



DEVELOPMENT OF THE NETWORK OF URBAN ROADS AND STREETS (ON THE EXAMPLE OF THE CITY OF URGENCH)

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Abstract– The article analyzes the state of the road network in Urgench. The importance of the organization of highways in improving the future road network of the city will be considered as a key issue. It covers the results of studies on the organization of the process of safe traffic and improving the capacity of the road, as well as suggestions and recommendations for solving existing problems. The proposed measures will significantly alleviate congestion on the city street network without disrupting transport links within the city.

Key words– urban road network, infrastructure, urban public transport, capacity of road, congestion, results, analysis, traffic flow.

I INTRODUCTION

An increase in traffic intensity, traffic flows and, as a result, congestion, excessive pollution and increased noise levels due to long stays at intersections, public transport delays due to disruption of public transport schedules, as well as an increase in traffic accidents has become an actual problem in the city of Urgench, along with other large cities. Therefore, the search for a modern solution to the problems of the city's transport complex, the development of transport infrastructure and the development of the road network remains relevant.

It is known that a rapid increase in traffic intensity on the road network of the city of Urgench is accompanied by an increase in traffic intensity due to a decrease in the capacity of streets and the speed of vehicles (especially cars). The main reason for these problems is due to the rapid increase in the number of vehicles on urban streets. Competent organization of the urban street and road network will largely achieve the reliability of the entire urban transport system, the quality of service and the adoption of the necessary engineering and technical solutions, including the reduction of traffic accidents.

In accordance with the Decree of the First President of the Republic of Uzbekistan dated December 6, 2012 No. DP-1874 “On measures to implement the master plan for the city of Urgench, to fundamentally improve the improvement and water supply of the population of the Khorezm region”, Design Institute “Uzshaharsozlik LITI” developed a program for the development of the road network until 2030 and is gradually implementing it [1].

However, it should be noted that in addition to the achievements in the industry, there are many problems that have yet to be solved. The fact that the indicators set by the current regulations in the field of urban transport exceed the normative indicators requires scientific research and the development of necessary measures in this area.

II MATERIALS AND METHODS

Scientists from a number of CIS countries and the world in their works, monographs and scientific articles gave a lot of information on the development of the urban street and road network, made important scientific and practical conclusions. But the vast majority of researchers have set themselves the task of finding options for optimizing urban transport and the road network in large cities [2-6]. Currently, traffic congestion and the associated increase in road traffic accidents are also increasing in cities with less than 100,000 inhabitants.

It is no secret that the development of transport infrastructure plays an important role in the development of economic sectors. In this regard, in accordance with the “Strategy of Actions”, initiated and implemented by the President of the Republic of Uzbekistan Sh. Mirziyoyev, a specific action plan has been defined and is gradually being implemented in five priority areas of development of the Republic of Uzbekistan. Including, in paragraph 4.3. noted that "...development

and modernization of road transport, engineering, communication and social infrastructure to improve the living conditions of the population..." [7].

III RESULTS AND DISCUSSION

In particular, the number of private vehicles in the city of Urgench in 2009 increased by 789 vehicles compared to 2008, and in 2010 this figure was 836 vehicles. As of November 2010, the total number of private vehicles in Urgench reached 13,242 units. In other words, in 2009 the number of vehicles registered in the city increased by 6.9% compared to 2008, and by 2010 this value had changed by 13.9%. As of January 1, 2020, more than 137,000 vehicles were registered in the Khorezm region, of which the number of vehicles registered in Urgench in 2017 was more than 20,429,000 vehicles. This means that the number of private vehicles in the city of Urgench has increased by 75.8% over the past 8 years. The graph of the steadily growing number of vehicles and population growth in the city (by years) is shown below (Fig. 1, 2).

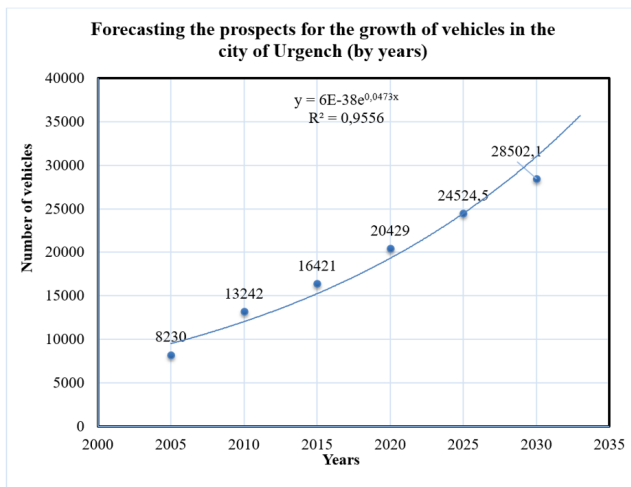


Fig. 1: Forecasting the growth of vehicles in the city of Urgench (by years). Source: compiled by the author based on research results.

It should also be noted that the city has not only vehicles registered in the area, but also traffic entering the city. According to the Urgench MDIA, 1,092 vehicles enter and leave the city daily. There are currently 10,125 vehicles in Urgench, including 8,775 personal and 1,350 company vehicles.

Based on modern urban planning concepts, measures are planned to improve the transport system of the city of Urgench, increase the capacity of the street and road network, as well as create a modernized, more convenient scheme of

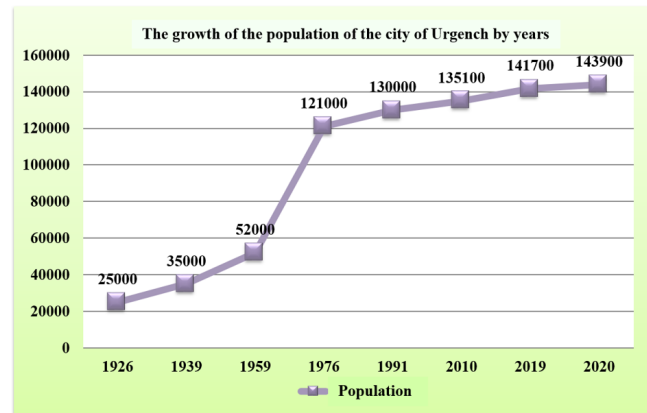


Fig. 2: Diagram of population growth in the city of Urgench (as of January 1, 2020)¹. Source: compiled by the author based on research results.

¹Data of the Khorezm Regional Department of Statistics

the transport system to create a modern image of the city, can be divided into organizational and road construction. Studying the methods for solving transport problems applied to the street networks of developed cities, as the most optimal solutions, presenting the following solutions in the development of the street network in Urgench (Fig. 3):

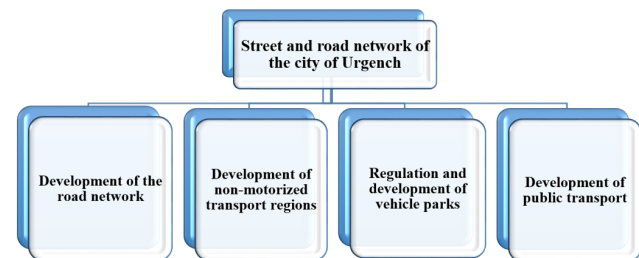


Fig. 3: The proposed solution to existing problems in the road network of the city of Urgench.

- On the development of the road network of the city of Urgench:

Development of public transport. Today, the fact that public transport in the city is only motor transport, including personal vehicles, due to the expansion of the urban area due to population growth, the construction of new streets and roads, makes urban public transport inefficient, modes of transport also require changes by examining the effectiveness of existing routes.

Also creating a separate lane for public transport. In this case, the outer lane is reserved for public transport. This, in turn, prohibits private vehicles from driving in that lane, or may also allow it to run during certain hours. During rush

hour, this lane serves only public transport. Also, when transferring public transport to immovable minor roads, the lane can be redirected through traffic signs.



Fig. 4: Arrangement lane reserved for public transport

Organization of vehicle parks. It should be noted that the problem of vehicle parking has become relevant for the streets of Urgench in recent years. In particular, in the city of Urgench there is a large shopping center "Urgench Farmer's Market", "Urgench Clothing Market", "Central Department Store" (CDS), densely populated places (parks, squares, entertainment centers, squares, etc.). The main reason for the problem of congestion on the streets of Al-Khorezmi, A. Bahodirkhan, Gurlan, Dusov, Khudaibergenov, P. Mahmud is that the throughput of the parking system does not meet the requirements or there is insufficient capacity (35-50 places). Therefore, in order to effectively serve the population of city streets and roads, it is necessary to create modern multi-storey vehicle parks and a complete ban on parking on the main streets that form the basis of the city's street network, and temporary parking on local streets. It is also possible to study the specific geology of the city of Urgench and the rational use of underground urbanization, the introduction of the construction of underground parking lots (Fig. 5)



Fig. 5: Traffic jams in front of the Central Farmer's Market in the city of Urgench

Vehicles left in the outer lane have a negative impact on traffic flow, especially during rush hours, causing traffic congestion and reducing road capacity. In many cases, due to the lack of permanent parking lots for vehicles in the city of Urgench, drivers mainly stop on the carriageway of the main streets adjacent to the markets, thereby creating an emergency situation in these sections. Therefore, the design and construction of modern parking lots is one of the main tasks

facing the urban planning activities of the city of Urgench. To solve the problem, the following was identified:

- Expansion of paid parking lots in the central districts of the city;
- Construction of short-term parking lots that do not interfere with traffic, including interchanges;
- Construction of parking lots for permanent storage of vehicles.

System "Permanent traffic". It is known that the non-intersection of pedestrian and vehicle traffic on the roads serves to increase the throughput of the road. At intersections where pedestrians are not moving, it is necessary to regulate the "red light", i.e. optimize their work (for example, reduce the burning time). The solution to the system of "permanent traffic" is the introduction of underground and surface routes of movement.

The intersection of pedestrian and vehicle traffic on the streets and roads of the city of Urgench at the same level leads to a decrease in the throughput of the road. To improve traffic at urban intersections, it is necessary to introduce a system of "permanent traffic" and regulate the "red light" of traffic lights at pedestrian crossings, i.e. optimize their work (for example, reduce the burning time) [8]. In connection with this study, it was revealed that there are 46 traffic lights on 86 streets of Urgench, of which 15 traffic lights do not meet the established requirements. For this reason, the use of a circle instead of a traffic light, that is, the introduction of a traffic rule in a self-regulating frame due to the fact that the traffic light can be turned off, is effective when using solar panels for lighting. (With the cost of one traffic light at least 16 million, the number of violations, such as crossing the red light, as well as vehicle accidents, the consumption of cash and electricity will be reduced).

Moto- and velo- transport. From the experience of developed countries, it is known that the development of cycling in cities will solve a number of problems associated with urban transport. A bicycle is an environmentally friendly and convenient form of transport. The organization of bike paths requires no more money than roads: it works without fuel, does not harm the environment with harmful gases and traffic noise, and also has a positive effect on the health of urban residents [9].

The city of Urgench has great potential to develop safe cycling on city roads and streets, as the city has dense housing, smooth roads and a mild climate zone that is conducive to cycling. A dense network of various road surfaces, including settlements, will help the development of cycling infrastructure. In this sense, it is necessary to take targeted measures for the use of this mode of transport.

Development of the street and road network. In order to

develop the road network of the city of Urgench, the following have been determined:

- Construction of a ring road to ensure uninterrupted traffic in the city, i.e. in the general plan of the city of Urgench, create a complete ring of the city, which will be transit through the city streets with the routes of Khanka, Chalysh, Gurlan, Shavat, Khiva, Yangiarik and Yangibazar;

- Reconstruction of the street and road network in order to ensure the priority of public transport;

- Arrangement of sidewalks that do not impede traffic;

- Application of local measures to improve traffic capacity and traffic safety;

- Construction of transport hubs.

Development of non-motorized transport regions. Of course, it is gratifying that bicycle paths have been built on new roads in our country in recent years. This is due to the fact that bike lanes not only eliminate the congestion of the street network, but also serve to improve the urban environment. Therefore, in the city of Urgench -

- Organization and development of bicycle paths in the city center;

- Formation of a pedestrian zone around historical buildings and densely populated areas of the city;

- It is necessary to limit and control the use of transport in the recreational areas of the city.

Analyzing the situation and problems in the street-road network of the city of Urgench, using the existing transport scheme of the city of Urgench, sections were identified where it is possible to design high-speed roads and roads leading to high-speed roads.

The main traffic flows entering the city of Urgench pass along the following routes:

1. 4R-156 - the automobile road of national importance "Urgench- Khanka -Khazarasp-Republic of Turkmenistan" approach to the city from the south-west, from the east along the ring road crossing the city in latitude.
2. 4K-931 - district traffic crosses the village of Chotkopir, and then the Shovot district. The road is of the II technical category and consists of an asphalt concrete pavement. Currently, the intensity of traffic from Khozarasp to Urgench is 15,089 vehicles per day.
3. 4P-157 - The Urgench-Yangiarik automobile road of national importance of category I enters the city from the south, crosses the ring road in the meridional direction and exits along the overpass to Khanka Street. The intensity of traffic on this route is 8955 vehicles per day.
4. 4R-158 is the national automobile road of the II category "Urgench-Khiva", entering the city from the north-

west, in the direction of the meridian. The traffic intensity is 18,504 vehicles per day.

5. Two automobile roads of republican significance, connecting from the north-west of the city, i.e. 4P-159 - "Urgench-Shavat" and 4P-160 - "Urgench- Gurlan". The intensity of traffic on these roads is 100,578 and 14,806 vehicles per day, respectively.
6. 4P-162 - automobile road along which all traffic along the routes Shovot, Gurlan, Khiva, Yangiarik, Chalysh and Khazarasp pass. Today it is the busiest, I and II technical category, asphalt concrete urban road. Its traffic intensity exceeds 16,100 vehicles per day, including 1,325 trucks.
7. 4P-162A automobile road - a meridional route passing through Al-Khorezmi street, connecting the city with Urgench airport and railway station. This is the central street of the city leading to the railway station. The number of vehicles registered in this direction per day amounted to 7295 units.

Currently, the number of registered vehicles in Urgench is more than 20,429, and the number of vehicles entering the city is more than 1,092, which carries about 10,125 passengers through the streets of the city daily (2,286 vehicles: 246 buses, 595 taxis and 1,445 fixed-route taxis), including 8775 private and 1350 official vehicles. Recent studies show an increase in the congestion of the street and road network in the city of Urgench, a decrease in the capacity of the street and road network. Of course, a number of measures have been taken to implement the Decree of the First President of the Republic of Uzbekistan dated December 6, 2012 No. PP-1874 "On measures to implement the master plan for the city of Urgench, to radically improve the improvement and water supply of the population of the Khorezm region" [10]. In particular, during the years of independence, the roads that make up the street network of the city of Urgench have been improved. Many roads, overpasses and bridges, transport interchanges have been built. However, based on today's observations of the city's street network, it can be said that this street network is weak enough to solve problems. That is, despite the fact that many automobile roads of the city have sufficient street sizes in accordance with current regulations, the width of the carriageway does not always correspond to the existing traffic intensity. The city has not yet formed a complete outer road ring that can cope with the flow of transit traffic, all external automobile roads flow into city streets. As a result of this distribution of traffic flows and the fact that many city automobile roads are 2-3 lanes wide, long traffic jams are observed at intersections and streets even during the peak period.

It should be noted that the main cause of the problem in the road network of the city of Urgench is the flow of trucks, vehicles and route vehicles from the main roads entering the city not only for any purpose in the city, but in many cases to close the road and save time unintentionally merges into the internal traffic flow of the city due to the lack of ring roads, overpasses, high-speed roads that cross the city.

Therefore, in the general plan of the city of Urgench, it is advisable to create a complete ring of the city, which will pass through the streets of the city in the direction of Khanka, Chalysh, Gurlan, Shavat, Khiva, Yangiaryk and Yangibazar.

In turn, the creation of a motor road to the "Big High-Speed Ring Road" in the city of Urgench in the future will increase the capacity of the city road and transport network, reduce the congestion of city roads, and increase freight and passenger traffic. Below is a perspective diagram of the city's automobile roads (Fig. 6).

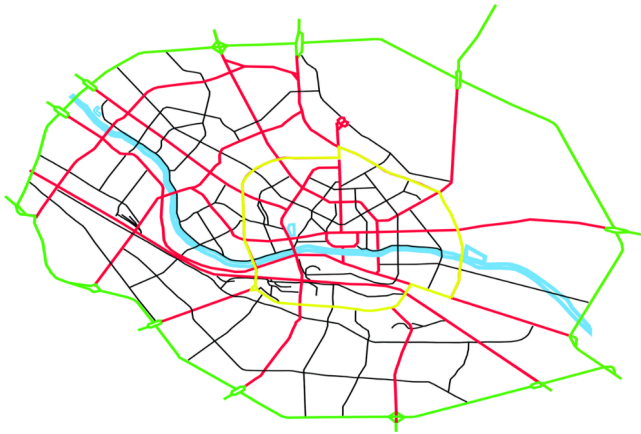


Fig. 6: Scheme of "Ringroad" of the city of Urgench.

Note: where green lines are the proposed ring road and high-speed roads leading to the city of Urgench, yellow lines are part of the high-speed road leading to the city center, and red lines are roads leading to the high-speed road.

Considering that the intensity of traffic on the Ringroad around the city in the future will be about 20.0 thousand per day, the project proposes to build 14 intersections and 4 overpasses to ensure traffic and pedestrian safety.

And roads can be designed as 4, 6 or 8 lanes, depending on the speed of traffic. According to SHNK 2.05.02-07 "Automobile roads" of the Republic of Uzbekistan, roads should provide a speed of 120-100 km/h [11]. The connection of the rolling stock must be carried out through intersections at different levels and junctions at the same level (without crossing the flows of the direct direction), located at a distance of at least 3 km from each other.

According to the main objective of the study, in the master plan of the city of Urgench, evaluating the economic effi-

ciency of creating a complete ring of the city of Urgench, which will pass through the streets of the city with the routes Khanka, Chalysh, Gurlan, Shavat, Khiva, Yangiaryk and Yangibazar.

1. The loss of time of various vehicles (cars, trucks and buses) "Before and After" from the event is determined. To do this, first of all, the travel time of various vehicles (buses, trucks and cars) is determined as follows [12]:

$$t = \frac{S}{V}$$

S - measurement distance, m;

V - speed of various vehicles - m/s;

t - transit time, s.

Cars:

$$t_1 = \frac{9.3}{22.15} = 0.42s \quad t_2 = \frac{9.5}{79} = 0.12h$$

Trucks:

$$t_1 = \frac{9.3}{18.6} = 0.5s \quad t_2 = \frac{9.5}{47.5} = 0.2h$$

Buses:

$$t_1 = \frac{9.3}{20.2} = 0.46s \quad t_2 = \frac{9.5}{79} = 0.12h$$

2. The time of vehicles is determined during a certain movement:

$$\Delta t = t^{after} - t^{before} \quad s;$$

t^{after} - in this case, the passage time after the event has occurred, s; t^{before} - time of passage before the event, s.

Cars:

$$\Delta t = t^{after} - t^{before}; \quad \Delta t = 0.3s;$$

Trucks:

$$\Delta t = 0.3s;$$

Buses:

$$\Delta t = 0.3s;$$

3. Determining the annual loss according to the specific loss time using the following formula [12]:

$$T_l = (N \cdot \frac{\Delta t}{3600}) t_c \cdot 305 \quad h;$$

T_l - time of loss of various vehicles during the year, hours;

N - traffic intensity, units /day;

Δt - time lost by various vehicles, s;

t_s - daily working hours, 10 hours, 305 working days a year.

$$T_l = (21550 \cdot \frac{0.3}{3600}) \cdot 3050 = 5477.3 \text{ h};$$

$$T_l = (2000 \cdot \frac{0.3}{3600}) \cdot 3050 = 508.4 \text{ h};$$

$$T_l = (1520 \cdot \frac{0.3}{3600}) \cdot 3050 = 386.3 \text{ h};$$

Thus, the amount of lost time for the year was 5477.3 hours for cars, 508.4 hours for trucks and 386.3 hours for buses. Naturally, there will be material damage due to lost time. Therefore, based on the data presented in Fig. 7, calculating the average cost by type of vehicle for 1 hour [12]:

Vehicle types		
Buses	Trucks	Cars
Mercedes-Benz 50-98 thousand sum	Isuzu 60-70 thousand sum	Cobalt, Lacetti 17-35 thousand sum
Isuzu 35-70 thousand sum	GAZ-53, ZIL-130 85-100 thousand sum	Spark 12-25 thousand sums
Minibuses 15-60 thousand sum	KAMAZ 1 20-130 thousand sum	----

Fig. 7: Calculating the average cost by type of vehicle for 1 hour

4. Determine the cost of lost time (in money) of various vehicles using the following formula:

$$C = Y_l \cdot C_c \text{ sum};$$

Average cost of C_s - vehicles for 1 hour work, thousand sum. The sum of these costs is presented in Fig. 7.

Cars: $S = 5477.3 \cdot 35\ 000 = 191\ 705\ 500$ sum;

Trucks: $C = 508.4 \cdot 12\ 500\ 0 = 63\ 550\ 000$ sum;

Buses: $C = 386.3 \cdot 98\ 000 = 37\ 857\ 400$ sum;

General costs: $\Sigma = 293\ 112\ 900$ sum;

5. The total cost of the trip is determined as follows:

$$C_{tot} = C_{cons.} + C_{tr.c} + C_{trav.ex}$$

Here:

$C_{cons.}$ - cost of road construction;

$C_{tr.c}$ - transportation costs (due to lost time);

$C_{trav.ex}$ - travelling expenses;

Calculate the total cost of travel along Al-Khwarizmi Street:

$$C_{tot} = C_{cons.} + C_{tr.c} + C_{trav.ex} = 0 + 32679212 + 50000000$$

$$C_{tot} = 82679212 \text{ sum};$$

10 years later: with capital repairs

$$C_{tot} = 826792120 + 700000000 = 1 + 526792120 \text{ sum};$$

Calculating the total travel costs for 1 km of the proposed Big High-Speed Ring Road of the city of Urgench:

$$C_{tot} = C_{cons.} + C_{tr.c} + C_{trav.ex}$$

$$C_{tot} = 1 \text{ bln. sum} + 0 + 10\ 000\ 000 = 1 \text{ bln. } 10 \text{ mln. sum}$$

After 10 years:

$$C_{tot} = 100 \text{ mln. sum} + 1 \text{ bln} = 1 \text{ blm. } 100 \text{ mln. sum}$$

1,526,792,120 sum, for 1 km of the projected Big High-Speed Ring Road and 1 bln 100 mln. Economic efficiency per km amounts to 426,792,120 sum with a pay-back period of capital investments of 10 years.

IV CONCLUSIONS

The existing problems in the street and road network of the city of Urgench, the causes of which are being studied on the basis of specific evidence, and the proposed optimal ways to solve them - organizational measures to improve the road network of the city, the priorities for solving problems in the transport system and according to the calculation schemes are as follows general conclusions:

- The current issue in the street-road network of the city of Urgench, in particular, the low capacity of the street-road network at the appointed time, the need for unregulated intersections of different levels, city highways;
- Identified the need to study the state street and road network of the city of Urgench and development of proposals for their improvement.
- Insufficient attention to the use of public transport in the city's road network was revealed and the necessary recommendations were developed;
- In order to further improve the density of the street-road network of the city of Urgench, it is necessary to take measures to regulate traffic on existing roads in some districts.
- In the master plan of the city of Urgench, proposals and recommendations have been developed for creating a complete ringroad of the city, which will reduce the transit of city streets, and its economic efficiency has been determined.

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