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Issue Article

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EVALUATION OF TRANSPORT-OPERATIONAL PERFORMANCE OF URBAN ROADS: A CASE STUDY OF NUKUS CITY, UZBEKISTAN

Abstract: *The sustainable development of urban transport infrastructure requires systematic assessment of transport-operational indicators of road networks. This study evaluates the transport-operational performance of urban roads in Nukus city, Uzbekistan. The research focuses on key parameters including traffic intensity, pavement roughness, skid resistance coefficient, and rut depth. Field investigations were conducted on selected sections of A. Dosnazarov Street and Uzbekistan Guzar Street. The results reveal that increasing traffic flow and climatic factors significantly influence pavement deterioration and operational performance. Practical recommendations are proposed to enhance pavement durability and improve traffic safety. The findings contribute to optimizing maintenance planning and extending pavement service life under regional climatic conditions.*

Key words: *urban roads; transport-operational indicators; pavement roughness; skid resistance; traffic intensity.*

Language: *English*

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Introduction

Urban road networks play a crucial role in economic development and social mobility. The operational efficiency of city roads directly affects transportation costs, traffic safety, and environmental sustainability. Rapid motorization in developing cities has led to increased traffic loads, accelerating pavement deterioration and reducing serviceability.

Nukus city, located in the Republic of Karakalpakstan, has experienced a steady increase in traffic demand over recent years. The total length of its road network is approximately 794 km, while the road network density of main streets remains below recommended international averages. Insufficient network density combined with increasing traffic intensity has resulted in reduced traffic capacity and declining pavement performance.

The objective of this study is to assess the transport-operational condition of selected urban road sections in Nukus city and to develop engineering recommendations aimed at improving pavement performance and extending service life.

The total length of the street and road network in Nukus City is 794.07 km. Given that the city occupies an area of 221 km², the density of the street and road network is calculated as:

$$\delta \frac{L}{S} = \frac{794{,}07}{221} = 3{,}6\ km/km^2$$

The density of primary (arterial) roads is 0.99 km/km², which is below the average regulatory standards.

As a result of the increase in traffic volume:

- vehicle speeds are decreasing;
- traffic congestion is occurring;
- fuel consumption is increasing;

- pavement deformations are accelerating.

The objective of the study is to evaluate the transport and operational performance indicators of the street and road network of Nukus City and to develop recommendations for extending its service life.

EXPERIMENTAL RESEARCH

Study Area

The research was conducted in Nukus city, Uzbekistan. Two major urban corridors were selected:

- A. Dosnazarov Street (4.7 km section)
- Uzbekistan Guzar Street (5.2 km section)

These streets represent primary urban arterials with high traffic volumes.

Investigated Parameters

The following transport-operational indicators were evaluated:

- Traffic intensity (vehicles/hour)
- Pavement roughness
- Skid resistance coefficient
- Rut depth
- Average traffic speed

Measurement Techniques

Field surveys were carried out using:

- Visual inspection methods
- Three-meter straightedge method for roughness assessment
- Instrumental skid resistance measurements
- Statistical data processing techniques

Roughness measurements were conducted during two seasonal periods (spring and summer) to capture climatic influence. Skid resistance was measured under wet surface conditions in accordance with accepted engineering practices.

RESEARCH RESULTS

Road Network Characteristics

The overall road network density in Nukus is approximately 3.6 km/km², while the density of primary roads is about 0.99 km/km². Compared to medium-sized international cities, this value remains relatively low, contributing to congestion and increased pavement loading.

Pavement Condition Assessment

Field investigations revealed:

- Surface cracking and localized deformations
- Rut depths ranging between 2–4 cm on heavily trafficked sections
- Moderate decline in pavement smoothness
- Reduction in skid resistance values approaching minimum allowable thresholds

High summer temperatures contribute to plastic deformation of asphalt concrete layers, accelerating rut formation.

Figure 1. Road roughness measurement using straightedge device.

Figure 2. Rut depth measurement on the road surface.

Table 1. Transport-Operational Performance Indicators

Indicator	Condition
pavement smoothness	Satisfactory, with localized deterioration
Tire–pavement friction coefficient	Close to the permissible limit
Rutting	2–4 cm in depth
Space mean speed	Decreased

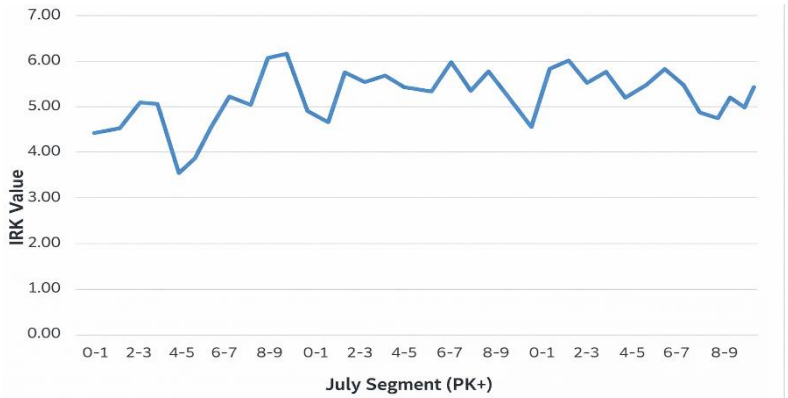

Figure 3. Graphical Representation of the IRI Pavement Roughness Values for the 0–3.9 km Section of A. Dosnazarov Street (D234) in Nukus City.

Table 2.

Measurement location		Vehicle speed	IRI	Comment
Km	Picket			
0	0-1	35.35	4.21	Satisfactory
	1-2	39.78	4.38	Satisfactory
	2-3	43.20	5.03	Satisfactory
	3-4	45.18	4.99	Satisfactory
	4-5	41.47	3.12	Good
	5-6	47.77	3.56	Good
	6-7	48.60	4.43	Satisfactory
	7-8	47.92	5.16	Satisfactory
	8-9	48.32	4.96	Satisfactory
	9-0	50.72	6.17	Қониқарсиз
1	0-1	52.09	6.29	Unsatisfactory
	1-2	52.70	4.74	Satisfactory
	2-3	53.28	4.46	Satisfactory
	3-4	54.54	5.83	Satisfactory
	4-5	54.00	5.56	Satisfactory
	5-6	53.14	5.72	Satisfactory
	6-7	52.24	5.41	Satisfactory
	7-8	51.12	5.39	Satisfactory
	8-9	50.05	6.12	Unsatisfactory
	9-0	49.75	5.35	Satisfactory
2	0-1	49.07	5.84	Satisfactory
	1-2	48.13	5.19	Satisfactory
	2-3	47.20	4.49	Satisfactory
	3-4	46.58	5.92	Satisfactory
	4-5	47.20	6.18	Unsatisfactory
	5-6	51.01	5.52	Satisfactory
	6-7	51.91	5.81	Satisfactory
	7-8	54.04	5.13	Unsatisfactory
	8-9	48.31	5.44	Satisfactory
	9-0	44.96	5.91	Satisfactory
3	0-1	45.50	5.47	Satisfactory
	1-2	48.67	4.53	Satisfactory
	2-3	52.27	4.37	Satisfactory
	3-4	55.26	5.36	Satisfactory
	4-5	56.66	4.46	Satisfactory
	5-6	40.75	4.99	Satisfactory

	6-7	43.55	5.23	Satisfactory
	7-8	44.60	4.75	Satisfactory
	8-9	48.67	5.44	Satisfactory
	9-0	52.27	5.31	Satisfactory

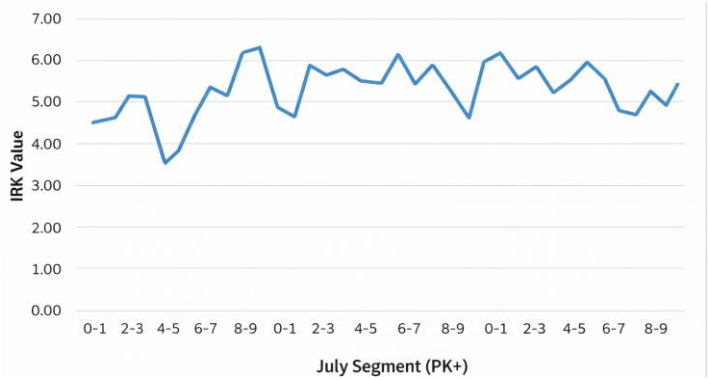

Figure 4. Graphical Representation of International Roughness Index (IRI) Values for the 0–4 km Section of Uzbekistan Guzori Street (D 234) in Nukus City.

Influence of Traffic Intensity

Traffic growth has resulted in:

- 15–20% reduction in average travel speed
- Increased dynamic loading on pavement layers
- Higher fuel consumption and vehicle operating costs
- Elevated risk of traffic accidents

Sections with the highest traffic intensity showed the greatest deterioration rates.

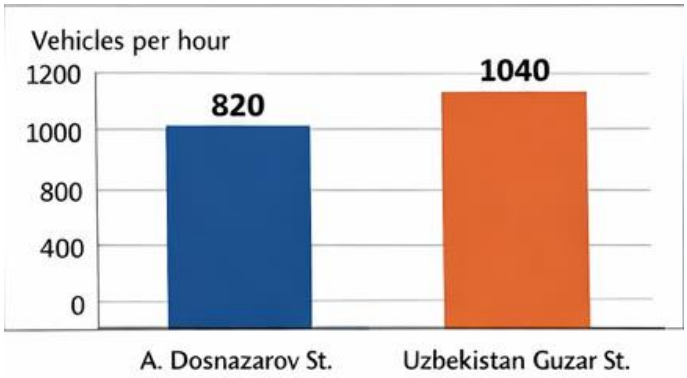

Figure 5. Trafic intensity on study roads (vehicles/hour).

Figure 6. Pavement skid resistance testing.

Fluency was measured twice a year (in spring and summer).

The meshing coefficient was determined using special measuring equipment.

DISCUSSION

The results indicate that urban road performance in Nukus is influenced by a combination of structural, climatic, and operational factors. The low density of the road network increases load concentration on major arterials. Additionally, extreme summer temperatures typical of the region accelerate asphalt binder softening and rut development.

Preventive maintenance practices remain insufficiently implemented, leading to reactive rather than proactive pavement management. The introduction of modified asphalt binders and improved drainage systems could significantly enhance long-term pavement performance.

Optimizing traffic organization and redistributing traffic loads may reduce excessive stress on critical corridors.

CONCLUSIONS

This study assessed the transport-operational indicators of selected urban roads in Nukus city and produced the following conclusions:

1. Road network density remains below recommended levels, contributing to congestion and accelerated pavement wear.
2. Increased traffic intensity significantly reduces pavement serviceability and operational performance.
3. Rutting and surface deterioration are strongly influenced by high temperature conditions.
4. Implementation of preventive maintenance strategies could increase pavement service life by 15–20%.
5. Engineering improvements such as polymer-modified asphalt and structural reinforcement are recommended for high-load corridors.

The research findings provide a technical basis for optimizing urban pavement management strategies in similar climatic and traffic conditions.

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