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Methods to improve the capacity of intersection in the city

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Abstract: The purpose of this article to present a method of traffic management in terms of traffic safety and environmental safety in the city due to improving the mode of operation of intersections, changing its geometry. Information about the increase in the number of cars in Uzbekistan and their contribution to environmental pollution has been reflected. The results of the research conducted in the city of Karshi on the improvement of transport management are presented. In particular, it has been shown that the service level of the intersection (LOS) has improved due to the improvement of the operation mode of the intersection of Mustaqillik and Nasaf streets and the change of the geometry of the intersection I.Karimov and A.Temur streets. Determination of passenger flow in public transport using the PASSIM program and data on the intensity of vehicles in the city are presented. In order to find out the opinion of the population of Karshi about public transport, a social survey has been conducted among the population. The survey covered 1% of the total population of the city. The survey revealed that the number of bicycle users is increasing. Pedestrians also make up the majority of the population.

Keywords: traffic management, traffic safety, environmental safety, intersection, population, intelligent transport, passenger flow

1. Introduction

Currently, the number of all cars in the whole world is 1 billion 500 million. The total number of cars in Uzbekistan is 3.6 million, 3.2 million of which are passenger cars. So, the number of cars in Uzbekistan is 0.24% of the number of cars in the whole world. The highest concentration of cars corresponds to the city. Currently, there are 780.000 cars in Tashkent, the capital of Uzbekistan. Their number is also increasing in the central cities of the province. The number of cars in the Republic of Uzbekistan has increased by 20% in the last 3 years [4].

The increasing number of cars complicates traffic flow in cities. The traffic congestion index in rush hours reaches 10 points. The number of traffic accidents has increased. In 1 year in Uzbekistan, the amount of harmful gases released from cars is 1.5 million tons. The contribution of cars to environmental pollution in the republic is 60%, while in Tashkent this figure is 88% [4].

The President and the government of Uzbekistan are paying serious attention to this issue. The decree of the President of the Republic of Uzbekistan dated 14.02.2023 No. 59 "On measures to reform the public transport system" was issued to increase the attractiveness of public transport in Tashkent city and regions, ensure pedestrian safety, reduce the number of road traffic accidents and prevent them.

This article presents the results and analyzes of the research conducted on the improvement of the transport system in the city of Karshi, the center of Kashkadarya region.

Like other cities of the republic, the number of cars in Karshi is increasing day by day. In 2021, compared to 2020, the number of cars registered in the city increased by 0.4%, in 2022 by 1.3% compared to 2021, and in 2023 by 5.13% compared to 2022. That is, the number of passenger cars in the city of Karshi has increased by 6.8% in the last 3 years. In one day, the number of cars in the city of Karshi exceeds 100.000. 50% of it enter from the country.

Today, there are various ways to improve traffic management in urban conditions. Examples of them include improving the geometry of the intersection, the phases and timings of the traffic lights at the intersection, coordinating the operation modes of the intersections, introducing a separate lane and traffic light phases for turning left and turning at the intersection, changing the road axis in order to calm traffic and etc.

World experience shows that expansion of existing roads, construction of bridges and overpasses may not always be effective. This can create conditions for increased traffic in the city. Currently, it is recommended to use intelligent transport systems in traffic management. For example, the use of "adaptive (intelligent)" traffic lights, the use of variable traffic signs, the use of roads in a reversible way, and the use of information exchange systems vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), when improving the work of intersections, creating a "green corridor" for vehicles by coordinating the operation of several traffic lights on the street also belongs them.

2. Methodology

Test-research works were carried out to create a transport micromodel of the city of Karshi using the PTV VISSIM program. Vehicles entering the city from 7 directions around the city were counted. The traffic flow has been studied in 30 central intersections in the city during rush hours of the day. Traffic in and out of the city was done by recording the streets on camera. In addition, the flow of passengers in existing public transport and stations in the city was studied. PASSIM and GEOTRACKER applications were used to study the flow of passengers and record the direction of buses. Calculation of passengers flow using the PASSIM program was carried out on-line, that is, the received data was sent to the database via the Internet. Below

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are some of the results of the public transport passenger flow study.

In addition, the information is presented using a map (Fig. 1). In the picture on the left, we can see that route #1, the total number of passengers in one run is 108, and the maximum number of passengers in the cabin is 71. The circles in the picture indicate the number of bus stops. The figure on the right shows the average technical speed of the bus. The picture shows that the average technical speed of the bus did not exceed 15 km/h.

This data is collected at rush times and helps to make inferences about traffic and the convenience of public transport.

In order to improve the transport system of Karshi city, proposals were made to change the geometry of existing intersections, to change the phases and timings of traffic lights at intersections, to introduce alternative streets to some streets with high traffic.

In order to study the demand for transport, a social survey was conducted among the population. The social questionnaire includes following questions: What means of transport do you use to go to work, study or other tasks? Are you satisfied with the public transport service? What profession do you represent? From which address do you start your movement? How many movements do you make a day and by what type of transport? What distance do you cover every day? The social survey was carried out online using a special application.

286.000 people live in the city of Karshi. 1% of the population participated in the survey. Below are some of the results of the social survey:

The population aged 16-50 actively participated in the survey. That is, it is an active and mobile part of the population. In general, people between the ages of 20 and 50 participated actively, and this is logical. Because most of the representatives of this age group are busy with work or studies.

60% of the participants in the survey are women. It is possible that the reason for this is that middle-aged men are not interested in the state of public transport, since most of them travel by private car.

1st place for transportation is private cars, 2nd place is public transport, 3rd place is taxi, 4th place is bicycle. About 40% are pedestrians. It means that it is important to create comfortable and safe infrastructure for pedestrians and cyclists.

When asked how long it usually takes to drive to a destination, most responses were 40-60 minutes.

90% of those who took part in the survey said that they would start their first move from home. 40% of them said they would go to work and 34% would go to university or college.

There are several ways to improve traffic flow in terms of reducing traffic congestion, reducing emissions from vehicles, preventing traffic accidents, increasing pedestrian safety, and ensuring sustainable transportation systems. These are optimization of traffic light phases at the intersection, change of its design, creation of separate lanes for bicycle users, control of pedestrian crossings by artificial intelligence, separate lanes for buses, changing road signs, etc.

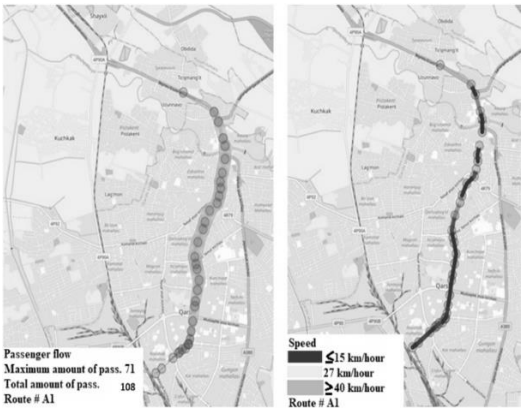

Fig. 1. View from results of searching the passenger flow in Karshi city in public transport

Analysis of the literature shows that with an increase in traffic flow in the city, it is more effective to use intelligent transport systems rather than widening the road or increasing the number of lanes to improve traffic management in the city. Also, changing the design of an intersection or introducing additional channels for U-turns or left turns gives a good result in terms of reducing conflict points and improving road safety. This article draws attention to the optimal organization of the traffic light and changing its design.

In order to improve the traffic in the city of Karshi, the streets with dense traffic flow and many traffic accidents were selected. They are I.Karimov, Mustaqillik, Nasaf and Jayhun streets. The phases of traffic lights at all intersections of these streets and the flow of traffic passing through them during the day were studied. During the study of traffic flow, attention was paid to the processes during the morning, afternoon and evening rush hours.

The conducted studies and the obtained results are presented on the example of the intersection of Mustaqillik and Nasaf streets in Karshi city.

The average number of vehicles that passed through the intersection during 1 hour, their traffic directions were entered into the VISSIM computer software, and the traffic flow at the intersection was simulated using this program. After creating a digital view of the intersection, the phases of the traffic lights have been changed several times and the option with the highest throughput is selected. The following table shows the results obtained in the case of unchanged and changed traffic light phases at the intersection.

In most cases, at two-phase intersections, green, yellow, and red lights are given the same lighting times. This is incorrect, because it is very unlikely that the same traffic flow will come from the 4 or 3 streets of the intersection. In such cases, it is necessary to optimize the phases of the intersection depending on the traffic flow.

At the intersection of Mustaqilik and Nasaf streets, the current and proposed traffic light phases of the intersection as follows:

- current traffic light phases: phase1: red 28 s, yellow 3 s, green 23 s;
- phase 2: red 23 s, yellow 3 s, green 28 s. Cycle period is 108 s.
- proposed traffic light phases: phase1: red 22 s, yellow 3 s, green 19 s;
- phase 2: red 19 s, yellow 3 s, green 22 s. Cycle period is 88 s.

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The cycle period of intersection has been decreased for 20 seconds. How it affected to losses of vehicles at the intersections is sown in table 1.

Table 1

Comparison of losses at the intersections before and after improvement of traffic light's phases

losses at the intersections	In current phases of intersection	In alternative phases of intersection	Savings after improvement of the intersection (USD per year)
Number of vehicles	6762	6762	-
Fuel consumption, L (per hour) /USD per year	372 / 763000	293 / 601000	162 000
Lost time by passengers, hours (per hour) /USD per year	97.5 / 600000	75.5 / 465 000	135 000
Emission CO, NOx, VOC, kg (per hour) /USD per year	25 / 313250	13.6 / 168675	144 575
Total consumption (USD)	1 676 250	1 234 675	441 575

From the table above, we can see that after the improvement of the traffic light phases at the intersection, the costs for one year have decreased by 26% [1].

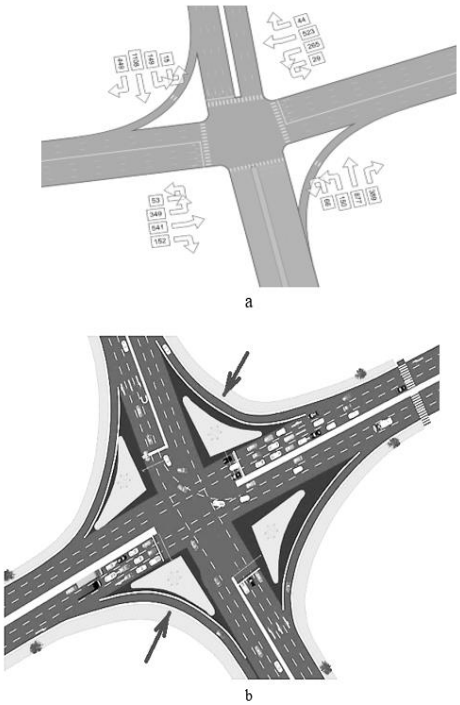

Fig. 2. a) Number of cars, passed through intersection of streets I.Karimov and A.Temur. View of the intersection before changing;
b) view of alternative version of the intersection with additional channels for turning to the right

After improving the operation mode of the intersection, its capacity has increased by 10.4 % per hour, which means that 5758 vehicles will pass through the intersection in 1 hour during the proposed traffic light phases (see table 2).

At the intersection of I.Karimov and A.Temur streets, the traffic capacity of the intersection has been increased by opening an additional lane for turning to the right (Fig. 2).

In order to increase the throughput of this intersection, it was proposed to open an additional road for turning to the right on its northeastern and southwestern sides (Fig. 2). As a result, the level of service (LOS) of the intersection improved from E to C. The indicators of the current state of the intersection and the proposed state are presented in the comparative table 2.

Table 2

Comparison of parameters of the intersection of I.Karimov and A.Temur streets before and after improvement

Parameters	Current state	Alternative state
Level of service (LOS) of intersection	E	C
Average delay of the vehicle (sec)	54.65	42.9
Average length of congestion (m)	43.03	32.75
Maximum length of congestion (m)	266.52	164.02
Average number of stops	1.26	1.09
Amount of the vehicle, passed through intersection	5159	5758
CO (gr)	10175	9569
NOx (gr)	1979	1861
VOC (gr)	2358	2217
Fuel consumption (L)	145	136

Data in table 2 for morning rush hour and calculated for one hour. Average delay of the vehicle, average number of stops are calculated for one vehicle. Fuel consumption and amount of CO, NOx, VOC gases are calculated with the help of PTV VISSIM software for all vehicles during they delay per one hour at an intersection.

3. Conclusion

The number of cars is increasing year by year. This leads to an increase in traffic congestion, traffic accidents, and environmental pollution in cities. In the research carried out in the city of Karshi, it can be seen that due to the improvement of the phases of the traffic lights at the intersections, due to the change of the geometry of the intersection, its throughput has increased, the delay time of cars at the intersection has decreased, fuel consumption and environmental pollution have decreased. For example, at the

intersection of Mustaqilik and Nasaf streets, the results of the study show that by changing the phases of the intersection, one-year expenses for fuel consumption, time loss, and environmental pollution will decrease by 26%. The level of service (LOS) of the intersection of I.Karimov and A.Temur streets was improved from E to C due to the change in the geometry of the latter. These changes at the intersection do not require large funds. However, it can bring great benefits to society. In order to find out the opinion of the population of Karshi about public transport, a social survey has been conducted among the population. Most of the participants in the survey are between 20 and 50 years old. Private cars are the number one form of transportation in the city. Unfortunately, it is not good indicator. Cyclists and pedestrians make up 16% of the mobile population. Pedestrians contribute more. It is necessary to improve the transport infrastructure for the safe movement of pedestrians and cyclists in the city. Also it is a good practice worldwide to increase a priority of public transport in order to provide an attractiveness of latter and avoid increasing a traffic jam in the city for what a big attention has been paying in city of Karshi and other big cities of Uzbekistan.

References

[1] Erica Wygonik, Anne Goodchild. Evaluating CO2 emissions, cost, and service quality trade-offs in an urban delivery system case study. IATSS Research, Volume 35, Issue 1, July 2011, pages 7-15.

[2] T. Le et al., “Unexpected air pollution with marked emission reductions during the COVID-19 outbreak in China,” Science (80-.)., 2020, doi: 10.1126/science.abb7431.

[3] S. Anenberg, J. Miller, D. Henze, and R. Minjares, “A global snapshot of the air pollution-related health impacts of transportation sector emissions in 2010 and 2015,” Int. Counc. Clean Transp., 2019.

[4] Tuychiev O.A. Advantages of using hub electric motors (analysis) // International conference of philology, social activities and modern science. May 10, 2023. –P.75-77.

[5] J. He, K. Chen, and J. Xu, “Urban Air Pollution and Control,” in Encyclopedia of Sustainable Technologies, 2017.

[6] Y. Wu et al., “On-road vehicle emissions and their control in China: A review and outlook,” Sci. Total Environ., 2017, doi: 10.1016/j.scitotenv.2016.09.040.

[7] C. K. Gately, L. R. Hutyra, S. Peterson, and I. Sue Wing, “Urban emissions hotspots: Quantifying vehicle congestion and air pollution using mobile phone GPS data,” Environ. Pollut., 2017, doi: 10.1016/j.envpol.2017.05.091.

[8] K. Zhang and S. Batterman, “Air pollution and health risks due to vehicle traffic,” Sci. Total Environ., 2013, doi: 10.1016/j.scitotenv.2013.01.074.

[9] K. Zhang, S. Batterman, and F. Dion, “Vehicle emissions in congestion: Comparison of work zone, rush hour and free-flow conditions,” Atmos. Environ., 2011, doi: 10.1016/j.atmosenv.2011.01.030.

[10] M. A. Figliozzi, “The impacts of congestion on time-definitive urban freight distribution networks CO2 emission levels: Results from a case study in Portland, Oregon,” Transp. Res. Part C Emerg. Technol., 2011, doi: 10.1016/j.trc.2010.11.002.

[11] K. Hirschmann, M. Zallinger, M. Fellendorf, and S. Hausberger, “A new method to calculate emissions with simulated traffic conditions,” 2010, doi: 10.1109/ITSC.2010.5625030.

[12] Khakimov, S., Fayzullaev, E., Rakhmonov, A., & Samatov, R. (2021). Variation of reaction forces on the axles of the road train depending on road longitudinal slope. E3S Web of Conferences, 264, 05030. https://doi.org/10.1051/e3sconf/202126405030.

[13] Sh. Khakimov., Vehicle ride regime as a main factor for GHG emission reduction. AIP Conference Proceedings 2432, 030127 (2022); https://doi.org/10.1063/5.0089563.

[14] Fayzullayev, E., Khakimov, S., and Abdurazzakova, D., “Correct choice of parameters of runaway truck ramp on the mountain roads is factor in saving people's lives,” AIP Conference Proceedings. https://doi.org/10.1063/5.0267594

[15] Mukhitdinov, A., Abdurazzokov, U., Ziyaev, K., & Makhmudov, G. (2023). Method for assessing the vehicle energy efficiency on a driving cycle. 060028. https://doi.org/10.1063/5.0114531.

[16] Abdurazzokov, U., Sattivaldiev, B., Khikmatov, R., & Ziyaeva, S. (2021a). Method for assessing the energy efficiency of a vehicle taking into account the load under operating conditions. E3S Web of Conferences, 264, 05033. https://doi.org/10.1051/e3sconf/202126405033.

[17] Kasimov, O. (2023). Method for regulation of permissible irregularity of brake forces on front axle. E3S Web of Conferences, 401, 02033. https://doi.org/10.1051/e3sconf/202340102033.

[18] Costa, E.d.S.; Santiciolli, F.M.; Eckert, J.J.; Dionísio, H.J.; Dedini, F.G.; Corrêa, F.C. Computational and Experimental Analysis of Fuel Consumption of a Hybridized Vehicle; SAE Technical Paper; SAE International: Warrendale, PA, USA, 2014; doi:10.4271/2014-36-0385.

[19] Eckert, J.J.; Santiciolli, F.M.; Bertoti, E.; Costa, E.d.S.; Corrêa, F.C.; Silva, L.C.d.A.e.; Dedini, F.G. Gear shifting multi-objective optimization to improve vehicle performance, fuel consumption, and engine emissions. Mech. Based Des. Struct. Mach. 2018, 46, 238–253.

[20] R. Jaikumar, S. M. Shiva Nagendra, and R. Sivanandan, “Modal analysis of real-time, real world vehicular exhaust emissions under heterogeneous traffic conditions,” Transp. Res. Part D Transp. Environ., 2017, doi: 10.1016/j.trd.2017.06.015

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