



TRAFFIC SAFETY ENHANCEMENT USING INTELLIGENT TRANSPORT SYSTEMS IN KARSHI CITY

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Abstract: *Traffic safety remains a critical challenge in urban areas due to increasing traffic volumes and complex traffic conditions. This study investigates the potential of Intelligent Transport Systems to enhance traffic safety through improved speed management, real-time traffic monitoring, and data-driven traffic control strategies. The research focuses on the analysis of vehicle speed characteristics and traffic behavior using field observations and analytical methods. Spot speed data were collected and evaluated to identify speed variations that may contribute to increased accident risk. The findings indicate that Intelligent Transport Systems can significantly improve traffic safety by supporting adaptive traffic management, timely incident detection, and informed decision-making. The study highlights the importance of integrating intelligent technologies into urban transport systems to reduce accident risk, improve traffic efficiency, and support sustainable urban mobility planning.*

Keywords: *Intelligent transport systems, traffic safety, speed management, urban traffic, spot speed analysis, traffic monitoring, smart mobility*

Introduction

Traffic safety has become a major concern for rapidly growing urban areas, where increasing vehicle ownership, population growth, and limited road capacity



intensify traffic congestion and accident risks. Traditional traffic management approaches are often insufficient to address the complexity of modern urban transport systems, particularly in cities experiencing dynamic changes in traffic demand. As a result, there is a growing need for innovative and technology-driven solutions that can enhance traffic safety while improving overall transport efficiency.

Intelligent Transport Systems represent an integrated approach that combines information, communication, and sensing technologies to support effective traffic management and safety enhancement. By enabling real-time data collection, processing, and dissemination, ITS applications contribute to improved traffic control, incident detection, speed regulation, and traveler information services. These technologies have demonstrated significant potential in reducing traffic accidents, minimizing congestion, and supporting sustainable urban mobility in various international contexts.

In Uzbekistan, and specifically in Karshi city, urban transport systems face increasing pressure due to rising traffic volumes and evolving mobility patterns. Conventional infrastructure expansion alone may not sufficiently address traffic safety challenges, highlighting the importance of adopting intelligent solutions tailored to local traffic conditions. The implementation of ITS offers an opportunity to improve traffic safety through better monitoring of traffic flow, timely incident response, and data-driven traffic management strategies.

This study focuses on traffic safety enhancement in Karshi city through the application of Intelligent Transport Systems. By analyzing traffic characteristics, accident data, and the potential role of ITS-based solutions, the research aims to identify effective approaches for reducing accident risk and improving traffic safety performance. The findings are expected to support urban transport planning and provide practical insights for the implementation of intelligent traffic management solutions in medium-sized cities.



Conceptual Framework and Functional Components of Intelligent Transport Systems

Intelligent Transport Systems represent an integrated technological framework that combines computing technologies, electronic devices, and communication networks with advanced management strategies to improve traffic safety and operational efficiency. The primary objective of ITS is to enhance the safety, comfort, and reliability of urban transport systems through systematic data collection, real-time analysis, and informed decision-making processes. Safety considerations serve as a fundamental driving force behind the development and implementation of ITS, as these systems aim to reduce traffic accidents, mitigate congestion, and improve overall transport performance.

By optimizing traffic flow and supporting proactive traffic management, ITS applications contribute to increased road network capacity and reduced transportation risks. Moreover, intelligent transport solutions facilitate coordination between different modes of transport, including road, rail, air, and water transport, enabling a more balanced and resilient urban mobility system. In rapidly urbanizing cities such as Karshi, the adoption of ITS provides an effective alternative to conventional infrastructure expansion, offering data-driven approaches to traffic safety enhancement.

Core Components of Intelligent Transport Systems

A central element of ITS implementation is the Traffic Management Center, which functions as the operational hub for collecting, processing, and disseminating transport-related information. The Traffic Management Center integrates real-time data from multiple sources and supports coordinated responses to traffic conditions, incidents, and emergencies. This centralized structure enables efficient decision-making and enhances system adaptability to varying traffic demands.

✓ Traffic Data Acquisition



Effective ITS operation relies on accurate and continuous data collection. Traffic data are obtained using a variety of sensing technologies, including automatic vehicle identification systems, GPS-based vehicle tracking, video surveillance cameras, and roadway sensors. These technologies capture essential parameters such as traffic volume, vehicle speed, travel time, congestion levels, and incident occurrence. Collected data are transmitted to centralized servers for storage and further analysis.

✓ **Data Communication and Transmission**

Timely and reliable data transmission is critical for ITS effectiveness. Traffic information is transmitted between field devices and the Traffic Management Center using wireless and wired communication technologies. Processed information is then disseminated to road users through multiple channels, including mobile applications, variable message signs, internet platforms, and short messaging services. These communication mechanisms enable drivers to make informed travel decisions and respond to changing traffic conditions.

✓ **Data Processing and Analytical Functions**

Collected traffic data undergo systematic processing, including error detection, data cleaning, aggregation, and analytical modeling. Advanced analytical techniques are applied to identify traffic patterns, predict congestion, and detect abnormal traffic conditions. The outcomes of these analyses support real-time traffic control strategies and long-term transport planning initiatives.

✓ **Traveler Information and Advisory Services**

ITS provides real-time traveler information services that enhance situational awareness for road users. These services include updates on travel time, traffic delays, accidents, route diversions, and roadwork activities. By delivering accurate and timely information, traveler advisory systems contribute to safer driving behavior, reduced congestion, and improved travel efficiency.



Fig. 1. Intelligent transport system framework for traffic safety enhancement.

Methodology

The study area was selected within an urban environment characterized by intensive traffic activity and increasing safety challenges. The research focuses on a principal urban road corridor that plays a significant role in daily traffic movement and connectivity between residential, commercial, and administrative zones. The selected road segment represents a critical part of the city's transport network, where traffic demand remains consistently high during both morning and evening peak hours.

The study corridor was identified based on several key criteria, including traffic volume intensity, congestion frequency, accident occurrence, and strategic importance within the urban transport system. Persistent congestion during peak periods has been observed along this corridor, resulting in reduced traffic flow efficiency, increased delay, and elevated accident risk. These conditions highlight the necessity for advanced traffic management solutions rather than conventional traffic control approaches.

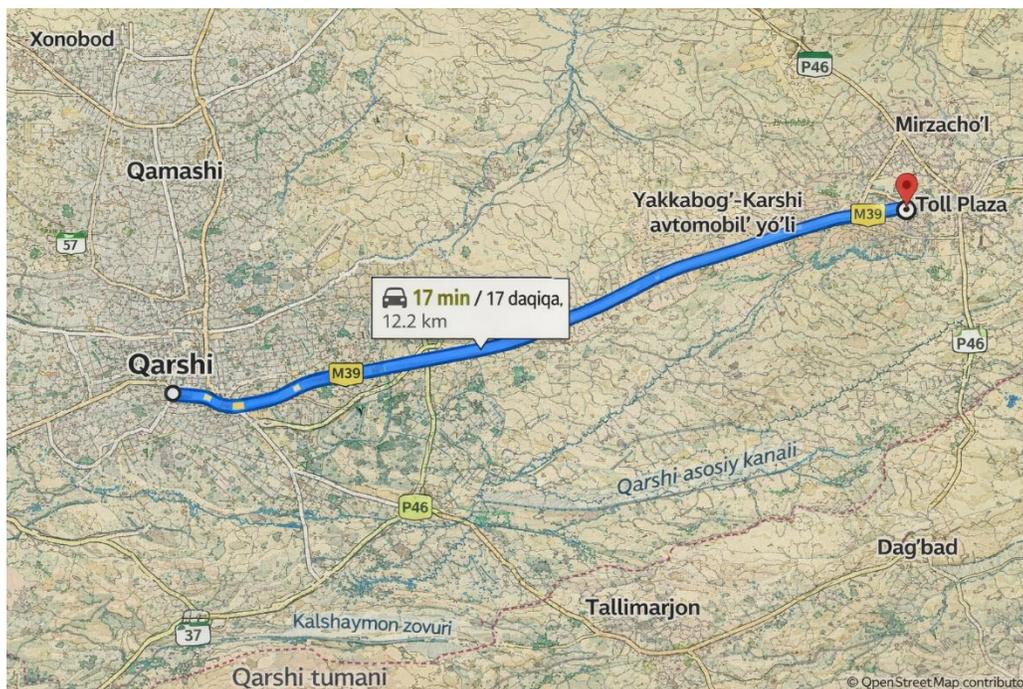


Fig. 2. Location of the selected study corridor based on the geological map of the Qarshi region.

The selected study area provides a suitable environment for evaluating the application of Intelligent Transport Systems aimed at enhancing traffic safety. The concentration of intersections, mixed traffic composition, and recurring congestion patterns create favorable conditions for assessing the effectiveness of ITS-based measures such as traffic monitoring, incident detection, and adaptive traffic control. Consequently, the chosen location serves as a representative case for analyzing how intelligent transport technologies can contribute to improving traffic safety and operational performance in urban road networks.

Results

Assessment of Vehicle Speed Characteristics Using Field Observation

Vehicle speed characteristics were analyzed to evaluate traffic safety conditions along the selected urban road segment. A field-based observation approach was applied to measure spot speeds over short time intervals, allowing for an accurate representation of prevailing traffic behavior. This method provides a



practical and cost-effective means of collecting speed data, particularly in urban environments where continuous monitoring systems may be limited.

Spot speed was determined by recording the time required for vehicles to traverse a predefined road section of known length. Measurements were conducted during representative traffic periods to capture variations in driving behavior under normal operating conditions. The collected speed data were subsequently used to assess compliance with speed regulations and to identify potential safety concerns related to excessive or inconsistent vehicle speeds.

The spot speed value was calculated using the following relationship:

$$v = \frac{L}{t} \quad (1)$$

where:

v denotes the spot speed of the vehicle in km/h;

L represents the length of the observed road segment in meters;

t corresponds to the travel time measured in seconds.

The results obtained from the spot speed analysis provide valuable insight into traffic flow efficiency and safety performance. When integrated with Intelligent Transport System applications, such speed assessments support the development of adaptive traffic control measures, speed management strategies, and real-time traffic monitoring solutions aimed at reducing accident risk and enhancing overall road safety.

Table 1. Spot Speed Distribution and Percentile Analysis

| Speed (km/h) | Observed frequency | Cumulative percentage (%) | Speed percentile |
|--------------|--------------------|---------------------------|------------------|
| 25 | 7 | 7 | 15th |
| 30 | 17 | 24 | |
| 35 | 22 | 46 | 50th |
| 40 | 18 | 64 | |



| | | | |
|----|----|-----|------|
| 45 | 14 | 78 | |
| 50 | 9 | 87 | 85th |
| 55 | 6 | 93 | |
| 60 | 3 | 96 | |
| 65 | 4 | 100 | |

Spot Speed Study Distribution Histogram

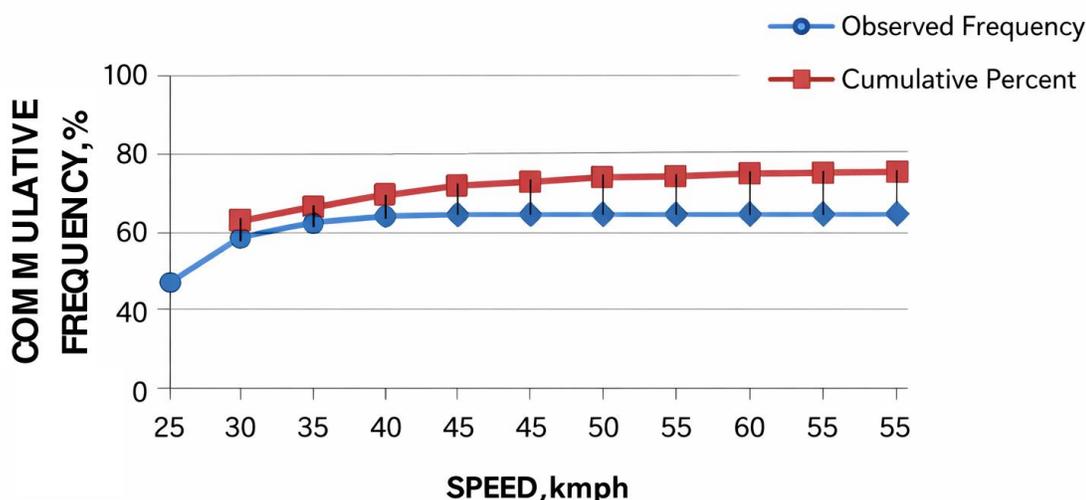


Fig. 3. Cumulative and observed frequency distribution of spot speed values.

Conclusion

This study confirms that Intelligent Transport Systems are effective tools for enhancing traffic safety through improved speed management, real-time monitoring, and timely information delivery to road users. The spot speed analysis indicates noticeable variations in vehicle speeds, which may increase accident risk under uncontrolled traffic conditions. The application of ITS-based measures enables better regulation of traffic flow, early detection of unsafe situations, and more responsive traffic management. Overall, the findings highlight the importance of integrating intelligent technologies into urban transport systems to support safer, more efficient, and sustainable traffic operations.



In addition, the study demonstrates that data-driven traffic management supported by ITS can assist transport authorities in identifying high-risk locations and implementing targeted safety interventions. The proposed approach provides a practical foundation for future ITS deployment and can be adapted to other urban areas with similar traffic characteristics, contributing to long-term improvements in traffic safety and mobility planning.

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