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Traffic flow characteristics and their impact on air pollution in urban streets: a case study of Tashkent

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Abstract: This study investigates traffic flow characteristics on major streets in Tashkent, focusing on Amir Temur and Fargona Yuli streets, to evaluate their impact on vehicular emissions and air pollution. The analysis examines temporal variations, vehicle composition, and traffic dynamics based on observational data from 2023 to 2024. Key findings highlight peak congestion periods, the dominance of passenger cars in traffic composition, and the significant contribution of heavy vehicles to emissions. The results provide insights into how traffic characteristics influence urban air quality, laying the groundwork for sustainable transportation and environmental policies.

Keywords: traffic flow, vehicular emissions, urban air pollution, environmental impact, urban streets

1. Introduction

Urbanization and economic growth in Tashkent have significantly increased vehicular traffic, leading to challenges for air quality and public health. The city's rapid expansion, combined with a rising number of vehicles, has resulted in a noticeable decline in air quality, directly affecting residents' well-being. Vehicular emissions from passenger cars, trucks, and buses are a major source of urban air pollution, contributing to respiratory diseases and environmental degradation. Traffic congestion exacerbates these emissions, as vehicles spend more time idling or moving slowly, increasing emissions per unit of travel. Studies by Barth & Boriboonsomsin [1], Jandacka et al. [2], and the IEA [3] highlight the detrimental health and environmental impacts of congestion.

This research focuses on analyzing traffic flow along Amir Temur and Fargona Yuli streets, two of Tashkent's busiest roads, to explore their relationship with vehicular emissions and their contribution to urban air pollution. By studying these key transport corridors, the research aims to provide insights into how traffic dynamics can be managed to mitigate environmental impacts.

2. Research Methodology

Research on traffic-induced air pollution highlights the need for sustainable urban mobility solutions to mitigate congestion's environmental effects. Barth & Boriboonsomsin [1] showed that heavy congestion is linked to increased CO2 emissions, as vehicles consume more fuel when idling or moving slowly. Similarly, Ravish & Swamy [4] suggest that intelligent traffic systems, such as real-time monitoring and signal optimization, can reduce emissions by improving vehicle flow. Researchers like Litman [5], Santos [6], and Azizov & Beketov [7] stress the importance of integrating emission-reduction strategies into transport planning, advocating for public transport, cycling, and electric vehicles. Jandacka et al. [2] highlight regional differences in traffic emission impacts, noting that cities like Tashkent require context-specific solutions due to unique traffic dynamics.

Traffic flow data was collected from Amir Temur and Fargona Yuli streets over a year, spanning various days and time slots (8:00–20:00). The data included vehicle types—cars, trucks, buses, and others—along with vehicle counts per hour. This data was analyzed to identify peak congestion times and assess the impact of congestion on emissions. By observing traffic flow, this study aims to understand how congestion contributes to air pollution and explore potential solutions.

3. Results and Discussion

Traffic Volume Analysis

Table 1

Traffic Volume on Amir Temur Street (vehicles/hour)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

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8:00-9:00	6,338	6,210	6,194	6,221	6,089	5,286	3,216
9:00-10:00	6,122	5,975	5,897	6,086	6,347	5,647	3,342
10:00-11:00	5,796	5,545	5,436	5,657	5,968	4,976	3,230
11:00-12:00	6,089	5,869	5,655	5,716	5,450	4,567	3,125
12:00-13:00	5,832	5,746	5,634	5,845	5,348	5,016	3,263
13:00-14:00	5,625	5,312	5,162	5,428	5,348	4,810	3,190
14:00-15:00	5,187	5,230	5,322	4,968	5,078	4,397	2,902
15:00-16:00	4,986	4,864	4,378	4,710	4,656	4,056	2,741
16:00-17:00	5,241	5,475	5,512	5,189	5,324	4,568	3,450
17:00-18:00	5,786	6,210	5,730	5,746	6,134	5,475	2,985
18:00-19:00	6,347	6,256	6,310	6,187	6,436	5,582	4,330
19:00-20:00	6,185	6,233	6,160	6,350	6,124	5,446	3,946
Total	69,534	68,925	67,390	68,103	68,302	59,826	39,720

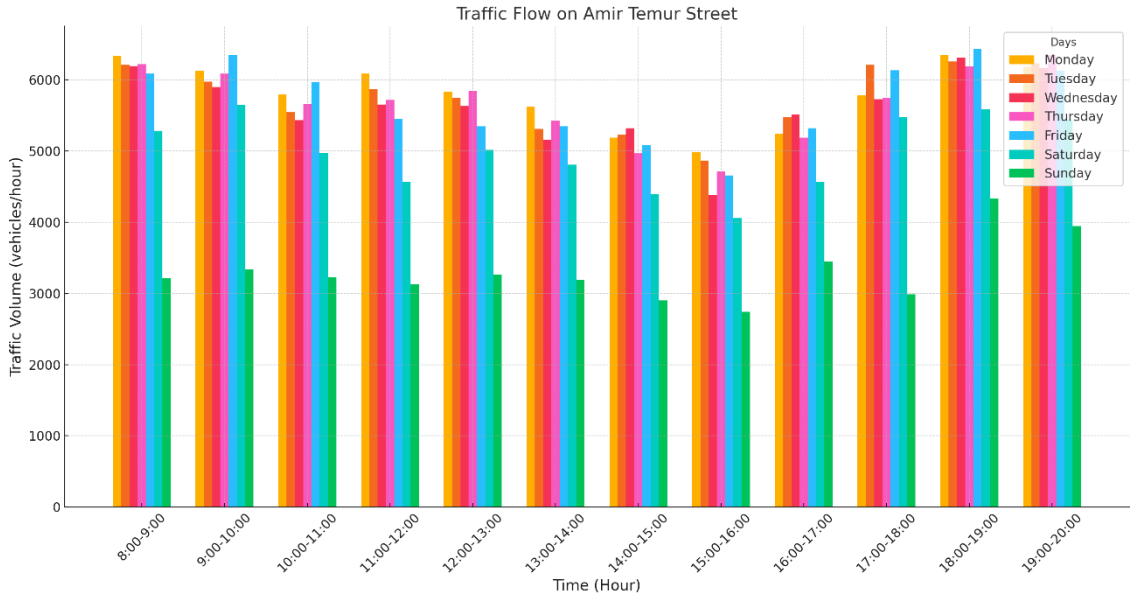

Figure 1. Traffic Flow on Amir Temur Street. ***Represents hourly traffic volume per day***

Table 2

Traffic Volume on Fargona Yuli Street (vehicles/hour)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8:00-9:00	4,866	5,151	5,054	5,189	5,020	4,142	2,935
9:00-10:00	5,186	5,094	5,148	5,294	5,164	4,267	3,086
10:00-11:00	5,247	4,902	5,076	5,348	4,983	4,186	2,706
11:00-12:00	4,986	4,853	4,973	5,139	5,019	4,286	3,125
12:00-13:00	4,752	4,628	4,628	4,829	4,698	4,075	3,189
13:00-14:00	4,532	4,459	4,752	4,511	4,572	3,875	3,096
14:00-15:00	4,729	4,825	4,619	4,352	4,765	3,942	2,946
15:00-16:00	5,049	5,209	4,752	4,698	4,993	3,712	2,843
16:00-17:00	5,124	5,216	5,037	4,817	5,065	3,956	2,975
17:00-18:00	5,275	5,148	5,162	5,193	5,269	4,218	3,048
18:00-19:00	5,346	5,038	5,087	5,007	5,137	4,307	3,142
19:00-20:00	5,075	5,547	5,113	5,127	4,801	4,297	3,276
Total	60,167	60,070	59,401	59,504	59,486	49,263	36,367

The data reveal that peak traffic volumes on Amir Temur and Fargona Yuli streets coincide with increased vehicular emissions during morning (8:00–10:00) and evening (17:00–19:00) hours. Passenger cars dominate, accounting for over

90% of traffic, with trucks and buses contributing significantly to emissions. These results are critical for assessing the environmental impact of urban traffic, as highlighted in [1, 2, 7].

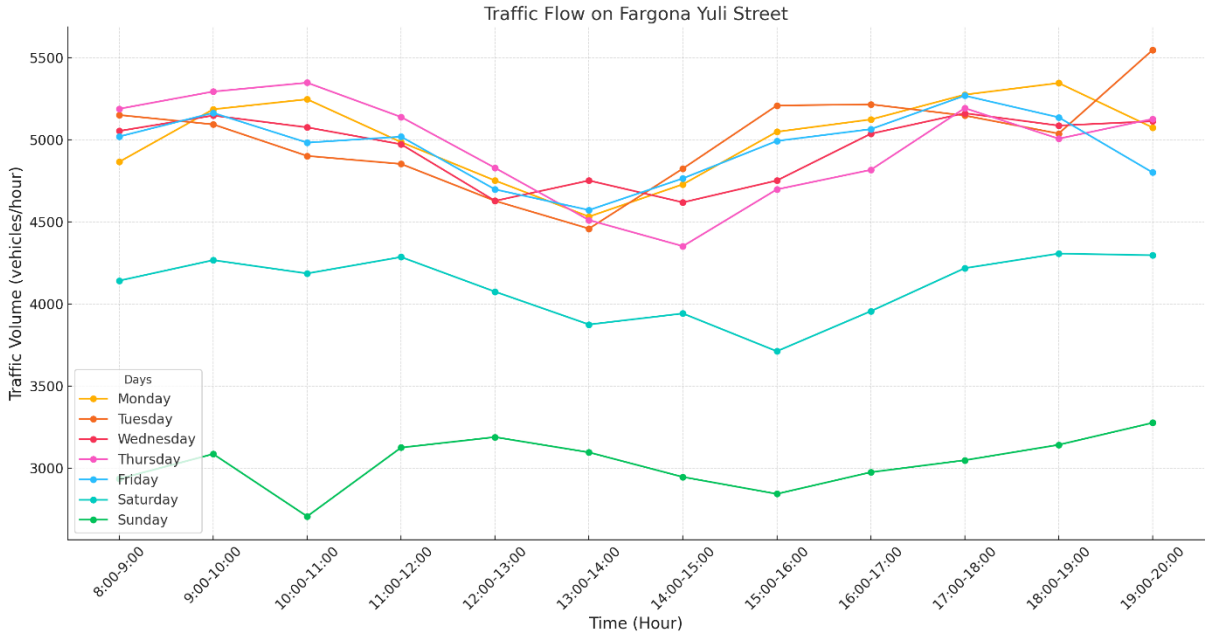

Figure 2. Traffic Flow on Fargona Yuli Street. ***Depicts hourly variation in traffic volume***

4. Conclusion

This study highlights the intersection between traffic characteristics and environmental concerns in Tashkent. Amir Temur and Fargona Yuli streets exemplify how urban traffic dynamics influence air pollution. Addressing these issues requires a multi-faceted approach, integrating sustainable transportation policies and emission reduction strategies to improve urban air quality.

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