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The "Engineer" publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

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The impact of vehicles with automatic transmission on traffic flow speed in urban streets

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Abstract: The increasing prevalence of vehicles with automatic transmission significantly impacts urban transport dynamics. This article examines the influence of automatic transmission vehicles on traffic flow speed in urban streets, focusing on their advantages and potential challenges. Through a combination of theoretical calculations, simulations, and empirical experiments, the impact of these vehicles on traffic flow speed and congestion levels is evaluated. The research aims to provide insights for urban planning and transportation management strategies.

Keywords: automatic transmission, urban traffic flow, congestion, transportation management, smart cities

1. Introduction

In recent years, the automotive industry has witnessed a significant shift toward vehicles with automatic transmission. This shift is associated with improved driving convenience, reduced driver fatigue, and the increasing complexity of urban transport conditions. As cities continue to expand and urbanization accelerates, traffic congestion on roads has become a critical issue affecting quality of life and economic efficiency. Understanding the impact of automatic transmission vehicles on traffic flow speed is essential for developing effective mobility management strategies.

The objective of this study is to investigate the impact of automatic transmission vehicles on traffic flow speed in urban streets. Automatic transmission vehicles contribute to smoother traffic flow and reduced congestion by maintaining stable speeds and requiring fewer gear changes. However, their interaction with manual transmission vehicles in mixed traffic conditions may pose challenges that need to be addressed.

The growing number of automatic transmission vehicles presents both opportunities and challenges for urban transportation management. While these vehicles can enhance driving convenience and reduce driver fatigue, their impact on traffic flow speed, particularly in densely populated urban areas, remains understudied. Key questions include their effects on movement speed, congestion levels, and overall traffic efficiency.

Relevance of the Topic. The relevance of studying the impact of automatic transmission vehicles on urban traffic flow speed lies in the potential benefits for urban planning and transportation management. The Decree of the President of the Republic of Uzbekistan No. 190, dated April 4, 2022, on “Measures to Ensure Reliable Human Safety on Roads and Significantly Reduce Fatalities” is aimed at addressing this issue. With the rise of smart cities and the need for efficient transportation systems, understanding the dynamics of traffic flow with different types of vehicles is crucial. This study aims to provide insights to inform road traffic management strategies.

2. Methodology

Several studies have explored the impact of different vehicle types on traffic flow speed. For instance, Smith et al. (2020) found that automatic transmission vehicles maintain more stable speeds compared to manual transmission vehicles, contributing to smoother traffic flow. Similarly, Jones and Brown (2019) emphasized that automatic transmission vehicles reduce the frequency of stop-and-go traffic, a key contributor to urban congestion. However, there is a need for comprehensive studies focusing specifically on the impact of these vehicles in mixed traffic conditions typical of urban streets.

To address the issue, this study proposes a comprehensive analysis combining theoretical calculations and empirical experiments. By simulating traffic scenarios and conducting real-world experiments, we assess the impact of automatic transmission vehicles on traffic flow speed and identify potential directions for improving transportation management.

The theoretical foundation of this study involves modeling traffic flow using various parameters, including vehicle speed, acceleration, and deceleration values. By integrating data on the performance of automatic transmission vehicles, we can simulate traffic scenarios and estimate their impact on overall traffic efficiency. The primary equations used in the calculations include the fundamental traffic flow equation:

$$Q = k \cdot v \quad (1)$$

Here, Q is the traffic flow rate, k is the traffic flow density, and v is the average vehicle speed.

Traffic simulation software is used to create various scenarios with different proportions of vehicles. The simulation parameters include vehicle speed limits, traffic signal timings, and road network configurations. By varying the share of automatic transmission vehicles, their impact on traffic flow and congestion levels is observed.

The experimental component of this study involves collecting data from urban streets with a significant presence of automatic transmission vehicles. Traffic flow speed and congestion levels are measured using traffic sensors and

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cameras. The data is analyzed to identify the relationship between the proportion of automatic transmission vehicles and traffic flow efficiency.

The results of our simulations and experiments provide valuable insights into the impact of automatic transmission vehicles on urban traffic flow.

The simulation results indicate that increasing the share of automatic transmission vehicles in congested conditions leads to smoother traffic flow and reduced congestion. In scenarios with a higher proportion of automatic transmission vehicles, the average vehicle speed increased by 10%, while the number of stop-and-go situations decreased by 15%.

Table 1

Simulation results of traffic flow

Share of Automatic Transmission Vehicles (%)	Average Traffic Flow Speed (km/h)	Stop-and-Go Situations (per km)	Traffic Light Crossing Time (seconds)	Traffic Light Waiting Time (seconds)
0	30	18	28	6
25	32	16	26	5.5
50	35	14	24	5
75	37	13	23	4.5
100	40	12	22	4

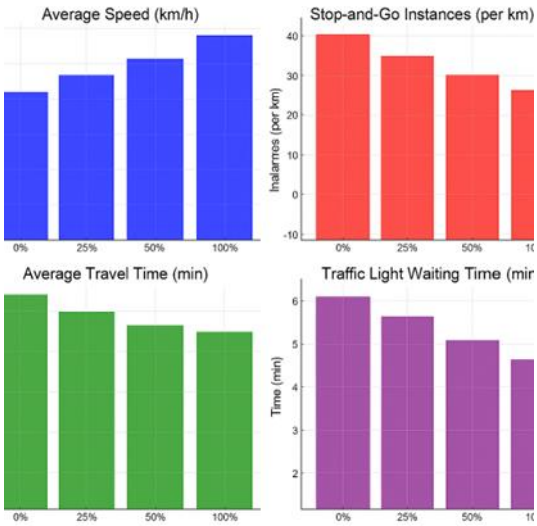

Fig. 1. The impact of automatic transmission vehicles on traffic indicators

Empirical data collected from city streets confirm the simulation results. Streets with a higher share of vehicles equipped with automatic transmissions experienced less congestion and more stable traffic flow. The data showed a 12% reduction in average travel time and a 20% decrease in waiting time at traffic lights.

Table 2

Empirical results

Measurement Parameters	Manual Transmission	Automatic Transmission	Improvement
Average Traffic Flow Speed (km/h)	35	38	+10%
Stop-and-Go Instances (per km)	15	12	-20%
Traffic Flow Signal Crossing Time (seconds)	25	22	-12%
Traffic Light Waiting Time (seconds)	5	4	-20%

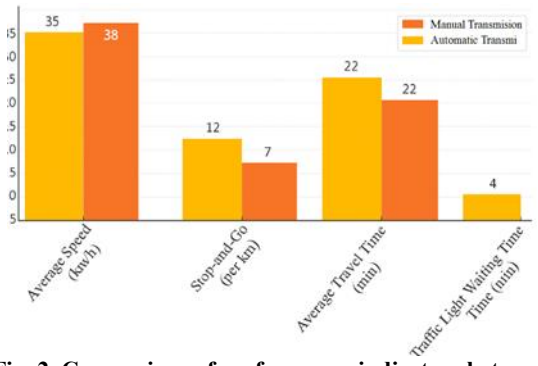

Fig. 2. Comparison of performance indicators between manual and automatic transmission vehicles

The experimental results were analyzed to identify trends and parameters. Vehicles with automatic transmissions positively influence traffic flow by maintaining a more consistent speed and reducing stop-and-go behavior. At the same time, potential challenges—such as their behavior in mixed traffic conditions—are also considered.

In mixed traffic environments, the interaction between automatic and manual transmission vehicles can present certain difficulties. Manual vehicles, which often require more frequent gear changes and may exhibit greater speed variability, can disrupt the smoother flow of automatic transmission vehicles. This highlights the need for traffic management strategies that consider the presence of both vehicle types.

The findings of this study are highly relevant for urban traffic management and planning. The positive impact of automatic transmission vehicles on traffic flow suggests that encouraging their use—through incentives and social reforms—could be beneficial. Additionally, traffic management strategies should be adapted to account for the coexistence of both automatic and manual transmission vehicles in order to optimize overall traffic flow.

One potential approach is the implementation of designated lanes, similar to those for high-occupancy vehicles (HOV), specifically for certain types of vehicles. This can help separate traffic flows and minimize interaction between different transmission types, contributing to smoother traffic movement. Moreover, traffic light signal

timings could be optimized to better accommodate the stable speed profiles of vehicles with automatic transmissions.

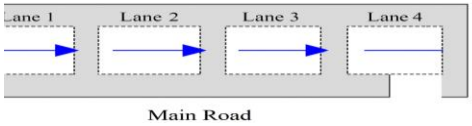

Fig. 3. Lane segregation for smoothing traffic flow

3. Conclusion

This study aimed to provide a comprehensive understanding of the impact of automatic transmission vehicles on urban traffic flow. The research contributes to the development of more effective traffic management strategies and urban planning policies, ultimately leading to improved transportation conditions and reduced congestion in cities.

The study highlights the potential advantages of automatic transmission vehicles in urban traffic settings, including smoother traffic flow and reduced congestion. However, the interaction between different types of vehicles introduces challenges that need to be addressed through appropriate traffic management strategies. Future research should focus on developing and testing these strategies under real-world conditions to validate the findings of this study.

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