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Smoke Remover Duct Design in Hall

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Abstract

This topic focuses on creating a smoke remover duct system for buildings to capture and remove smoke generated during fires or other sources. Referring to fire accidental data, more than half the deaths from accidental fires are due to smoke rather than fire. The system aims to improve indoor air quality, enhance occupant safety, and reduce damage to building contents and structure. The design involves calculating smoke generation rates, selecting materials and components, designing duct layout and configuration, incorporating fire-resistance and safety features.

Smoke remover ducts play a vital role in maintaining indoor air quality and ensuring occupant safety in buildings. These ducts are designed to efficiently remove smoke, heat, and toxic gases generated during fires, reducing the risk of damage and harm to people and property. Effective smoke remover duct design considers factors such as building layout, occupancy, fire risk assessment, and ventilation rates. Properly installed and maintained smoke remover ducts can minimize smoke spread, prevent re-ignition, and create a safer evacuation route.

Keywords: Air purification, Smoke removal, Duct cleaning, Ventilation systems, Indoor air quality, smoke, fire, accidents …

1. INTRODUCTION

Smoke remover duct systems are a crucial component of building design, playing a vital role in maintaining indoor air quality and ensuring occupant safety during fires or other smoke- generating events. These systems capture and remove smoke, reducing the risk of smoke inhalation and damage to building contents and structure. In the event of a fire, smoke can spread rapidly, posing significant risks to occupants and emergency responders. To mitigate this threat, smoke remover duct systems have emerged as a crucial component of building safety infrastructure. These systems are designed to extract smoke and heat from buildings, improving visibility, reducing temperature, and enhancing evacuation safety. Effective design of smoke absorber ducts is essential to ensure efficient smoke capture, airflow distribution, and maintenance accessibility.

These ducts are designed to efficiently remove smoke, heat, and toxic gases generated during fires, reducing the risk of damage and harm to people and property. Effective smoke remover duct design considers factors such as building layout, occupancy, fire risk assessment, and ventilation rates. Properly installed and maintained smoke remover ducts can minimize smoke spread, prevent re-ignition, and create a safer evacuation route. Moreover, integrating smoke remover ducts with other building systems, such as HVAC and fire suppression, enhances overall fire safety. Regular inspections and maintenance are crucial to ensure optimal performance. Advances in materials and technologies have led to more efficient and durable smoke remover ducts, making them an essential component of modern building design and fire safety strategies.

Fig no 1 Smoke remover duct in building

The scope of a smoke remover duct in a building is focused on ensuring the safe evacuation of smoke, heat, and toxic gases during a fire, thereby protecting occupants and maintaining clear escape routes. It involves the design, installation, and maintenance of a system that effectively extracts smoke from critical areas such as corridors, stairwells, and open spaces, preventing smoke from obstructing escape routes or exacerbating fire hazards. The ducts, fans, and associated components must be strategically placed and sized to handle the expected smoke load based on the building's size, occupancy, and fire risk. These systems must meet stringent fire safety codes and regulations, including those outlined in standards like NFPA 92 and local building codes. Additionally, the smoke removal system must be integrated with fire detection and alarm systems, and include features such as fire dampers and emergency power supplies to ensure functionality during a fire. Regular inspection, testing, and maintenance are crucial to ensure the system will operate effectively in an emergency. Overall, the scope encompasses all aspects necessary to provide a reliable and efficient smoke control solution, safeguarding both the building and its occupants in the event of a fire.

Fig no 2 smoke

2. METHODOLOGY

2.1 Accident Data Collection

For a comprehensive road safety audit at the Mundur Intersection, we have collected accident data from various sources such as police records and through questionnaire surveys.

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1. Data From Police Records

We collected accident data from Kongad Police Station to conduct a comprehensive accident analysis. The primary objective of this data collection was to identify accident patterns, understand accident characteristics, and inform road safety measures. This data was collected through visits to Kongad Police Station, filling out data request forms, reviewing police records, and conducting interviews with police officials. The collected data was analyzed to identify trends, patterns, and correlations. By analyzing this data, we provided valuable insights into accident causes, consequences, and prevention strategies, ultimately contributing to improved road safety in the region.

2. Questionnaire survey

As part of our data collection process, a questionnaire survey was conducted at Mundur Intersection to gather information on road user behavior, traffic characteristics, and safety perceptions. The survey was designed to capture the opinions and experiences of various road users, including drivers, pedestrians, and cyclists. A total of 50 questionnaires were distributed to road users at the intersection. The questionnaire consisted of 10 questions, including multiple-choice and rating-scale questions. The questions covered topics such as road user behavior, traffic volume, speed, and safety concerns, as well as demographic information. The survey was conducted during peak hours, to capture the diverse range of road users. The data collected from the survey was analyzed using descriptive statistics to identify trends, patterns, and correlations. The results of the survey provided valuable insights into the traffic characteristics, road user behavior, and safety perceptions at Mundur intersection, which will inform the development of effective safety measures and strategies to improve road safety in the region

2.2 Data Analysis

As a part of enhancement of road safety at the Mundur intersection, analyzing accident data using statistical methods in Microsoft Excel can reveal patterns, risk factors, and trends that contribute to accidents. Started by organizing data from sources like police records and surveys in a structured spreadsheet format. Began with data cleaning to address inconsistencies, handle missing values, and remove duplicates. Use descriptive statistics to calculate frequencies and percentages of accident types, causes, and severities. The objective of this step was to analyze the collected accident data to identify trends, patterns, and correlations. The collected accident data was cleaned and formatted to ensure consistency and accuracy. Charts and tables were created to visualize the data and facilitate analysis.
The following is the compiled record of accident data collected from Kongad Police Station.

Table 1: Accident data

Year	No of accident	Cause of accident	Nature of accident	
			Fatal	Non-fatal
2020	1	Over speeding	0	1
2021	2	Over speeding	0	2
2022	1	Over speeding	0	1
2023	3	Over speeding	1	2
2024	7	Over speeding	3	4

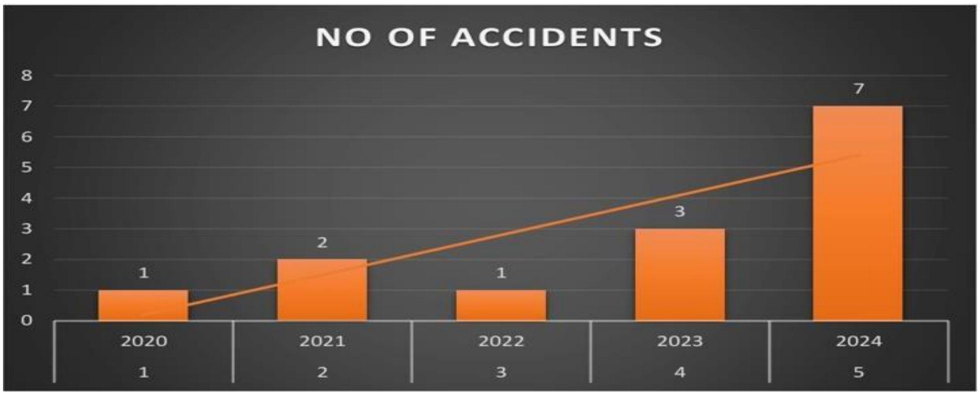
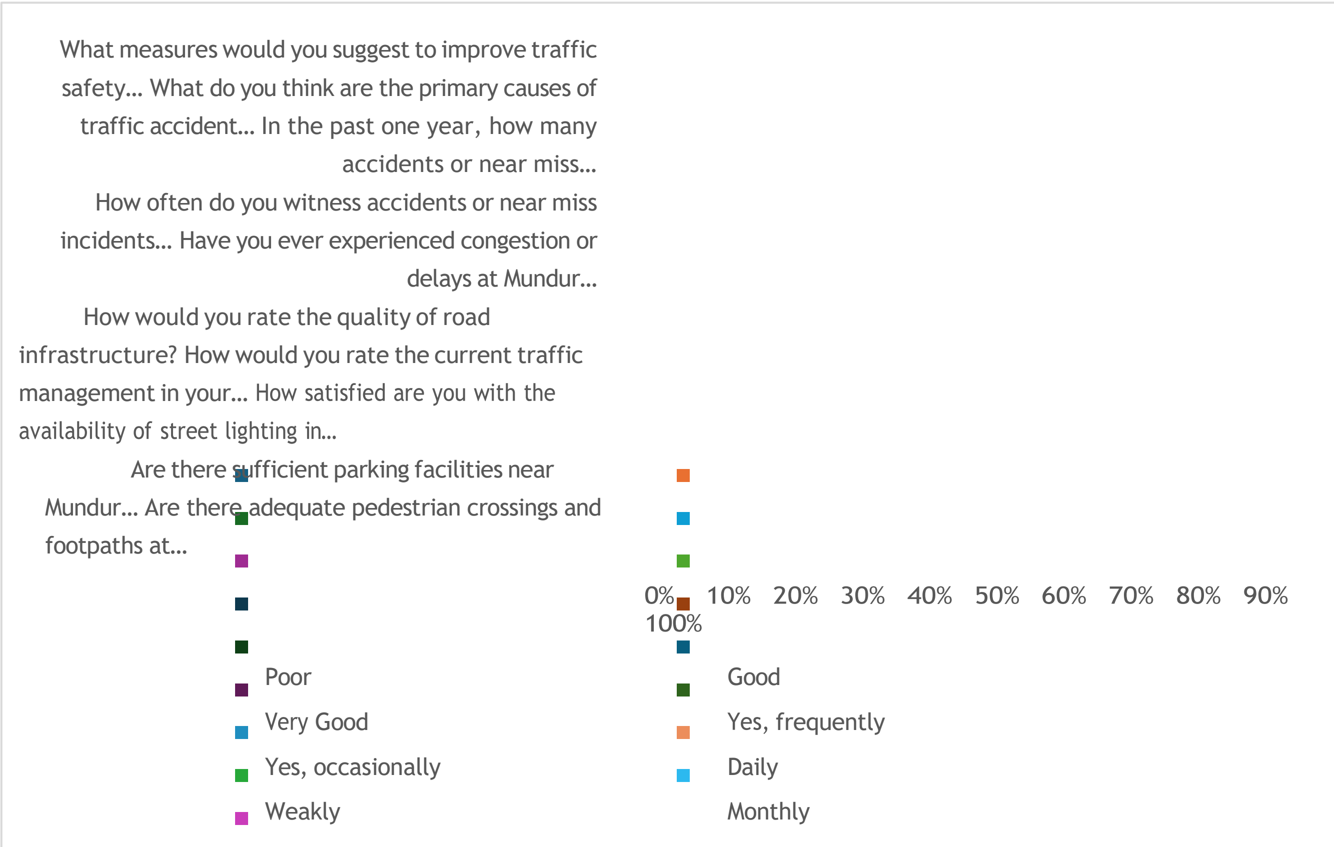


Chart 1: Result of accident data analysis

Analysis of the collected data is shown below

Conclusion of the Analysis

The analysis of the collected accident data indicates a significant increase in the rate of accidents from 2023 to 2024, with the maximum number of accidents occurring in 2024. These findings suggest that urgent measures are needed to address the rising trend of accidents at Mundur Intersection.



Likewise, the responds from the questionnaire survey were also analyzed and the following results were obtained.

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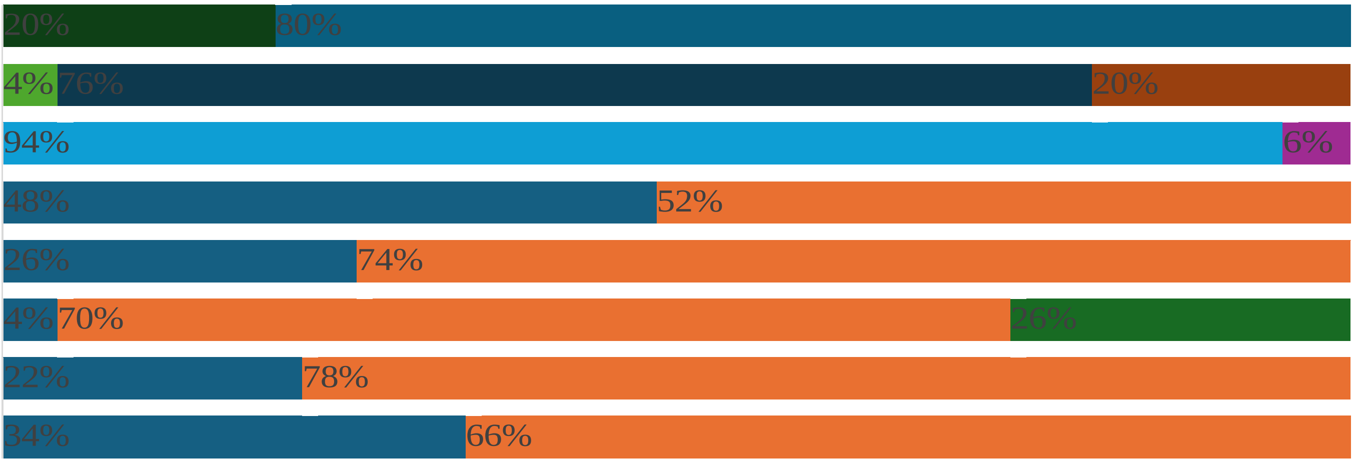

Chart 2: Result of analysis of questionnaire survey

Conclusion of Questionnaire Survey

The questionnaire survey revealed that the primary cause of vehicle accidents at Mundur intersection is the absence of a traffic signal, with a significant 68% of respondents advocating for the installation of a traffic signal system to enhance safety.

2.3 Solution Development

A thorough traffic analysis at Mundur Intersection has revealed significant congestion issues, delays, and uncoordinated vehicle movement, particularly during peak hours. The study assessed key factors such as traffic volume, vehicle queuing patterns, intersection delay times, pedestrian activity, and existing road infrastructure. The findings indicated that the intersection currently experiences high vehicle stoppages, inefficient right-of-way allocation, and frequent conflicts between different traffic streams. These inefficiencies result in frequent road accidents, longer travel times, increased fuel consumption, higher vehicle emissions, and overall dissatisfaction among road users. Alternative solutions such as road widening, flyovers, or roundabout conversion were considered, but these approaches would require substantial financial investment, land acquisition, and long construction periods. In contrast, developing a traffic signal system emerged as the most practical and cost-effective solution, as it allows for better traffic flow management without the need for significant infrastructural modifications. By developing a traffic signal system, vehicles from different directions can move in a more coordinated manner, reducing unnecessary conflicts and improving intersection throughout.

To implement the traffic signal system efficiently, Simulation of Urban Mobility (SUMO) software is used for the designing and simulation of the signalized Mundur Intersection. SUMO is an advanced, open-source microscopic traffic simulation tool that enables accurate modeling of urban traffic conditions and testing of different traffic control strategies. The use of SUMO will allow for testing various signal timing configurations to determine the most efficient setup for managing traffic at Mundur Intersection.

2.3.1 Data Collection

Collected geometric data, such as intersection layout, lane widths etc. Collecting geometric data is crucial for designing a signalized intersection. It ensures the design meets capacity, safety, and operational efficiency requirements. The plan of Mundur Intersection was collected from the Public Works Department (PWD) Office, NH Division, Palakkad. This plan provides detailed information about the road geometry, which is essential for understanding the intersection's design and potential safety hazards.

Gathered traffic volume data for the intersection, pedestrian and cyclist volumes. The traffic volume data of Mundur Intersection is collected from Public Work Department (PWD) Office, NH Division, Palakkad.

Table 2: Traffic Volume

Day	Date	Car	Two-Wheeler	Bus	2 Axle Truck	Multi Axle Truck	Cycle/ Cycle rikshaw	Total Vehicles
Monday	Date-1	5928	6867	712	1224	1003	17	15751
Tuesday	Date-2	4712	6326	656	1284	1010	19	14007
Wednesday	Date-3	4561	6518	563	1252	985	7	13886
Thursday	Date-4	4580	6544	693	1144	865	16	13842
Friday	Date-5	4695	6488	758	1107	865	16	13929
ADT (Avg Daily Traffic)		4895	6584	676	1202	945	15	14317

2.3.2 Calculation of Average Volume Count

Day-by-day bus and car data (Monday-Friday)

Table 3: Car and bus volume count

Day	Car (daily)	Car/hr	Bus (daily)	Bus/hr
Mon	5928	5928/24 = 247	712	712/24 = 29.7
Tue	4712	4712/24 = 196	656	656/24 = 27.3
Wed	4561	4561/24 = 190	563	563/24 = 23.5
Thu	4580	4580/24 = 191	693	693/24 = 28.9
Fri	4695	4695/24 = 196	758	758/24 = 31.6

Average car/day = (5928 + 4712 + 4561 + 4580 + 4695)/5 = 4895
Average car/hr = 4895/24 = 204
Average bus/day = (712 + 656 + 563 + 693 + 758)/5 = 676 Average bus/hr = 676/24 = 28

Table 4: Two-wheeler and truck data

Day	Two- Wheeler	2- Axle Truck	Multi- Axle Truck	Trucks (2-Axle + Multi)
Mon	6867	1224	1003	2227
Tue	6326	1284	1010	2294
Wed	6518	1252	985	2237
Thu	6544	1144	865	2009
Fri	6488	1107	865	1972

Table 5: Two-wheeler and truck volume count

Date	Two- wheeler (daily)	Two- wheeler/hr	Trucks (daily)	Trucks/hr
Mon	6867	6867/24 = 286	2227	2227/24 = 93
Tue	6326	6326/24 = 264	2294	2294/24 = 96
Wed	6518	6518/24 = 272	2237	2237/24 = 93
Thu	6544	6544/24 = 273	2009	2009/24 = 84
Fri	6488	6488/24 = 270	1972	1972/24 = 82

Average Two-wheeler/day = (6867 + 6326 + 6518 + 6544 + 6488)/5 = 6548 Average Two-wheeler/hr = 6548/24 = 273

Average Trucks/day = (2227 + 2294 + 2237 + 2009 + 1972) = 2148 Average Trucks/hr = 2148/24 = 90

Table 6: Cycle volume count

Day	Cycles (daily)	Cycles/hr
Mon	17	17/24 = 0.71
Tue	19	19/24 = 0.79
Wed	7	7/24 = 0.29
Thu	16	16/24 = 0.67
Fri	16	16/24 = 0.67

Average Cycles/day = (17 + 19 + 7 + 16 + 16)/5 = 15 Average Cycles/hr = 15/24 = 0.63

2.3.3 Design

The design of signalized intersection is carried out using SUMO (Simulation of Urban Mobility) software, an open-source traffic simulation tool widely used for modeling and analyzing transportation system.

The first step in the design process involves creating the network of Mundur Intersection in SUMO software. The calculated average volume count per hour is a critical input for the simulation process in traffic signal design. This data is fed into the software to accurately model real-world traffic conditions. Based on this input, the software analyzes traffic flow, evaluates congestion levels, and determines optimal signal durations for each phase of the intersection. The signal timings are adjusted to ensure a balanced distribution of green time among different traffic movements, minimizing delays and improving overall intersection efficiency. By optimizing signal durations, the design enhances traffic flow, reduces waiting times, and contributes to a more effective and well-managed transportation system. 10.83668458495827, 76.57995057185873

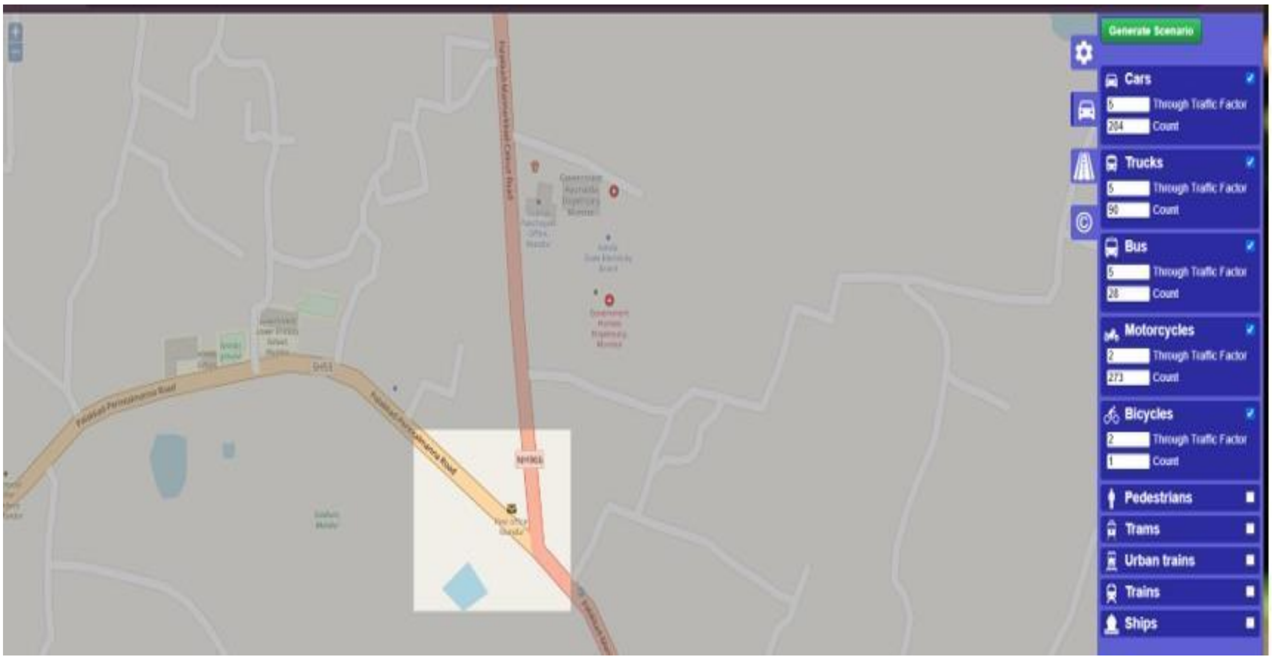

Fig 3: Network Creation

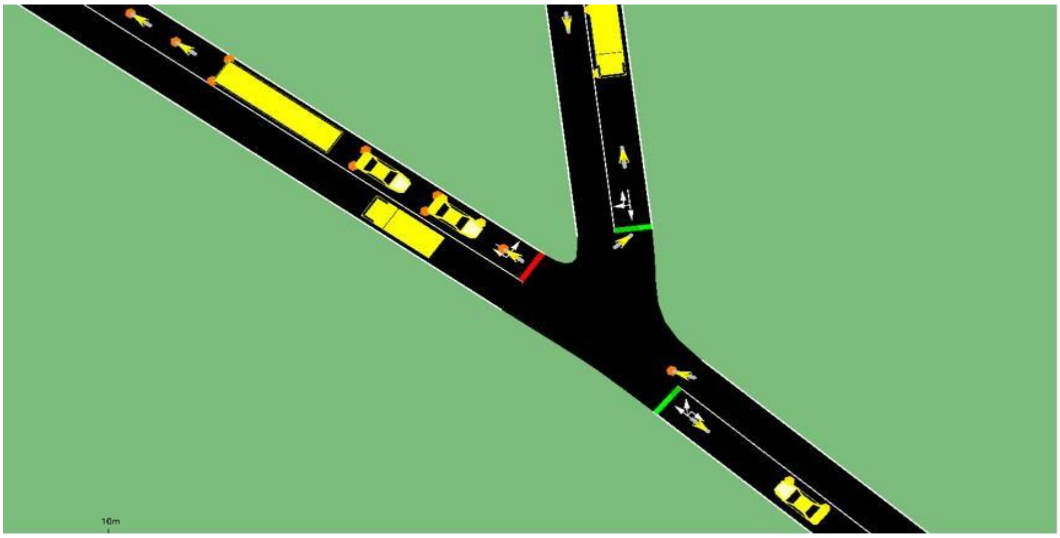

Fig 4: Signalized Mundur Intersection

Signal duration Green light 40sec Red light 40Sec Yellow Light 5Sec

3. CONCLUSION

The study conducted at Mundur Intersection emphasized the urgent need for a well-structured traffic signal system to reduce the frequency of accidents and improve overall traffic management. The intersection has been experiencing high accident rates due to unregulated vehicle movement, lack of proper lane discipline, and pedestrian safety concerns. Through a detailed traffic analysis, it was observed that the absence of a signaling system led to frequent congestion, unpredictable vehicle interactions, and increased collision risks.

To address these issues, a signalized intersection was meticulously designed using SUMO (Simulation of Urban Mobility) software. The proposed signalized system is designed to regulate vehicle movement efficiently, minimize delays, and enhance road user safety. The design process involved analyzing realtime traffic data, evaluating peak-hour congestion patterns, and simulating different signal timing scenarios to ensure optimal performance. By implementing this signalized intersection, the study aims to create a safer and more organized traffic environment at Mundur Intersection, ultimately reducing accident rates and improving the overall commuting experience for road users.

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