# Improving Traffic Sign Management: Creating an Indian Specific-Asset Management System

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**Abstract**
Asset management is a systematic process focused on maintaining, upgrading, and operating assets effectively. Numerous agencies have adopted asset management principles as a strategic tool to define goals and prioritize resources for decision-making. In the realm of road asset management, key components include bridges, traffic signs, pavement markings, and culverts.
This project aims to develop a comprehensive Traffic Sign Asset Management System tailored for the Indian context. The core of this system involves a visual nighttime inspection method to assess the retro-reflectivity of traffic signs. Regular nighttime surveys will be conducted using vehicle high beam lights to evaluate the visibility of each sign. Signs failing to meet visibility standards will be identified, and maintenance or replacement actions will be recommended accordingly.
The study highlights the importance of integrating asset management programs into decision-making processes. It includes a detailed cost analysis of each traffic sign, covering both manufacturing and maintenance costs. The project also involves recording the latitude and longitude of each sign, creating a detailed map using ArcGIS to plot the exact positions of all traffic signs.
Key findings of the study emphasize the need for formal asset management programs to improve traffic sign visibility and maintenance. This research provides a foundational framework for establishing a traffic sign asset management system in India, ensuring that traffic signs are adequately maintained and managed for optimal road safety.

**Keywords**: Asset Management, Traffic Signs, Management Methods, ArcGIS, Cost Analysis, Retro-reflectivity

## 1. Introduction
### 1.1 General
#### 1.1.1 Background

Traffic management is a critical aspect of road safety and infrastructure efficiency. Effective traffic sign management plays a pivotal role in guiding drivers, ensuring safety, and facilitating smooth traffic flow. In India, with its rapidly expanding road network and increasing vehicular population, managing traffic signs efficiently has become a significant challenge. The need for a systematic approach to traffic sign management is essential to address issues such as sign visibility, maintenance, and overall asset management.

### 1.1.2 Asset Management Overview

Asset management is a systematic process that involves maintaining, upgrading, and operating assets efficiently throughout their lifecycle. It is widely recognized as a crucial business tool for organizations to set goals, allocate resources, and make informed decisions. In the context of road infrastructure, asset management encompasses various components such as bridges, pavement markings, culverts, and traffic signs. Effective asset management helps organizations optimize resource utilization, enhance asset performance, and extend the lifespan of infrastructure components.

## 1.2 Traffic Sign Management

In India, traffic signs are essential for ensuring road safety and regulating traffic flow. However, the management of these signs often lacks a systematic approach, leading to challenges such as reduced visibility, inadequate maintenance, and inefficient resource allocation. Traffic signs are subject to wear and tear from environmental conditions and traffic loads, necessitating regular inspections and maintenance to ensure their effectiveness.

Traditional methods of traffic sign management in India have been reactive rather than proactive. Often, issues with traffic signs are identified only when they lead to accidents or when signs are reported as being non-functional. This reactive approach can result in higher costs and increased risks. To address these challenges, a more systematic and proactive approach to traffic sign management is needed.

## 1.3 Problem Statement

The road network constitutes one of the most crucial community assets, primarily managed and maintained by government agencies. These agencies are responsible for the comprehensive management of transport infrastructure, which includes maintaining, operating, improving, replacing, and preserving roads and highways. The efficient use of economic and human resources is essential to achieving the performance objectives of the road network while meeting increasing demands from the public for improved safety, reliability, and comfort.

Given their importance, roads are among the most valuable public assets in many countries. Governments are under growing pressure to enhance the efficiency and accountability of road management systems.

The challenge is to develop and implement a comprehensive Traffic Sign Asset Management System that addresses these needs, ensuring that road signs are maintained and managed efficiently. This system should improve visibility, optimize maintenance, and ensure cost-effective management of traffic signs to enhance overall road safety and performance.

## 1.4 Objectives and Scope

- Develop a Database System: Create a comprehensive and accessible database system for managing traffic sign assets. This system will facilitate easy retrieval and updating of data related to traffic signs, including their locations, conditions, and maintenance history.

- Build a Decision Support System: Design and implement a decision support system (DSS) using the collected data to aid in asset management decisions. The DSS will help prioritize maintenance and replacement activities based on factors such as sign visibility, condition, and traffic impact.

- Optimize Asset Utilization: Develop tools and methodologies to optimize the use of traffic sign assets. This will involve strategies for efficient maintenance scheduling, cost-effective replacement, and maximizing the lifespan of each asset.

- Incorporate Economic and Service Principles: Apply principles from economics, accounting, and customer service models to enhance the asset management system. This includes cost-benefit analyses, budget management, and ensuring that the system meets the needs of road users and stakeholders.

**Scope**

- Database Development: The project will involve creating a user-friendly database system to store and manage information about traffic signs. This will include data on the location, type, condition, retro-reflectivity, and maintenance history of each sign.

- Decision Support System: Develop a decision support system to analyze data and generate actionable insights for traffic sign management. The DSS will assist in making informed decisions regarding maintenance schedules, sign replacements, and resource allocation.

- Asset Optimization: Implement strategies and tools to optimize the management of traffic sign assets. This includes planning for maintenance and replacement to ensure the effective use of resources and extending the operational life of the signs.

- Economic and Service Model Integration: Utilize principles of economics to conduct cost analyses and budget management, apply accounting practices for financial oversight, and integrate customer service models to ensure the system meets user needs and enhances road safety.

## 2. Literature Review

**Harris, E.A., and Rasdorf et al.** describe the minimum traffic sign reflectivity standards. This paper presents an analysis of several traffic sign reflectivity maintenance methods using a sign asset management approach based on inspection and data collection processes. The simulation involves 30 scenarios focusing on the annual maintenance cost per sign and the percentage of traffic signs meeting reflectivity standards. The simulation results generally indicate that higher maintenance costs result in a lower percentage of signs requiring maintenance. For some signs, the nighttime inspection method was used.

**Petri Jusi et al.** describe the road network of Papua New Guinea, which includes 8,258 km of nationally classified roads and 19,937 km of low-traffic roads. The total cost of road maintenance is estimated at 1 billion dollars. The Department of Works (DOW) is responsible for maintaining the road assets but has not given sufficient attention to this task. This neglect affects the country's economic growth and gross domestic product. Poor road maintenance limits access to basic services for the rural population, such as markets, administrative centers, healthcare, and education. DOW, with guidance from the Asian Development Bank and assistance from a Finnish consultant, developed a Road Asset Management System. This system facilitates the collection and presentation of road data, and the formulation of short-term and long-term maintenance budgets.

**Michael J. Markow (2008)** describes asset management practices for pavement markings. The study outlines the principles and asset management strategies for pavements and bridges. Six classes of non-pavement infrastructure assets are identified from the NCHRP synthesis topic 37-03: traffic signals, signing, lighting, pavement markings, culverts, and sidewalks. The study reviews various aspects of asset maintenance, budgeting methods, asset performance measurement, asset service life, material usage, and technology. It provides basic knowledge on pavement markings management and site condition service life for different materials. The use of a reflectometer for reliability in asset management is also discussed.

**Curtis Berthelot et al. (2009)** evaluate road substructure drainage systems through asset management. The study highlights the increased volumes of heavy commercial vehicles in many areas of western Canada, driven by resource-based economic development. Changing moisture conditions, marginal granular materials, and heavy loadings contribute to road structure distress and failure. Slow-moving and turning truck traffic can exacerbate stress and moisture pumping within the road structure. The impacts on structural rigidity are challenging to assess with empirical and mechanistic models.

## 3 Study Methodology

### 3.1 General

An asset management system in use by a road administration will utilize the following data:

- Definition of the system
- Definition of the benefits on the system
- Location of the advantages on the system.
- Condition of the assets.
- Levels of utilization
- Policies and measures (e.g. Support models and medication plans and additionallyobserving data, for example, execution measures).
- Budget data (*e.g.* Broken down by asset type, program level)

### 3.2 Sign Asset Management Method

#### 3.2.1 Visual Night Time Inspection Method

#### 3.2.2 Measured Retro Reflectivity Method

The visual night time method uses human observers visually judge at a night time weather and observers should have some judgment on the reflectivity of signs. Generally it should beconducted at regular highway speeds from the travel lane using the low beam headlights.

To measure Retroflectivity method uses a retroreflecto meter to measure all signs. At least four retro reflectivity readings are taken during the daytime and the average retro reflectivity value of the sign is compared to the established minimums for that particular sign.

### 3.3 Management Methods

- Expected sign life method
- Blanket replaces method
- Control sign method

The expected sign life method calculates a sign life from the signs. It should be combinationof sheet colour and sheet type. It should require the tracking age of signs eighter by using the sign installation date labels on the back of each sign.

The blanket replacement method replaces all signs along the corridor within an area. Replacement should be based on the manufacturer warranty.

The control sign method uses signs either in a controlled study yard or a sample of signs from the field to determine sign life. The control sample of signs is used to represent all of thesigns in an agency.

### 3.4 Data Administration

For all asset management systems, the importance of effective data organization cannot be overstated. Establishing a clear and detailed relationship between the data, its ownership, and its description must be achieved at the outset and maintained throughout the system's lifecycle. It is the responsibility of management within an organization to promote the significance of effective data organization and to ensure that staff are adequately trained and equipped for this task.

Special attention must be given when data originates from external sources. Management must clearly define what information is required, identify the responsible parties, and specify the data to be provided. Adopting a structured approach will help to identify any gaps in the data and highlight areas where data quality may be insufficient. This systematic approach ensures that all necessary information is accurately collected, managed, and utilized, ultimately supporting the effectiveness and efficiency of the asset management system.

## 4. Study Area and Data Collection

### 4.1 Study Area

Ambikapur is a city and headquarters of Surguja district in the Indian state of Chhattisgarh. It is one of the oldest cities in the state, in east-central India. Ambikapur is also the divisional headquarters of Surguja Division which consists of the six districts of Surguja, Korea, Manendragarh, Balrampur, Surajpur and Jashpur.Ambikapur was the capital of the Princely state of Surguja before Indian Independence. The name of the city is derived from the Hindu goddess Ambika (Mahamaya) Devi, who is the central figure of worship for the Hindus in the area.[4] The area under Ambikapur Municipal Corporation is 35.360 km$^2$.[5]

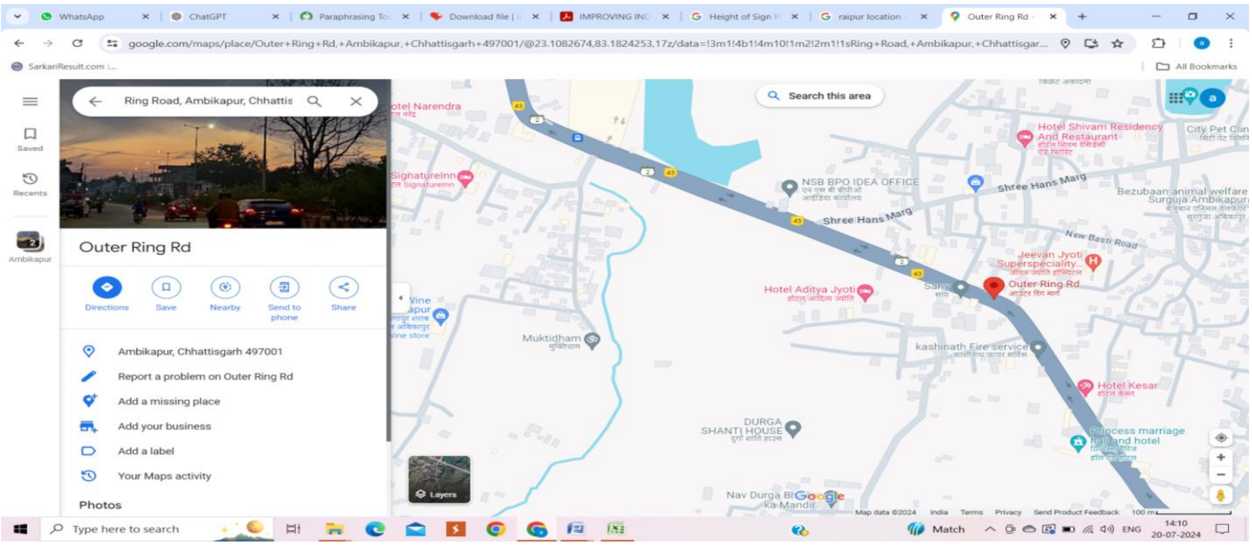


*Fig 4.1 Study Area of Data Collection*

### 4.2 Data Collection

Data collection for the traffic signs and signals was conducted along the outer ring road of Ambikapur, specifically from the NSB BPO Idea office to Jila Hospital Ambikapur. The inspection covered the signs and signals on the route from Sail Chock to Ispat Market using a combination of visual inspection methods and cameras.

The data collection involved a visual night-time inspection method to assess the retroreflectivity of the signs. Retroreflectivity measures a material's ability to reflect light back toward its source, such as vehicle headlights, particularly during nighttime conditions. This test was performed between 7:30 PM and 9:30 PM, with vehicles traveling at a speed of 40 km/h. During the inspection, the visual assessment was conducted from a distance of 100 meters from the sign. Vehicle headlights were directed at the signs to evaluate their retroreflective properties.

## 5. Results

### 5.1 Minimum Distances for Sign Visibility and Legibility

***Table 5.1 Minimum Distances for Sign Visibility and Legibility***

| Speed (Km/hour) | Visibility (m) | Legibility (m) |
|---|---|---|
| 40 | 90 | 55 |
| 50 | 100 | 55 |
| 60 | 150 | 70 |
| 70 | 170 | 70 |
| 80 | 185 | 70 |

To find the coefficient of retroflection (Ra) values for each sign. The coefficient of retro reflection (Ra) is the ratio of the light which the sign reflects to a driver (cd) to the light which illuminates the sign (lx) per unit area ($m^2$). By getting the Ra values we can find the observation angle, entrance angle. From these two angles we can find the coefficient of retroflection (Ra).

Vehicle to sign distance is 100 mts sign height is 2.0 mts. Vehicle headlight distance from theroad 0.65 mts driver sight distance is 1.2mts**.** from these distances can find the observation angles and entrance angles. First can find the observation angle and entrance angle for the visibility distance. These distances are based on the type of roadways and cities.

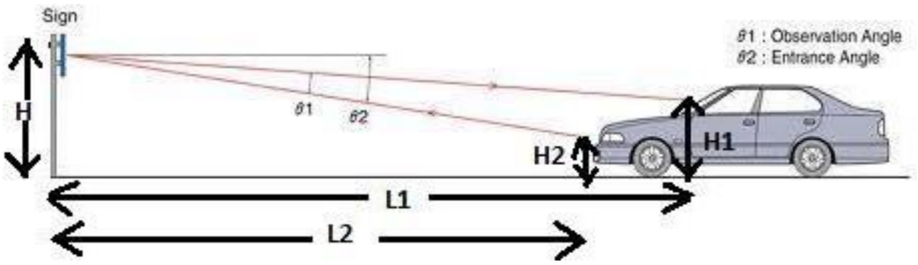


***Figure 5.1 Source from Nippon Carbide Industries***

### 5.4 Retro-Reflectivity Performance Standards

***Table 5.2 Retro-Reflectivity Performance Standards***

| | |
|---|---|
| White | A=342<br>R=307 |
| Yellow | A=238<br>R=212 |
| Red | A=67 |

| | |
|---|---|
| | R=60 |
| Blue | A=17 |
| | R=15 |

A= annual tests conducted if below, these values.R= replacement considered below, these values.

As per based on that standards some signs having the less retro-reflectivity standards. For thatsigns we can need replaced or maintenance the signs. The sign inspected and compare these with the retro-reflective standards. The signs failed at the night time inspection methods using the legibility and visibility sight distances. These observations are compared with the AASHTO specifications and there is a minor percentage of error, so these values are reliable for the further analysis of the study.

***Table 5.3 Sign Inspected Data***

| | **Regulatory Signs** | **Informatory Signs** | **Warning Signs** |
|---|---|---|---|
| Tested | 10 | 23 | 3 |
| Passed | 8 | 15 | 3 |
| Failed | 2 | 8 | 0 |
| % failed | 20% | 35% | 0% |

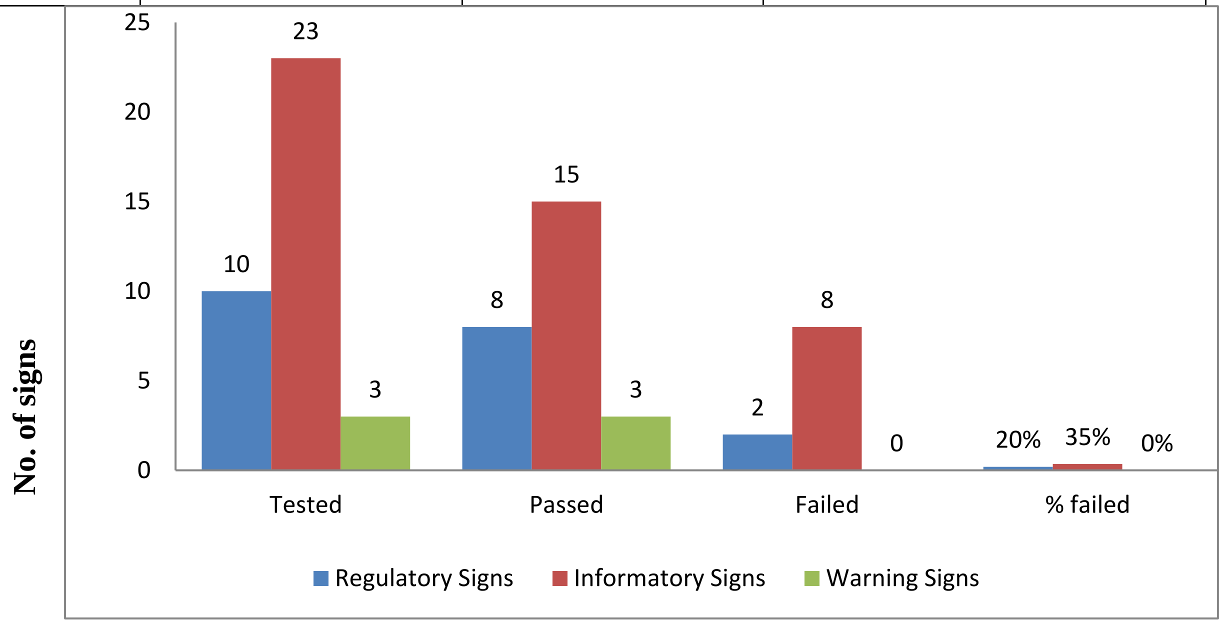


***Fig 5.2 ToFig.5.2 Total Signs and Failed Signs in Each Type of Sign***

**5.5 Asset Data Mapping In a Geographic Information System (GIS)**

The collected signs will be plotted in a geographic information system. First, we should takea position of the each sign and then noted the longitude and latitude of the each sign. And thisshould be plotted in the arc GIS we should create a file. Data from various sources can be integrated into the road safety database and displayed all together in Google Earth. This makes it easier to find out the contributing factors that influences the safety performance of the road.

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***Table 5.4 Latitude and Longitude of the Each Sign***

| Latitude | Longitude |
|---|---|
| 22$^0$14’46.56 | 84$^0$52'46.41" |
| 22$^0$14'46.00" | 84$^0$52'44.69" |
| 22$^0$14'35.29" | 84$^0$52'41.05" |
| 22$^0$14'27.94" | 84$^0$52'37.18" |
| 22$^0$14'22.44" | 84$^0$52'34.35" |
| 22$^0$13'54.35" | 84$^0$52'17.10" |
| 22$^0$13'51.72" | 84$^0$52'14.18" |
| 22$^0$13'49.47" | 84$^0$52'13.37" |
| 22$^0$13'49.47" | 84$^0$52'13.37" |
| 22$^0$13'23.67" | 84$^0$52'03.88" |
| 22$^0$13'24.21" | 84$^0$52'05.17" |
| 22$^0$13'21.41" | 84$^0$51'56.64" |
| 22$^0$13'21.61" | 84$^0$51'52.61" |
| 22$^0$13'21.60" | 84$^0$51'47.24" |
| 22$^0$13'21.60" | 84$^0$51'47.24" |
| 22$^0$13'18.68" | 84$^0$51'31.20" |
| 22$^0$14'52.27" | 84$^0$51'52.56" |
| 22$^0$15'02.57" | 84$^0$52'48.61" |
| 22$^0$15'12.04" | 84$^0$52'46.18" |
| 22$^0$15'16.64" | 84$^0$52'37.35" |
| 22$^0$1505.30" | 84$^0$52'42.48" |

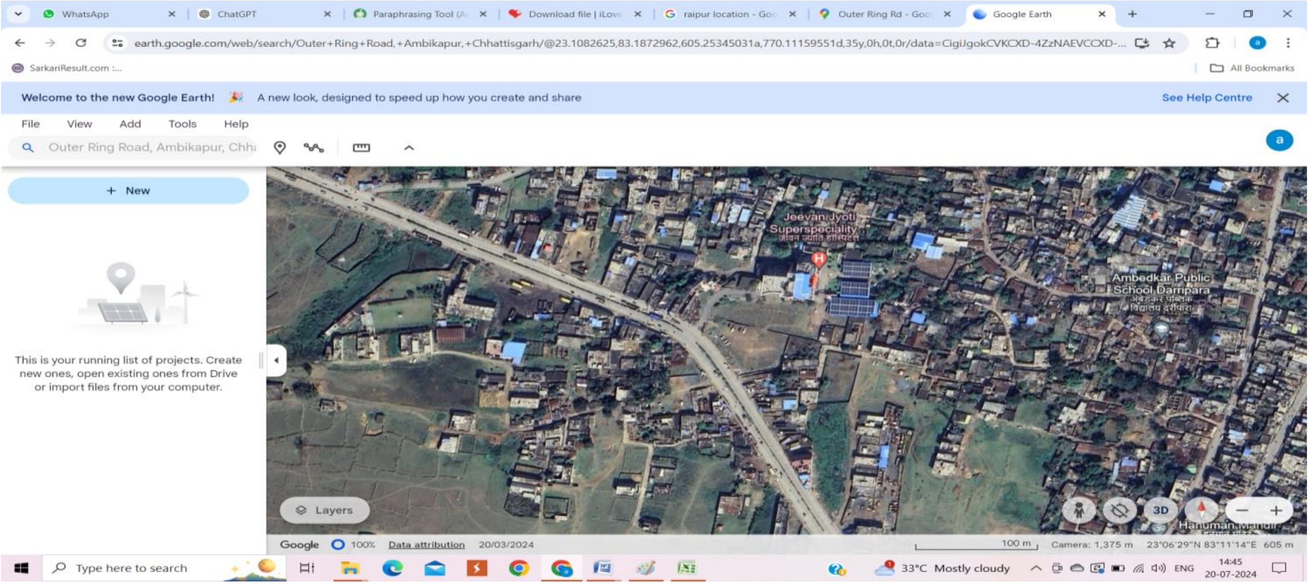


*Fig 5.3 Sign Asset Data in GIS*

### 5.6 Steps Followed In Arc GIS

- Get the latitude and longitude in an excel sheet
- Import the excel sheet to arc GIS
- Define the x and y values in arc GIS
- Then the point of features opened in the arc GIS
- Convert the point features into a layer feature using the arc GIS tool
- Then convert the layer to (. kml) format for viewing the layer file in Google earth
- Open Google earth and import the (. kml) file to open in Google earth

### 5.7 Management Data

*Table 5.4 Sizes of Collected Signs Data*

| S.No | Sign Type | No of Signs | Diameter of Sign (Mm) | Sheet Type |
|---|---|---|---|---|
| 1 | Maximum Speed 40kmph | 05 | 600mm | Engineering Grade |
| 2 | Speed BeakerSign | 01 | 600mm | EngineeringGrade |
| 3 | Major Road Ahead Sign | 02 | 600mm | Engineering Grade |
| 4 | No Parking Sign | 03 | 600mm | Engineering Grade |
| 5 | Informatory Signs | 23 | 450mm | Engineering Grade |

### 5.7.1 Cost of Each Sign

*Table 5.5 Approximate Manufacture Costs of Signs*

| S.No | Sign Type | Manufacture Cost (INR) | Maintenance Cost (INR) | Total Cost (INR) |
|---|---|---|---|---|
| 1 | Maximum Speed 40 kmph | 1010*5 | Individual sign crew worker wage/total No.of signs. | 5050 |
| 2 | Speed Beaker Sign | 510 | | 510 |
| 3 | Major Road Ahead Sign | 2*510 | | 1020 |
| 4 | No Parking Sign | 3*1140 | | 3420 |
| 5 | Informatory Signs | 23*760 | | 17480 |

The cost of the regulatory sign is the INR 1010 and no of signs should be 5 and speed beaker sign cost INR 510 and two major road ahead signs with the cost of 510. No parking sign should be INR 1140inr total 3 signs. And 23 more number of informatory signs each signcost is 760. Then the total manufacture cost of the total signs is INR 27480. And themaintenance cost should be included in the management methods (daily wages, paintings, repairs) for all this the minimum maintained cost per year INR 250 per sign approximately. We have to maintain 33 signs the total cost should be 8250 per year. The maintain should be twice in a year. The total cost of the signs was INR 35730.these values are based on the population and traffic volume and market prices. These costs are changes year by year.

## 6. Conclusion

The goal of analyzing the asset management of traffic signs is to minimize asset costs while maintaining a high level of safety on local and state roads. This analysis has demonstrated that effective management and maintenance of traffic signs are crucial for ensuring road safety and optimizing costs. The observations from this study, when compared with the AASHTO specifications, show a minor percentage of error, indicating the reliability of these values for further analysis.

Key findings from the study include:

➢ **Regulatory Signs:** Approximately 75% of the signs met the visibility and legibility standards. However, some regulatory signs need to be replaced due to insufficient reflectivity. Maintenance is required for three specific signs to ensure they meet safety standards.

➢ **Informatory Signs:** Several informatory signs must be replaced as their directional information is not visible from a certain distance, impacting their effectiveness.

➢ **Parking Signs:** These signs need to be visible from all distances and angles to ensure proper compliance and safety.

➢ **Cost Estimation:** The manufacture and maintenance costs for all signs have been estimated. These costs are expected to change annually, influenced by factors such as population growth, traffic volume, and market prices.

By addressing these issues, the overall safety of the road network can be improved while keeping costs in check. The findings and recommendations from this study provide a solid foundation for enhancing traffic sign asset management and ensuring that traffic signs effectively contribute to road safety.

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