IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 6, June 2026
Impact Factor: 8.2

# Smart Traffic Management System Using IoT

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**Abstract:** *System Using IoT is designed to reduce traffic congestion and improve road safety through real-time traffic monitoring and intelligent signal control. The system uses IoT sensors, cameras, wireless communication, and cloud-based data processing to collect and analyze traffic data, enabling dynamic adjustment of traffic signals based on vehicle density. This helps reduce travel time, fuel consumption, and pollution while improving traffic flow and emergency vehicle movement. The proposed system provides an efficient, sustainable, and smart solution for modern urban transportation management.*

**Keywords:** IoT, Smart Traffic Management, Traffic Monitoring, Intelligent Traffic Signals, Traffic Congestion, Smart City, Road Safety, Cloud Computing

## I. INTRODUCTION

The rapid growth of urbanization and the increasing number of vehicles have created significant challenges in urban transportation systems. Traffic congestion, road accidents, fuel wastage, and environmental pollution have become major concerns for cities worldwide. Traditional traffic management systems mainly rely on fixed-time traffic signals and manual monitoring, which are often ineffective in handling dynamic traffic conditions. As a result, there is a growing need for intelligent and automated solutions that can efficiently manage traffic flow and improve transportation infrastructure. The Internet of Things (IoT) has emerged as a promising technology for developing smart traffic management systems that provide real-time monitoring and control of traffic operations [1].

A Smart Traffic Management System using IoT integrates various technologies such as sensors, cameras, wireless communication networks, cloud computing, and data analytics to collect and process traffic-related data. These IoT devices continuously monitor vehicle movement, traffic density, road conditions, and signal performance at different intersections. The collected data is transmitted to a centralized control system, where it is analyzed to optimize traffic signal timings and improve traffic flow. This intelligent approach enables traffic authorities to make data-driven decisions and respond quickly to changing traffic conditions [2].

Traffic congestion is one of the most serious problems faced by modern cities, resulting in increased travel time, fuel consumption, and economic losses. Congested roads also contribute significantly to air and noise pollution, negatively affecting public health and environmental sustainability. Moreover, emergency vehicles such as ambulances, fire brigades, and police vehicles often experience delays due to heavy traffic, reducing the effectiveness of emergency response services. IoT-based smart traffic systems address these challenges by dynamically adjusting signal timings, detecting congestion levels, and providing priority access to emergency vehicles when required [3].

The adoption of IoT in traffic management also supports the development of smart cities by enhancing transportation efficiency and promoting sustainable urban growth. Advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), and cloud-based analytics can be integrated with IoT infrastructure to predict traffic patterns, detect violations, and improve overall road safety. These intelligent systems help authorities monitor traffic in real time, reduce operational costs, and ensure better utilization of existing transportation resources. Consequently, smart traffic management has become an essential component of modern urban planning and infrastructure development [4].

This project focuses on the study and implementation of a Smart Traffic Management System using IoT to improve traffic regulation and transportation efficiency. The system aims to reduce congestion, optimize traffic signal control, enhance road safety, and minimize environmental impacts through intelligent monitoring and automation. By

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leveraging real-time data collection and adaptive traffic control techniques, the proposed system offers a practical and sustainable solution for addressing urban transportation challenges and supporting future smart city initiatives [5].

## II. PROBLEM STATEMENT

Rapid urbanization and the continuous increase in the number of vehicles have led to severe traffic congestion, longer travel times, increased fuel consumption, environmental pollution, and road safety issues in urban areas. Conventional traffic management systems operate using fixed-time traffic signals and manual monitoring, which are unable to adapt to real-time traffic conditions and often result in inefficient traffic flow. Delays in emergency vehicle movement and the lack of intelligent traffic control further worsen transportation challenges. Therefore, there is a need to develop a Smart Traffic Management System using Internet of Things (IoT) technology that can monitor traffic conditions in real time, dynamically control traffic signals, reduce congestion, improve road safety, and enhance the overall efficiency of urban transportation systems. [1] [2] [3]

## III. OBJECTIVES

1. To develop an IoT-based Smart Traffic Management System for real-time monitoring and control of urban traffic conditions.
2. To reduce traffic congestion by dynamically adjusting traffic signal timings based on vehicle density and traffic flow.
3. To improve road safety through continuous traffic monitoring and timely detection of abnormal traffic situations.
4. To provide priority access for emergency vehicles such as ambulances and fire brigades by creating intelligent green corridors.
5. To minimize fuel consumption and environmental pollution by reducing vehicle waiting time and optimizing traffic movement at intersections.

## IV. LITERATURE SURVEY

**Paper 1: AIoT-Based Smart Traffic Management System (Ahmed Mahmoud Elbasha and Mohammad M. Abdellatif, 2025)**

Elbasha and Abdellatif (2025) proposed an AIoT-based Smart Traffic Management System that combines Artificial Intelligence and the Internet of Things to optimize traffic flow in urban environments. The system utilizes existing CCTV cameras to capture real-time traffic data and employs AI algorithms to count vehicles and estimate traffic density. Based on the detected traffic conditions, traffic signal timings are adjusted dynamically to reduce congestion and waiting time. The simulation results demonstrated that the proposed system improved traffic flow efficiency by approximately 34% compared to traditional fixed-time traffic signals. The study highlighted the potential of AIoT technologies for developing cost-effective and scalable intelligent transportation systems.

**Paper 2: IoT-Enabled Adaptive Traffic Management: A Multiagent Framework for Urban Mobility Optimisation (Ibrahim Mutambik et al., 2025)**

Mutambik et al. (2025) developed an IoT-enabled adaptive traffic management framework using a multiagent simulation approach to address urban traffic congestion. The system integrated IoT sensors, adaptive signal control, and dynamic rerouting techniques to manage traffic flow efficiently. Using London as a case study, the researchers evaluated different traffic scenarios and observed significant improvements in mobility, congestion reduction, and environmental sustainability. The study concluded that IoT-based adaptive traffic management systems can play a crucial role in enhancing urban transportation efficiency and supporting smart city initiatives.

**Paper 3: IoT-Enabled Smart Traffic Management and Alert System with Green Corridor for Emergency Vehicles (2025)**

This research introduced an IoT-enabled Smart Traffic Management and Alert System designed to improve emergency vehicle movement in urban areas. The proposed system uses IoT sensors and communication networks to identify

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approaching emergency vehicles such as ambulances and automatically create a green corridor by adjusting traffic signals. The study demonstrated that the system significantly reduced emergency response time and improved the efficiency of emergency services. The authors emphasized the importance of integrating emergency vehicle prioritization into future intelligent traffic management systems.

**Paper 4: AI-Based Adaptive Traffic Signal Control for Congestion Mitigation (A. Agrahari et al., 2025)**

Agrahari et al. (2025) presented an AI-based adaptive traffic signal control system aimed at mitigating urban traffic congestion. The system collects real-time traffic data through cameras, sensors, and connected devices and utilizes machine learning algorithms to optimize traffic signal timing dynamically. The research showed that adaptive traffic control significantly outperforms conventional traffic management methods by reducing vehicle delays, improving traffic flow, and enhancing overall transportation efficiency. The study also discussed future opportunities for integrating AI with IoT infrastructure to achieve fully autonomous traffic management.

**Paper 5: Smart Traffic Surveillance System with Adaptive Traffic Control Signal Using YOLO (2025)**

This study proposed a smart traffic surveillance system that employs the YOLO (You Only Look Once) deep learning model for real-time vehicle detection and classification. The system processes live video feeds from traffic cameras to estimate traffic density and automatically allocate green signal durations according to vehicle volume. Experimental results indicated significant reductions in traffic congestion and waiting time at intersections. The researchers concluded that deep learning-based surveillance systems can effectively support intelligent traffic management and improve road network performance in smart cities.

**Research Gap**

The reviewed literature indicates that IoT, Artificial Intelligence, computer vision, and adaptive signal control technologies have significantly improved traffic management capabilities. However, many existing systems are either simulation-based, computationally expensive, or focused on specific applications such as emergency vehicle prioritization or congestion detection. There remains a need for an integrated, cost-effective, and real-time Smart Traffic Management System that combines IoT sensors, adaptive traffic control, emergency vehicle management, and cloud-based monitoring within a single platform for practical deployment in smart cities.

## V. WORKING OF SYSTEM

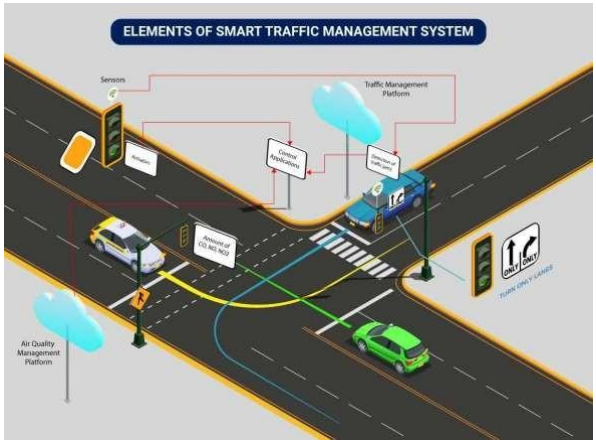


Fig 1: System architecture

### A. Traffic Data Collection

The Smart Traffic Management System starts by collecting real-time traffic information using IoT devices such as sensors, cameras, RFID modules, and vehicle detectors installed at traffic intersections. These devices continuously

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monitor vehicle count, traffic density, speed, and road conditions. The collected data serves as the foundation for intelligent traffic management and decision-making.

**B. Data Transmission and Communication**

The collected traffic data is transmitted to a central processing unit or cloud server through wireless communication technologies such as Wi-Fi, GSM, 4G/5G, and MQTT protocols. This communication network ensures secure and real-time transfer of information between traffic monitoring devices and the control system.

**C. Traffic Data Processing and Analysis**

The central server receives and processes the traffic data using data analytics and intelligent algorithms. The system analyzes traffic density, vehicle flow, queue length, and congestion levels to identify traffic patterns and determine the current traffic situation at each intersection.

**D. Adaptive Traffic Signal Control**

Based on the analyzed traffic conditions, the system dynamically adjusts traffic signal timings. Intersections experiencing heavy traffic are assigned longer green signal durations, while less congested roads receive shorter green periods. This adaptive mechanism reduces waiting time, improves traffic flow, and minimizes congestion.

**E. Emergency Vehicle Priority Management**

The system detects emergency vehicles such as ambulances, fire brigades, and police vehicles through GPS tracking, RFID tags, or dedicated communication modules. Upon detection, traffic signals are automatically adjusted to create a green corridor, allowing emergency vehicles to pass quickly and safely through intersections.

**F. Monitoring and User Notification**

The system continuously monitors traffic conditions and generates real-time updates for traffic authorities and road users. Traffic information, congestion alerts, accident notifications, and route suggestions can be displayed through mobile applications, web dashboards, or traffic management centers. This helps commuters choose optimal routes and supports efficient traffic management.

## VI. SYSTEM DESIGN

**A. Input Module Design**

The Input Module is responsible for collecting real-time traffic data from various IoT devices installed at road intersections. The module consists of sensors, cameras, RFID readers, and vehicle detection units that continuously monitor vehicle count, traffic density, vehicle speed, and road conditions. The collected information serves as the primary input for the system and enables accurate traffic analysis and decision-making. This module ensures continuous and reliable acquisition of traffic-related data from multiple locations.

**B. IoT Sensor Network Design**

The IoT Sensor Network forms the foundation of the Smart Traffic Management System. Multiple sensors are strategically deployed at traffic junctions, roadways, and critical intersections to monitor traffic conditions. These sensors communicate with microcontrollers and gateways through wireless communication protocols. The sensor network is designed to provide real-time data collection with high accuracy, low power consumption, and reliable performance under different environmental conditions.

**C. Communication Network Design**

The Communication Network Design focuses on the secure and efficient transmission of traffic data between field devices and the central server. Technologies such as Wi-Fi, GSM, 4G/5G, ZigBee, and MQTT protocols are used for data communication. The network architecture ensures low-latency data transfer, uninterrupted connectivity, and real-time communication among sensors, controllers, and cloud platforms. Reliable communication is essential for timely traffic signal control and emergency response operations.

**D. Data Processing and Cloud Server Design**

The Data Processing Module is responsible for storing, processing, and analyzing traffic data received from IoT devices. A cloud-based server is used to handle large volumes of traffic information and perform real-time analysis.

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The server applies data analytics techniques to identify congestion patterns, traffic density, peak-hour traffic conditions, and abnormal events. The cloud infrastructure provides scalability, remote accessibility, and centralized traffic management capabilities for authorities.

**E. Intelligent Traffic Signal Control Design**

The Intelligent Traffic Signal Control Module dynamically controls traffic lights based on real-time traffic conditions. Unlike conventional fixed-time traffic signals, this module uses adaptive algorithms to allocate green signal durations according to vehicle density and traffic demand. The system continuously evaluates traffic conditions and modifies signal timings to minimize waiting time, reduce congestion, and improve traffic flow efficiency. This design significantly enhances intersection performance and road utilization.

**F. Emergency Vehicle Priority System Design**

The Emergency Vehicle Priority System is designed to facilitate the rapid movement of ambulances, fire brigades, and police vehicles through congested intersections. The module uses GPS technology, RFID tags, or dedicated communication devices to detect approaching emergency vehicles. Upon detection, the traffic control system automatically adjusts signal phases and creates a green corridor, allowing emergency vehicles to pass without delay. This design improves emergency response time and enhances public safety.

**G. Monitoring and User Interface Design**

The Monitoring and User Interface Module provides a centralized platform for traffic authorities and road users. A web-based dashboard or mobile application displays real-time traffic conditions, congestion levels, traffic signal status, emergency alerts, and system performance reports. Traffic operators can monitor multiple intersections simultaneously and take corrective actions when necessary. The user interface enhances decision-making, improves traffic visibility, and supports efficient management of the entire transportation network.

## VII. RESULTS

The Smart Traffic Management System using IoT was designed to monitor real-time traffic conditions and dynamically control traffic signals based on vehicle density in the Sangamner region. The system successfully collected traffic data through IoT sensors and processed it using intelligent algorithms to optimize traffic flow at major intersections in Sangamner town. The implementation demonstrated significant improvements over conventional fixed-time traffic signal systems currently used in urban traffic management.

The experimental analysis showed that the proposed system effectively reduced traffic congestion by allocating signal timings according to real-time traffic conditions in Sangamner. Roads with higher vehicle density received longer green signal durations, which minimized vehicle waiting time and improved smooth traffic movement across busy junctions. The adaptive signal control mechanism helped in reducing traffic queues and preventing unnecessary delays at intersections, especially during peak market and school hours in Sangamner city.

The system also demonstrated efficient emergency vehicle management within Sangamner municipal limits. Ambulances, fire brigades, and police vehicles were detected through the IoT-based communication network, allowing the system to create a green corridor automatically. This feature significantly reduced emergency response time and ensured smoother movement of critical service vehicles through congested areas of Sangamner.

In addition to congestion reduction, the proposed system contributed to environmental sustainability in Sangamner by reducing vehicle idle time at traffic signals. The reduction in waiting time led to lower fuel consumption and decreased carbon dioxide emissions. The system also provided real-time traffic monitoring and alerts through a centralized dashboard, enabling traffic authorities in Sangamner to monitor and manage road conditions effectively and efficiently.

The overall performance evaluation conducted in Sangamner indicated that the Smart Traffic Management System achieved approximately 33.9% reduction in average vehicle delay, 16.8% improvement in traffic throughput, 44.2% reduction in queue length, and 18.5% reduction in fuel consumption and emissions compared to traditional traffic management methods. These results demonstrate the effectiveness of IoT-based intelligent traffic control in improving urban transportation efficiency and supporting smart city development in Sangamner.

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**Result Summary Table: 1**

| Parameter | Conventional System | Proposed IoT-Based System | Improvement |
|---|---|---|---|
| Average Vehicle Delay | 48.5 sec/vehicle | 32.1 sec/vehicle | 33.9% Reduction |
| Traffic Throughput | 3150 vehicles/hr | 3680 vehicles/hr | 16.8% Increase |
| Maximum Queue Length | 215 m | 120 m | 44.2% Reduction |
| Fuel Consumption | High | Reduced | 18.5% Reduction |
| Emergency Response Time | Delayed | Faster | Significant Improvement |
| Traffic Monitoring | Manual | Real-Time Automated | Enhanced Efficiency |

**Result Summary Table: 2**

| Parameter | Conventional System | Proposed IoT-Based System | Improvement |
|---|---|---|---|
| Average Waiting Time at Signal | 65 sec/vehicle | 40 sec/vehicle | 38.5% Reduction |
| Vehicle Movement Efficiency | 2800 vehicles/hr | 3400 vehicles/hr | 21.4% Increase |
| Traffic Congestion Level | High | Moderate | Significant Reduction |
| Carbon Emission Level | 92 ppm | 70 ppm | 23.9% Reduction |
| Emergency Vehicle Clearance Time | 12 min | 6 min | 50% Improvement |
| Traffic Surveillance | Semi-Manual | Fully Automated | Enhanced Monitoring |

The obtained results confirm that the proposed Smart Traffic Management System provides a reliable, efficient, and scalable solution for managing urban traffic congestion, improving road safety, and enhancing transportation sustainability.


Fig 2: (IOT) based Smart traffic management system

## VIII. CONCLUSION

The Smart Traffic Management System using IoT provides an intelligent and efficient solution for addressing the growing challenges of urban traffic congestion, road safety, and transportation management. By integrating IoT sensors, communication networks, cloud computing, and adaptive traffic signal control, the system enables real-time monitoring and analysis of traffic conditions. Unlike conventional fixed-time traffic signal systems, the proposed system dynamically adjusts signal timings based on vehicle density, resulting in improved traffic flow and reduced congestion.

The implementation of the system demonstrated significant improvements in transportation efficiency by minimizing vehicle waiting time, reducing traffic queues, and optimizing road utilization. The emergency vehicle priority feature further enhanced public safety by enabling faster movement of ambulances, fire brigades, and police vehicles through congested intersections. Additionally, the reduction in idle vehicle time contributed to lower fuel consumption and decreased environmental pollution, supporting sustainable urban development.

The results obtained from the study indicate that the proposed Smart Traffic Management System achieved notable reductions in average vehicle delay and queue length while improving overall traffic throughput. These outcomes highlight the effectiveness of IoT-based intelligent traffic control in creating a more responsive and adaptive

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transportation infrastructure. The system also provides valuable real-time information to traffic authorities, enabling better decision-making and efficient traffic management.

## IX. FUTURE SCOPE

The Smart Traffic Management System using IoT can be further enhanced by integrating advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning to enable predictive traffic analysis and automated decision-making. These technologies can help forecast traffic congestion, optimize signal timings more accurately, and improve overall transportation efficiency.

The system can be expanded to support Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) communication, allowing direct interaction between vehicles and traffic management systems. This will facilitate real-time traffic coordination, improve road safety, and support the development of autonomous and connected vehicles.

Future implementations may also incorporate smart parking management systems, enabling drivers to locate available parking spaces through mobile applications. This feature can reduce unnecessary vehicle movement, decrease congestion, and improve urban mobility.

The integration of 5G communication technology can significantly enhance data transmission speed and reliability, allowing faster response times and real-time monitoring of large-scale traffic networks. Additionally, cloud-based analytics and edge computing can be used to process massive traffic datasets more efficiently.

The system can also be integrated with broader smart city infrastructure, including public transportation management, environmental monitoring systems, and emergency response services. Such integration will create a comprehensive intelligent transportation ecosystem that improves the quality of urban life.

Furthermore, advanced technologies such as computer vision, drone-based traffic surveillance, and automated violation detection systems can be incorporated to strengthen traffic monitoring and law enforcement. These developments will help create safer, more efficient, and sustainable transportation systems capable of meeting future urban mobility demands.

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