USER PERCEPTIONS BASED LEVEL OF SERVICE FOR UNCONTROLLED MID-BLOCK CROSSINGS USING TRAFFIC SURVEYS AND ITS REGRESSION ANALYSIS

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Abstract : *The exponential growth of urban populations has led to a substantial increase in traffic on urban roads, prompting extensive research into optimizing road networks for vehicular traffic. However, there has been a noticeable lack of attention given to the safety and well-being of pedestrians. One particularly perilous scenario for pedestrians occurs at mid-block crossing locations where well-designed crosswalks are absent. In such areas, pedestrians are forced to identify safe crossing points, often with limited safety measures in place. Ensuring the safety, convenience, comfort, and minimal delay for pedestrians in these situations is imperative. To address this gap, a comprehensive evaluation of the quality of service at mid-block crosswalks is necessary. This research study focused on assessing the quality of service at non-signalized mid-block pedestrian crossings from the perspective of consumers. The analysis employed regression techniques and gathered data from four distinct mid-block crossing locations in different areas of Visakhapatnam. Data collection involved video image surveillance to obtain data on pedestrian quantities, volume-based characteristics, walking speeds, capacity, and gap sizes, complemented by questionnaires to capture real-time experiences and opinions of pedestrians. The questionnaire encompassed various variables affecting crossing quality, including demographic information and pedestrian perceptions of safety and comfort. Pedestrians rated these attributes on a scale of one to six, with their scores serving as variables for subsequent analysis. This approach seeks to ensure that pedestrians have the safest, most comfortable, and efficient means to cross the street while minimizing potential delays.*

Keywords:*Pedestrian safety,Mid-block crossing,Quality of service,Urban road traffic,Crosswalk design, Consumer perspective,Data collection, ,Questionnaires,Perception,Safety measures,Comfort, Demographic information,,Efficiency,Delay mitigation,Regression analysis,Vehicular traffic optimization,Urbanization impact.*

I. INTRODUCTION

India's rapidly expanding population is increasingly participating in diverse economic activities, primarily in urban centers, leading to a substantial surge in the demand for urban transportation. To cater to these mounting demands, a wide range of transportation methods, including bicycles, scooters, public transit, and automobiles, are being employed.However, the rapid proliferation of vehicles, coupled with limited road infrastructure in India, especially in urban areas, presents a significant challenge. Mixed traffic in India encompasses a broad spectrum of motorized vehicles, including motorcycles, scooters, cars, buses, auto rickshaws, light and heavy vehicles like trucks and tractors. Non-motorized vehicles like bicycles and cycle rickshaws are also part of this mix, varying in size and characteristics.Unlike organized traffic systems found in developed nations, vehicles within mixed traffic flows often do not adhere to strict lane discipline, which poses a unique challenge, especially in developing countries like India. Traffic planners and engineers face complex traffic scenarios requiring specialized solutions.

Historically, research efforts have focused on traffic flow and traffic engineering. India's population growth has led to a substantial surge in traffic volume. Transportation engineers have primarily concentrated on motorized transportation systems, with less attention to pedestrian and cyclist needs. However, there is a growing emphasis on adopting a multi-modal approach to enhance pedestrian and cyclist experiences, aiming to improve air quality, extend infrastructure lifespan, and enhance overall quality of life. Providing safe pedestrian crossing facilities is particularly complex in areas with mixed traffic and non-lane managed transportation systems, demanding suitable locations and environmentally friendly solutions to effectively address these challenges.

Objective:

The primary objective of this assessment is to ascertain the pedestrian-perceived degree of service concerning mid-block crosswalks situated on urban undivided roads within mixed traffic scenarios. This endeavor is pursued with the following specific objectives in mind:

1. Identification of various factors that exert influence on the pedestrian-perceived degree of service, warranting comprehensive examination and consideration.
2. Enhancement of distinctive model characteristics to facilitate the accurate estimation of the level of service experienced by pedestrians.
3. Determination of the individual pedestrian level of service through the application of qualitative methodologies, affording an in-depth and nuanced perspective.

In essence, this study endeavors to discern the multifaceted aspects impacting the perceived level of service among pedestrians at mid-block crosswalks in urban environments characterized by mixed traffic conditions. The pursuit of this understanding is undertaken with the aim of developing refined models and methodologies to effectively gauge and improve the quality of service experienced by pedestrians

navigating these specific transportation settings.

Polusetal's (1983) study delved into the investigation of characteristics associated with pedestrian pathways. This investigation encompassed data collection from six distinct sites located in the pertinent region of HFA (Central Business District). Video tape recorders were employed to model three-phase flow pattern models and to assess the rate of review.LemandL. (1995) conducted an analysis of pedestrian flow characteristics in Hong Kong, establishing correlations between velocity, flow, and density parameters. Furthermore, Belts and Chu (2002) developed a comprehensive level of service framework for pedestrians within mid-block locations, considering a myriad of 21 variables observed in Florida's streets. This framework aimed to holistically assess and improve the pedestrian experience in these specific urban settings.

II. METHODOLOGY

The present research focuses on assessing the influence of pedestrian movement on the Level of Service (LOS) for urban residents in the absence of effective control measures such as designated crosswalks, pedestrian signals, police management, and specific informational points. This study is conducted in various locations within the Talabana region of Visakhapatnam, situated in the southern parts ofIndia.

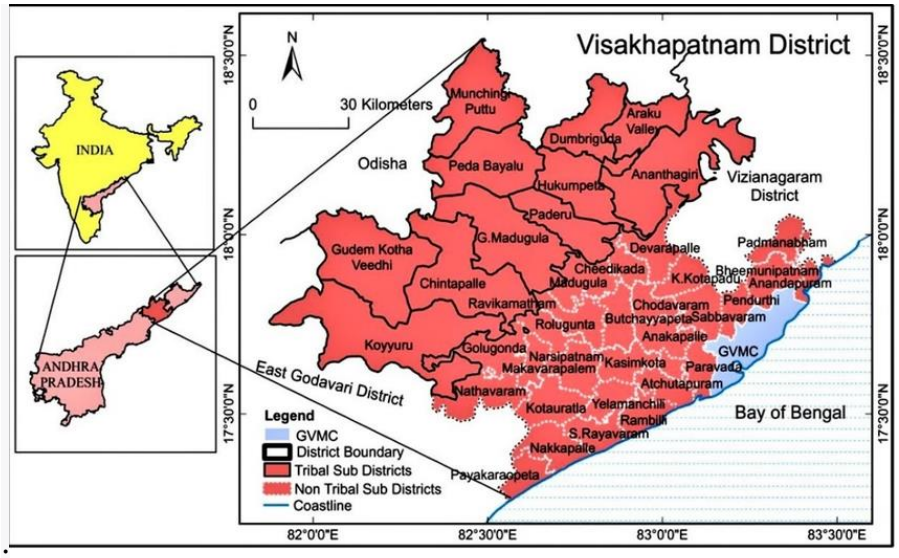


Figure 2.1 Map showing the selected study sections

2.1 QUESTIONNAIRE SURVEY

A questionnaire survey was undertaken to gauge pedestrian responses concerning factors influencing the level of service. The survey design initially comprised 31 questions, but, following analysis of pedestrian feedback, this was streamlined to 17 questions. The survey aimed to attain precise insights into the roadway geometrics and traffic conditions at diverse pedestrian crossing locations. Conducted throughout September 2023, the preliminary survey sought to comprehensively capture pedestrian perspectives, offering a focused examination of the specific elements influencing the perceived level of service. This

iterative process of refining questions based on respondent feedback enhances the survey's efficacy, ensuring a more targeted and relevant inquiry into the factors that impact pedestrians' experiences at various crossing points.

PROJECT SURVEY LOCATION AND DETAILS

S NO	Road Name	Towards
1	Mvp double road	Kailasagiri
2	Madhurwada	Pm palem
3	Siripuram	Andhra university main gate
4	Old dairy farm	Yendada

2.2 DATA EXTRACTION PROCESS

The factual extraction process encompasses laboratory work, wherein recorded videos are likely played back to discern various characteristics of vehicles, including speed, types of vehicles, traffic flow, and traits of pedestrians such as walking speed, waiting time, and crossing time. To facilitate the extraction of such information, video editing software will be employed. The precise entry and exit times of vehicles at each checkpoint will be meticulously recorded with an accuracy of 1/100th of a second.

This methodological approach ensures a comprehensive analysis of crucial parameters related to vehicular and pedestrian behavior. The utilization of video editing tools enhances the precision and efficiency of data extraction from the recorded footage. The commitment to recording entry and exit times with remarkable

accuracy, down to the fraction of a second, speaks to the rigorous methodology employed in this study. Through these meticulous laboratory techniques, the research aims to provide a nuanced understanding of the dynamics of vehicle and pedestrian movement, contributing valuable insights to the broader discourse on traffic and pedestrian flow in urban environments.

2.2.1 EXTRACTION OF AGE GROUP

In the present study, the categorization of age groups involves the exclusion of youth (individuals aged between 10 to 30 years), with a focus on adolescents, adults (ranging from 30 to 50 years old), and older individuals (50 years and above). It is important to note that the assessments are primarily derived from visual observations, given the constrained field of view of the camera, and conclusive determinations may be limited in fairness.

2.2.2 PEDESTRIAN CROSSING SPEED

The crossing velocity is computed by measuring the time taken by pedestrian travelers to traverse the distance between the starting point and the crossing. The study segment is delineated by reference points on both sides of the street, specifically aligned with the location of the crosswalk. The road width is considered at the time of pedestrian crossing, and the entire walking duration is recorded using AVS Video Editor Software for each pedestrian in the traffic video.

2.2.3 PEDESTRAIN GAP SIZE

The gap length is defined as the time interval between one pedestrian initiating the crossing and the immediate start of the crossing by the subsequent pedestrian. This factor plays a crucial role in assessing pedestrian safety. A greater gap length correlates with a reduced risk of accidents for pedestrians.

2.3 DETERMINATION OF LEVEL OF SERVICE (LOS) USING QUALITATIVE APPROACH

Pedestrian Level of Service (LOS) for crosswalk facilities will be determined through a questionnaire survey, capturing valuable insights from pedestrians themselves. By directly gauging user experiences and opinions, the survey responses will inform LOS rankings, ensuring a comprehensive and user-centric evaluation of crosswalk effectiveness. This approach goes beyond technical criteria, considering real-world perspectives to shape a nuanced understanding of pedestrian satisfaction and facility performance.

2.4 COLLECTION OF DATA

2.4.1 Traffic Volume:

Traffic volume data collection can be achieved through two primary methods: manual and automated. The selection of an appropriate calculation method is crucial and should align with the study's objectives.

Careful consideration of the time and location for data collection is paramount. The calculation should encompass all days of the week, each month, and offer a representative snapshot of the entire year. It is imperative to avoid special events and atypical situations to ensure data accuracy. The calculation period can vary from as short as 5 minutes to as long as a year.

Automated counting methods, such as auto-counting, provide a robust source of aggregated traffic data. Typically, calculations are conducted hourly over a 24-hour period. Portable counters, a manual monitoring method, serve a similar purpose to automatic counting devices but allow for a more extended data collection period. In contrast, permanent counters are employed for prolonged, continuous data collection.

2.4.2 Speed of Traffic:

The process of recording traffic speed data entails the utilization of timers to gauge the time it takes for vehicles to traverse a specified distance. When manually measuring vehicle speed, a starting point and an

ending point are typically demarcated, usually 30 meters apart. The calculation involves timing how long it takes the vehicle to cover this distance.

The Apollyon system stands out by recording data with an exceptional resolution of 0.031 milliseconds, positioning itself as one of the fastest recorders globally. This remarkable level of accuracy enables precise data collection, even when dealing with short distances between measurement points.

2.4.3 Road Width:

In low-speed urban settings, the width of lanes emerges as a pivotal factor in ensuring safety. Narrow lanes elevate the likelihood of accidents involving lane departures. Lane widths can be adjusted strategically to incorporate various elements such as bike lanes, on-street parking, transit stops, and landscaping for effective access control.The combination of narrow lane widths and curvilinear horizontal alignments amplifies the risk of lane departure accidents, particularly on high-speed roads. Moreover, the presence of larger vehicles may lead to their encroachment into adjacent lanes or shoulders, impacting the safety and functionality of these lanes. This has repercussions for other road users, including cyclists utilizing the lanes or shoulders.

2.5 DATA COLLECTION AND EXTRACTION

Information was gathered from four distinct locations through a combination of questionnaire surveys and video recording technology. These locations include Botsaramam, Siripuram, Dhananakhan, and Apal. The survey covered three key state conflicts, encompassing a diagnostic examination of demolition, life-saving

measures, heart attacks, and appellate issues. A total of four sites were selected for data collection, ensuring that they met specific criteria outlined on the designated survey page.Each site was required to have a medium block pass section, extending 150 meters from the square. Additionally, the chosen sites had to be situated on undivided roads and should exhibit higher interaction with pedestrian traffic. Furthermore, these sites were mandated to be free from visitor spots such as bus stops, car stands, and parking areas.Four pedestrians, including Old Dairy Farm, Siripuram, MVP Double Road, were selected as candidates for the study, representing different cities in Andhra Pradesh. The Siripuram site was chosen due to its popularity as a prominent pedestrian location. The MVP Double Road site was positioned in front of the medical college, approximately 8 kilometers away from Chhattisgarh Nagar. The Madilpallem site was located near a bus stop and experienced elevated pedestrian flow. The Apol site was selected for its heightened pedestrian activity, featuring a cross order width of 7.5 meters and a network length of 20 meters.The screenshots of the chosen website's video section and its corresponding format are detailed below, spanning from figure 2.5 to 2.8.

Figure 2.5 Photograph and layout of the undivided carriage way section at Siripuram

Figure 2.6 Photograph and layout of the undivided carriage way section at MVP double road

Figure 2.7 Photograph and layout of the undivided carriageway section at Old dairy farm

Figure 2.8 Photograph and layout of the undivided carriage way section at Madhurwada

Approximately four to five surveillance survey questionnaires were distributed to pedestrians at each site.

Random pedestrians crossing the non-parallel section were surveyed immediately after crossing the road. The survey data for all four sites is presented in Table 2.9

Time of survey	3.00PM-4.00PM	3.30PM-4.30PM	5.30PM-6.30PM	4.00PM-5.00PM
Duration of survey	1 hour	1 hour	1 hour	1 hour
Number of pedestrians responses	106	90	107	113
Total number of pedestrians crossing the road.	115	108	148	123

Table 2.9 Survey data of all four sites

III. RESULTSANDDISCUSSIONS

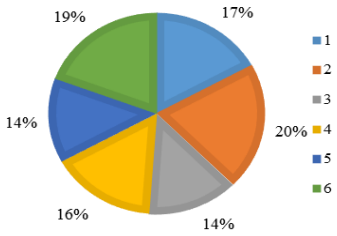
The results of the questionnaire survey encompass demographic information such as pedestrian gender, age, and group size. A total of 416 pedestrians were surveyed across four different sites. The demographic analysis is presented in detail in Table 3.1.

Table 3.1 Demographic analysis

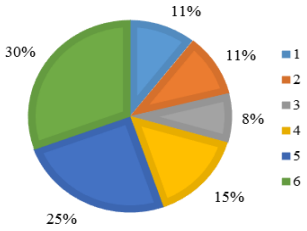
Variable	Description	Total data	
		Frequency	Proportion (%)
Gender	Male	246	59.13
	Female	170	41.16
Age group	<15	55	13.22
	15-30	119	28.6
	30-45	89	21.39
	45-60	73	17.54
	>60	80	19.23
Group size	Single	159	38.22
	Accompanied by one	101	24.27
	By two or three	75	18.02
	>Three	81	19.47

3.2.1 ANALYSIS OF QUESTIONNAIRE RESPONSES - MVP DOUBLE ROAD

Thirty percent of pedestrians acknowledge facing challenges when crossing, while 36 percent find crossing the road to be easy. A significant 37 percent express strong agreement on the need for a crossing facility for those walking or hiking. Similarly, 37 percent of pedestrians advocate for the implementation of police control at the location. Additionally, 33 percent of pedestrians provide a ranking based on their experiences and perceptions.



(a) Safety



(b) Difficulty

(c) Comfort

(d) Need for crossing facility

(e) Crossing facility preference

(f) LOS

Figure3.2 Questionnaire Responses –MVP double road

3.2.2 ANALYSIS OF QUESTIONNAIRE RESPONSES -SIRIPURAM

Forty-eight percent of pedestrians affirm the difficulty of crossing, while 35 percent find it easy to traverse the road. A notable 42 percent of pedestrians express agreement on the necessity of introducing a crossing facility. Furthermore, 36 percent of pedestrians advocate for the implementation of a zebra crossing at this location. Lastly, 36 percent of pedestrians provide ratings based on their experiences and perceptions.

(a) Safety

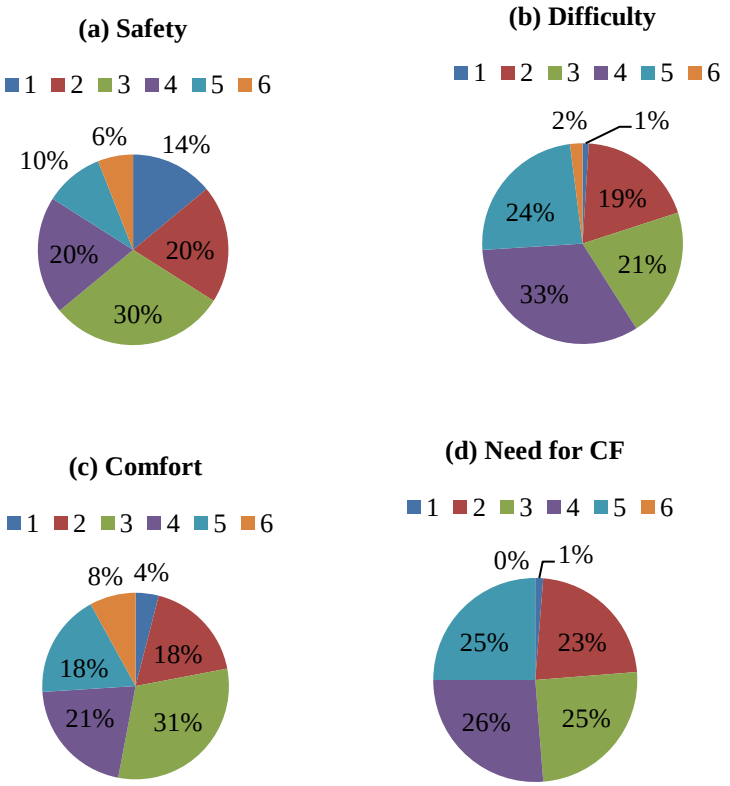
(b)Difficulty

(c) Comfort **(d) Need of CF**

Figure 3.3 Questionnaire Responses –Siripuram

3.2.3 ANALYSIS OF QUESTIONNAIRE RESPONSES -MADHURWADA

As depicted in Figure 5.3, the data reveals that 30% of pedestrians somewhat agree regarding safety during crossing in this area. Meanwhile, 33% of pedestrians acknowledge the difficulty of crossing, and 31% find it straightforward to traverse the street. Additionally, 21% of pedestrians express agreement on the necessity of introducing a crossing facility. Moreover, 36% of pedestrians advocate for the implementation of a zebra crossing at this location. Finally, 36% of the pedestrians provide ratings based on their experiences and perceptions.



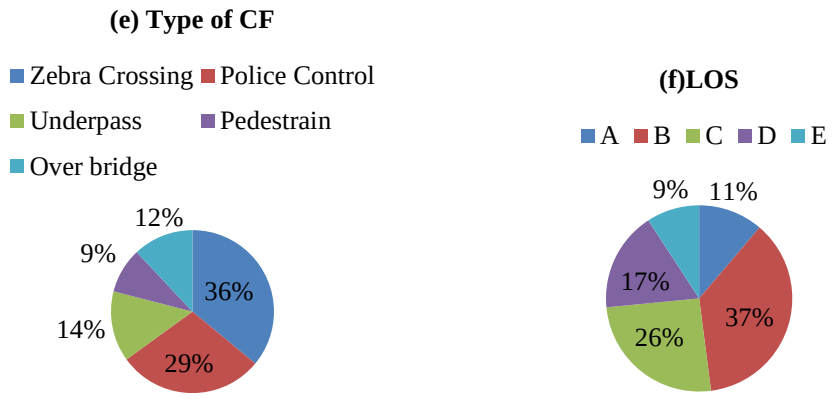


Figure 3.4 Questionnaire Responses - Madhurwada

3.2.4 ANALYSIS OF QUESTIONNAIRE RESPONSES -OLD DAIRY FARM

In Figure 5.4, it is evident that 33% of pedestrians express disagreement regarding the safety while crossing this area. Additionally, 38% of pedestrians only slightly agree that there may be difficulty in crossing. Another 33% of pedestrians slightly disagree that it is convenient to cross the street. Similarly, 33% of pedestrians mildly disagree that there is a need to introduce a crossing facility. Furthermore, 24% of pedestrians express a preference for the implementation of a pedestrian overbridge at this location. Lastly, 34% of pedestrians assign a rating of 'C' based on their experiences and perceptions.

(a) Safety

(b) Difficulty

(b) Comfort

(d) Need of CF

(d) Type of CF **(f) LOS**

Figure 3.5 Questionnaire Responses – Old dairy farm

IV. Conclusion

In the current study, multiple rational equations were developed by considering various variables such as traffic volumes, street widths, and other relevant factors. Specifically, this study focuses on four distinct road configurations with varying widths. The objective is to account for a range of scenarios and variations in road infrastructure.The study is designed to address several aspects, particularly the interplay between variable road widths and traffic patterns. It recognizes that vehicle speed is influenced by factors such as road width, street layout, and the overall volume of traffic.Through analysis, it was revealed that pedestrians' perceptions play a pivotal role in assessing the quality of service provided by a crosswalk. The study indicates that the level of service, as derived from questionnaire surveys based solely on waiting times (as per IRC: 103-2023), may not comprehensively capture the overall pedestrian experience. It is crucial to broaden the assessment criteria to include considerations of safety, comfort, and the difficulty pedestrians face while crossing. These additional factors contribute significantly to a more holistic evaluation of the level of service at crosswalks.

Major findings from the study areas follows

1.MVP double road site

Here are the findings from the study:

1.Pedestrian Crossing Speed:The average pedestrian crossing speed is recorded at 1.1 m/s, aligning closely with the speed recommended by IRC: 103-2023, which is 1.2 m/s.

2.Gap Size Awareness:Pedestrians in the Siripuram location exhibit a gap size of 9.52 seconds, surpassing other sites. This indicates a higher awareness and consciousness about safety among pedestrians in Siripuram.

3.Individual Crossing Preference:A notable 40% of pedestrians prefer crossing individually, highlighting a significant concern for safety.

4.Zebra Crossing Demand:Out of 107 pedestrians surveyed, 35% expressed a desire for the implementation of a zebra crossing facility.

5.Perceived Difficulty and Safety:Approximately 48% of pedestrians strongly agree that crossing the road poses a difficulty, while 41% state that road crossings are less safe. Additionally, 35% of pedestrians do

not feel comfortable during road crossings.

These findings collectively provide insights into pedestrian behaviors, preferences, and perceptions, highlighting areas that require attention for enhancing safety and overall pedestrian experience.

2.Madhurwada site

Here are the key findings from the study:

1.Pedestrian Crossing Speed:The average pedestrian crossing speed is measured at 1.34 m/s, exceeding the speed recommended by IRC: 103-2023, which is 1.2 m/s.

2.Crossing Difficulty Perception:Approximately 38% of pedestrians acknowledged facing difficulty when crossing the road.

3.Safety Perception:Safety at the crossing is deemed less satisfactory, as indicated by the lower satisfaction ratings provided by pedestrians.

4.Desire for Crossing Facility:A significant portion, 32% of pedestrians, expressed a desire for the implementation of a crossing facility.

5.Pedestrian Ratings:Among 113 pedestrians surveyed, the majority, 32%, assigned a 'C' rating to the crossing site.

These findings highlight aspects of pedestrian experience, safety concerns, and preferences, indicating potential areas for improvement in crossing facilities and overall urban infrastructure.

3.Siripuram site

Here are the summarized findings from the study:

1.Walking Velocity:The average walking velocity is 1.23 meters/second, closely aligning with the IRC: 103-2023 recommendation of 1.2 meters/second.

2.Pedestrian Crossing Patterns:Over 50% of pedestrians exhibit a crossing pattern.

3.Preferred Crossing Facility:A majority of pedestrians express interest in implementing police control as a crossing facility.

4.Perceived Difficulty and Safety:Pedestrians find it challenging to cross the road, and safety and comfort are not primary concerns at this site.

5.Age Group Responses:The majority of responses (37%) come from the 15-30 years age group.

In conclusion, the study suggests that road width is less critical than traffic volume. Altering traffic volume without considering the proportion of buses has been observed to increase speed and reach a higher service level. Consequently, the recommendation is to implement changes, such as traffic signal adjustments, on the selected streets to enhance service levels, road safety, and vehicle speed.

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