused by rushing and competitiveness among pedestrians to reach the bus.

3.1.7. Teenager's Unconsciousness: Teenagers in particular are known to cross streets while wearing headphones.

3.1.8. Illegally Occupied Footpath: Hawkers, little tea stalls, and other vendors unlawfully occupied the sidewalks and footpaths close to the crossroads, forcing people to cross the carriageway and putting them in danger from cars. Consequently, the likelihood of accidents rises[3].

3.1.9. Lack of Uses of Overpass: A few crossings in Jharkhand, such as the Science Laboratory intersection, feature overpass facilities. However, in the majority of situations, they are inhabited by hawkers and do not draw people. Consequently, there are major safety risks when pedestrians cross the road.

3.1.10 Illegal On-street Parking: On-street parking close to crossings and illegal parking on sidewalks make it difficult for pedestrians to observe cars when crossing the street. They also encourage pedestrians to cross the street, exposing them to cars.

3.1.11. Garbage Stock: Pedestrians are forced to cross the carriageway of the roadways when trash or an open dustbin is thrown near junctions, increasing their risk.

3.1.12. Poor Construction Materials: During the rainy season (monsoon), the use of subpar construction materials frequently results in muddy conditions and water logging on the sidewalks, which discourages people from utilizing the sidewalks and instead encourages them to use the carriageways.

3.1.13. Absent of Footpath Barrier: In regions with heavy pedestrian activity, such as Farmgate crossroads, and close to intersections, there are typically barriers to pathways. However, this feature is absent from a significant section of the walkway. Consequently, the efficacy of the walkways close to the junctions is significantly diminished.

3.1.14 Drivers' Perceptions: The results of the survey indicate that the majority of drivers do not wish to assume responsibility for pedestrian injuries. bad traffic control, bad traffic management, and haphazard pedestrian crossings from any part of the roads at intersections are the things they blame. Another factor that drivers acknowledge as contributing to these fatalities is the failure to use crosswalks. They rarely acknowledge, however, that speeding is a major contributing factor in the incidents.

3.1.15 Pedestrians' Perceptions: Pedestrians, on the other hand, state that the primary cause of accidents is vehicles traveling too fast. Once more, unlawful vendors on sidewalks and in on-street parking force people to utilize carriages, which raises the risk of collisions. Fading crosswalk markings, inadequate flyover facilities, and poor pedestrian traffic signal management are also recognized as contributing factors to the accidents.

3.3.1 Design and Layout of Pathways

Wide vs. Narrow Paths: Narrow places can cause congestion, but wider walkways facilitate smoother mobility.

Intersection Design: Signage, signals, and pedestrian crossings are essential for preserving flow where paths converge.

Space Segmentation: Accidents and confusion can be avoided in places where walking zones are clearly marked off (e.g., sidewalks vs. roadways).

Density and Volume of Pedestrians

City centers and other high-density locations need to pay close attention to managing pedestrian movement in order to avoid bottlenecks. Temporary infrastructure or crowd control techniques may be necessary for events like concerts or protests that result in an increase in foot traffic.

3.4.1 Pedestrian Behavior

Walking speed: People usually walk at varying rates, and slower pedestrians have a propensity to gather in particular spots, which slows down traffic flow.

Group walking: Groups of people can impede traffic, particularly on small roads.

Environmental Factors: Rain or snow can have an impact on how swiftly and comfortably people can move.

3.5.1 Technological Solutions

Smart Traffic Systems: Some cities allow for more efficient movement by synchronizing pedestrian signals and traffic lights with real-time traffic flow data.

Data Analytics: Through the analysis of pedestrian movement data (from sensors or cameras, for example), city planners can pinpoint possible areas of congestion and implement solutions.

3.6.1 Safety Considerations

It's crucial to make sure that pedestrian walkways are clear of obstructions, such as shoddy building materials or incorrectly parked vehicles. Particularly in locations with heavy traffic, pedestrian safety can be maintained by installing features like elevated crosswalks, pedestrian bridges, or underpasses. Would you like to go into further depth about any one of the specific ways to improve pedestrian traffic flow? The patterns and traits of how people move on foot in different situations are referred to as pedestrian walking behavior. Numerous elements, including as personal traits, the environment, and societal or cultural influences, all have an impact on this behavior.

3.7.1 Speed and Walking Patterns:

Average Walking Speed: Pedestrians typically move between 1.2 and 1.4 meters per second, or 4 and 5 feet per second. Depending on variables including age, health, and surroundings, this can change.

Walking Styles: People can walk in a variety of ways, such as briskly, leisurely, or aimlessly. The pedestrian's destination, time constraints, or mood can all influence the style and speed.

3.8.1 Personal Characteristics:

Age: In general, older persons move more slowly than younger ones. Youngsters also walk at a distinct tempo, which may be more irregular or slower.

Physical Condition: A person's walking pace and endurance might be influenced by their level of fitness.

Disabilities: Individuals with mobility problems may require assistive devices such as walkers or wheelchairs, or they may walk more slowly.

3.9.1 Social and Group Behavior:

Group Walking: Due to the coordination needed, pedestrians may form a line or cluster when walking in groups, which frequently results in slower movement. Social elements like connection and conversation can also influence how they move.

Pedestrian Interactions: To prevent collisions with other people, pedestrians may alter their walking route, slow down, or accelerate in busy areas. They frequently convey their intentions through body language or eye contact.

3.10.1 Environmental Factors:

Infrastructure: The way pedestrian areas, such sidewalks, crossings, or pathways, are designed has a big impact on how people travel. While pedestrians may move more slowly on narrow or badly built walkways, wide, clear paths promote speedier travel.

Weather: Rain, snow, and intense heat are examples of weather conditions that can impact walking comfort and pace.

Urban vs. Rural Settings: People may walk more slowly and deliberately in urban locations with more traffic, but they may walk more leisurely and slowly in rural areas.

3.11.1 Cognitive Factors:

Attention: The actual surroundings, their mobile gadgets (such as texting or utilizing maps), and other activities like socializing or shopping frequently receive different amounts of the attention of pedestrians. Distractions might cause risky behavior or slow down walking.

Way finding: In order to find their way around, pedestrians usually rely on signs, landmarks, or their local knowledge. On the other hand, walking more slowly and cautiously could be the result of unfamiliar surroundings.

3.12.1 Safety and Risk Behavior:

Crosswalk Usage: For safety, pedestrians typically use designated crosswalks and crossings. However, depending on their sense of urgency or safety, individuals occasionally may take shortcuts or jaywalk.

Awareness of Surroundings: Safety concerns cause pedestrians to alter their behavior, such as avoiding busy locations, keeping an eye out for cars, or crossing at slower times.

3.12.1 Pedestrian Flow in Crowded Spaces:

Density and Flow: People tend to follow the lead of others and move in a smooth, flowing manner in crowded areas like malls, transportation stations, and busy streets. The crowd's density can influence this movement; slower walkers tend to be passed by faster ones, resulting in a natural flow pattern.

Congestion: Congestion can result in slower walking speeds, delays caused by the congestion, or even jams when the density reaches a specific threshold, particularly in small areas.

3.12.2 Cultural Influences:

Walking Etiquette: There are various cultural standards about pedestrian behavior, such as which side of the sidewalk one should use or when one should stop for another.

Walking and Transportation Systems: Walking to train or bus stations is one example of a pattern that may influence pedestrian behavior in cities with robust public transportation systems. In contrast, the reliance on cars in rural regions may make walking less necessary. Urban planning, transit design, and public safety all benefit from an understanding of pedestrian walking behavior since it makes walking environments safer, more effective, and more enjoyable. The term "motorized traffic flow" describes how automobiles, trucks, buses, and motorcyclists go along roads and highways. It deals with the safe and effective flow of these cars, making sure that traffic is controlled and that there are as little delays, accidents, or congestion as possible.

3.12.3 Key factors that affect motorized traffic flow include:

Road design: Traffic flow is significantly influenced by the design and construction of roadways, including the number of lanes, intersections, and road conditions.

Traffic signals and signs: Traffic control devices, like stoplights, yield signs, and speed limits, are used to regulate the flow of vehicles and prevent accidents.

Traffic density: The number of vehicles on the road at any given time influences how easily traffic can move. High density leads to congestion, while low density typically allows smoother flow.

Vehicle types: The types of vehicles on the road (e.g., light cars vs. heavy trucks) can affect traffic flow, as heavier vehicles might slow down or take up more space.

Driving behavior: The actions of individual drivers, such as speeding, lane changes, and aggressive driving, can influence the overall flow of traffic.

Traffic management systems: Advanced systems like adaptive traffic signals, road sensors, and real-time traffic monitoring can help optimize the flow and reduce bottlenecks.

External factors: Weather conditions, accidents, roadwork, and special events can all disrupt traffic flow. Efficient motorized traffic flow is essential for reducing travel time, improving safety, and enhancing the overall experience of commuting.

4. Research area

Given the high number of traffic accidents in Jharkhand, pedestrian safety is an urgent issue. Jharkhand saw 5,175 traffic incidents in 2022, which led to 3,898 fatalities and 3,747 injuries. This represents a 9.5% increase in accidents over 2021. Pedestrians are especially at risk, accounting for 19.5% of all fatalities in traffic accidents in the country[4]. Although there is little precise data on pedestrian accidents in Jharkhand, reports from nearby states such as Odisha indicate that two-wheelers account for 31.8% of pedestrian fatalities, with trucks and lorries coming in second at 21.4%.

To address these challenges, Jharkhand has initiated several road safety measures:

Bokaro District Initiatives: Bokaro's District Level Road Safety Committee has started a number of comprehensive initiatives, such as clearing up encroachments, enforcing parking laws, and fixing areas that are prone to accidents. The goal of these initiatives is to improve traffic flow and road safety.

Awareness Campaigns: To encourage safe driving habits, the District Commissioner of Jamshedpur has launched a road safety awareness vehicle. The program involves putting up road safety signboards, handing out posters, and stressing the importance of wearing seat belts and helmets. It also emphasizes preventing underage driving, excessive speeding, and drunk driving. The Jharkhand Police advise pedestrians to safely cross roadways by using the available traffic infrastructure, such as foot over bridges, zebra crossings, and subways. The likelihood of accidents can be considerably decreased by developing the habit of using these facilities. Notwithstanding these initiatives, the ongoing increase in traffic accidents emphasizes the necessity of ongoing and improved road safety protocols. Improving pedestrian safety in Jharkhand requires persistent efforts, increased public awareness, and rigorous enforcement of traffic laws.

Overall Road Accident Statistics in Jharkhand: About 5,175 traffic incidents were reported in Jharkhand in 2022, with 3,898 people killed and 3,747 injured. The most common cause of these collisions was found to be excessive speeding, with two-wheelers playing a major role.

Pedestrian-Involved Accident Data: In accidents where pedestrians were victims, two-wheelers caused the greatest casualties, accounting for 23.19% of such instances. Trucks and lorries followed closely, contributing to 22.18% of pedestrian casualties. According to specific statistics, two-wheelers were responsible for 115 pedestrian fatalities, and trucks and lorries were responsible for 110. In addition, 61 pedestrians were hurt and 83 pedestrians died in the Ranchi district in 2022 after being hit by cars. **Contributing Factors:** Over speeding, drunk driving, driver distraction, red light jumping, and disregard for safety precautions like seat belts and helmets are common behaviors that result in accidents. These figures highlight how urgently Jharkhand has to improve pedestrian safety measures and enforce traffic laws more strictly. the

movement of bikers and motorized vehicles (private cars, buses, trucks, and power two vehicles) in each road section across the street for the same 15-minute period. Passenger Car Units (PCU) were used to determine the traffic flow based on the kind of vehicle (private vehicle = 1.00, bus = 3, truck = 3, power two vehicle = 0.5, bicycle = 1.5).

5. Result and Analysis

Table-1 Detail of Pedestrians walking

Particular/Location	Birsa Chowk	Sect.4	Chas
Pedestrians walking on the sidewalk	89.60%	91.50%	80.70%
Pedestrians walking in the street for a short/entire length	3.50%	2.40%	8.10%
Pedestrians crossing the street outside designated crosswalks	6.90%	6.10%	11.20%

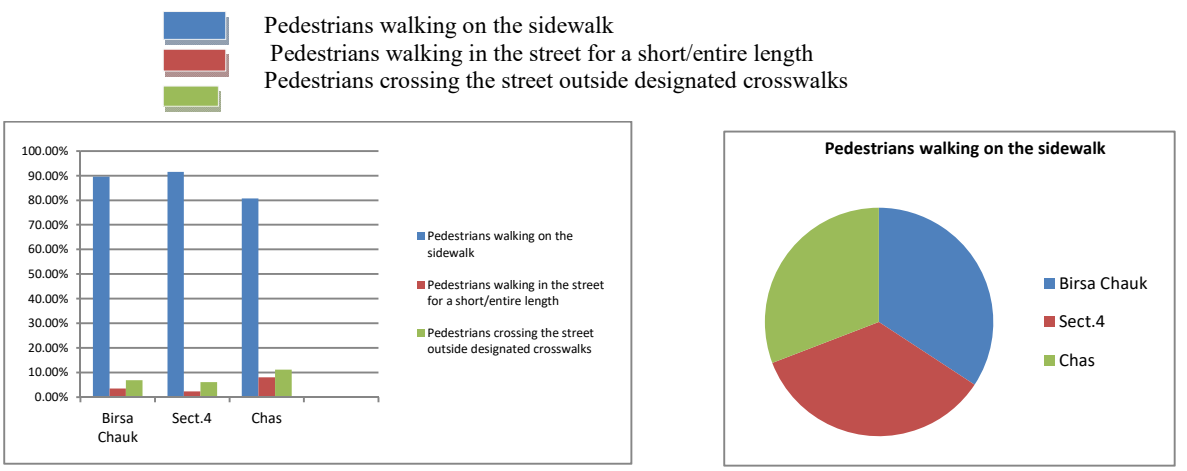

Figure 1. Pedestrian walking behavior

Table 2. Motorized traffic flow (road segments, duration 15min).

Street	Birsa Chauk	Sect.4	Chas	Birsa Chauk	Sect.4	Chas
Duration 15min	Mean value (Side A, B)			Passenger Car Units (Side A, B)		
Private vehicle	110.1	80.2	96.2	110.1	80.2	96.2
Bus	7.1	7.8	0	21.3	23.4	0
Truck	0.2	0.1	0.1	0.6	0.3	0.3
Power two vehicle	10.8	37.5	32	5.4	18.75	16
Bicycle	7	6.3	10.5	10.5	9.45	15.75
Traffic flow (PCU)				147.9	132.1	128.25

Table 3. Pedestrian flow for 30 minute duration

Location	Pedestrian flow (side A+B)
Birsa Chowk	122.4
Sect.4	98
Chas	112.2

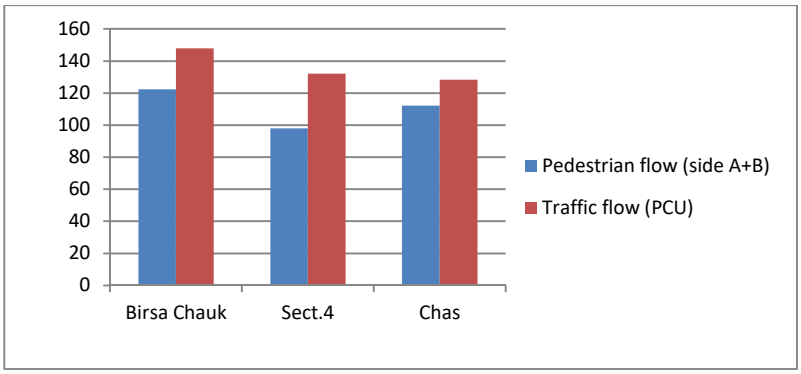

Figure 3. Pedestrian and motorized traffic flow (in PCU).

6. Conclusion: To enhance pedestrian safety on urban roads, several strategies can be implemented such as Infrastructure Improvement, Traffic Calming Measures, and Community Engagement etc. The kind of urban roadways and traffic patterns have a big impact on how safe pedestrian roads are used. Road design, traffic volume, speed limits, and pedestrian infrastructure—such as crosswalks, signals, and pedestrian zones—all have a significant impact on safety, it is for pedestrians. While roads with adequate pedestrian amenities and well-balanced traffic flow improve safety results, high-traffic roads with fast-moving automobiles increase the chance of accidents. Additionally, pedestrian safety in urban settings can be improved by traffic calming techniques including speed bumps, reduced lanes, and improved enforcement of traffic regulations. In order to safeguard vulnerable road users and promote walking as a sustainable form of transportation, future urban design should place a high priority on developing pedestrian-friendly roads by including safety measures, lowering vehicle speeds, and encouraging effective traffic management. [5]

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