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OPTIMIZATION OF URBAN TRANSPORT FLOWS BASED ON SIMULATION MODELING

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Abstract: This article examines the problems of optimizing urban transport flows and their solutions based on modeling. The unevenness of transport flows, the increase in passenger mobility, and the low capacity of road networks were analyzed as pressing issues. The possibilities of effective management of the transport system using modeling, in particular, simulation models, are highlighted. Based on statistical data, ways to forecast traffic flows, improve traffic light control regimes, and develop infrastructure were studied. As a result, it served to increase the efficiency of the transport system and reduce traffic jams.

Key words: transport, flow, modeling, optimization, traffic, road network, traffic intensity, traffic light.

Introduction

In traffic flow management, a number of tools are used to optimize traffic flow. Modeling with an analytical approach is one of them. Competent traffic management on roads, taking into account the types of transport, is the result of rational decision-making and a comprehensive analysis of the current situation and needs [1]. The transport mobility of the population in cities is increasing every year. This, in turn, creates a number of existing problems in the processes of providing transport services to the population. Changes in the non-uniformity coefficient of passenger traffic negatively affect the possibilities of effectively organizing the use of public transport. The random nature of changes in passenger flow parameters, which are the main criteria for organizing public transport in cities, also creates certain problems in the rational organization of this process. Large traffic flows, regular traffic jams during peak hours, low road capacity, and ensuring road safety are among the problems that engineers must solve. To solve existing problems and improve the quality of public transport services, it is first necessary to have reliable information regarding changes in passenger traffic [2]. Furthermore, the periodic change in passenger traffic over time and the organization of their work require the consideration of many factors in the process of organizing these processes. Currently, the most pressing problem is the optimization of transport flows and transport networks. Solving these problems requires an in-depth study and analysis of the main tasks of traffic flow optimization, the role of statistics in modeling, and the composition of information [3]. Therefore, it is necessary to determine which factors are important in the optimization of transport flows based on modeling.

Literature review

In recent years, issues regarding the optimization and modeling of transport flows have been extensively studied not only from a practical but also from a theoretical perspective. Research in this direction is aimed at effective management of transport systems, reducing traffic congestion, and improving the quality of passenger service.

Various approaches to modeling transport flows have been developed by foreign scientists. In particular, in the scientific works created by Michael Treiber and Arne Casting, microscopic models of

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traffic flow, driver behavior and the relationship between traffic density are deeply analyzed. Their research is important in explaining and predicting the unevenness of transport flows [4]. Also, Dirk Helbing studied the processes of self-organization in transport systems and identified the mechanisms of traffic jams. Based on his research, innovative approaches to traffic flow management have been developed, including the concepts of adaptive traffic light systems and intelligent transport systems [5].

Among scientists from Russia and the CIS countries, Vladimir Shvetsov made a significant contribution to the issues of mathematical modeling of transport flows and optimization of transport networks. He developed the statistical and probabilistic foundations of transport systems [6]. Alexander Korchagin proposed effective methods for the comprehensive analysis of transport infrastructure and the management of transport flows [7].

Methodology

The research process utilized methods of systematic analysis, statistical data collection and processing, as well as simulation modeling. Initially, data on traffic flow (traffic intensity, speed, vehicle composition) were collected. Then, a model was created based on this data and simulated using a special software tool. Various scenarios were tested, and the most optimal option was selected. The results obtained were analyzed and practical recommendations were developed.

Result and discussion

In addition to the ability to create traffic flow models, transport planning, and public transport optimization, this package also has extensive animation capabilities that do not require programming knowledge. To achieve traffic flow optimization on the roads, it is necessary to understand the real problems of the situation. The analysis of the most in-demand areas among drivers, passengers, and pedestrians allows for an understanding of where traffic jams occur, how long they take to clear and eliminate naturally, and the causes of difficulties. For proper optimization, the correctness of traffic light object modes is of great importance, which can account for vehicle traffic intensity parameters at different times of the day. It may be necessary to design additional facilities and intersections, intersections, and junctions, as well as to create new infrastructure for unloading. The approval procedure in state regulatory bodies is the final part of the optimization process for the further implementation of the created action model. Reducing the load on specific routes is also a priority task for optimizing the transport system. Special attention will be paid to parking lots. If they are unplanned and disorganized, it negatively affects the capacity of the roads and reduces their initial performance. Parking management occupies a special place in the optimization system, as in addition to convenience, the legislative framework must be taken into account for the operation of transport. Considering that modeling is the foundation of optimization, the following points can be made. In addition to the ability to create traffic flow models, transport planning, and public transport optimization, this package also has extensive animation capabilities that do not require programming knowledge. Initial data for creating the intersection model: - detailed diagram of the modeled territory; - number of lanes in each direction of movement; - line width; - directions of movement for each section; - technical and geometric characteristics of all types of vehicles; - traffic intensity; - composition of incoming vehicle and pedestrian flows; - placement and width of sidewalks; - priority of movement at conflict points.

For example, we have examined in detail the stages of modeling one of the intersections at the intersection of Babur shoh Street and S. Zunnonova Street (80 meters) in the city of Andijan. Thus, the first step is to set the simulation parameters, which is a visual representation of the modeling and analysis processes carried out in Vissim. Running a simulation involves executing a solution to systems of equations that determine how all road users interact with each other. Due to the simplicity

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and clarity of working with the Vissim software suite interface, creating a model is not difficult for the user; therefore, a user without programming skills can model any part of the road network.

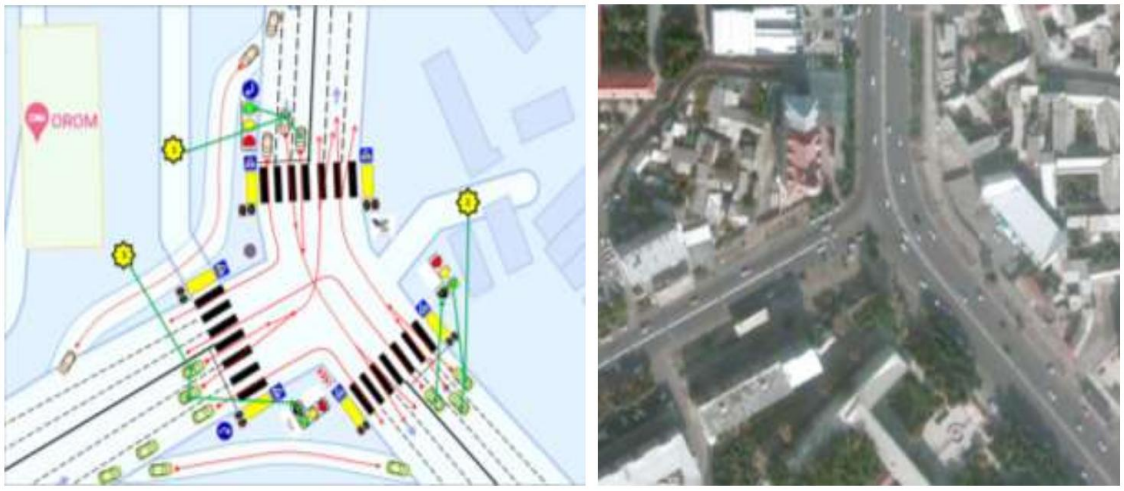


Fig. 1. The intersection of Bobursho Street and S. Zunnonova Street (80 meters) in the city of Andijan

Example of modeling the intersection of Babursho Street and S. Zunnonova Street (80 meters) in Andijan city at PTV Vissima [8]. Three types of traffic lights are used to control traffic in a specific direction. The direction of travel is indicated by an arrow on the traffic light lens. The traffic flow in the direction indicated by the arrow does not intersect or merge with other traffic flows (including pedestrian flows). In such control, separate traffic lights are installed for each direction [9].

The creation of traffic optimization projects, regardless of scale, is based on an analysis of the street-road network Transport systems provide logistical connections at the level of cities, settlements, and regions. By optimizing the performance of roads, vehicles, pedestrians, and other road users, optimal indicators for problem-based criteria can be achieved under existing conditions [10]. Therefore, the stage of collecting and analyzing objective primary data is of great importance. It is precisely they that allow for the competent elimination of obstacles while maintaining the required level of speed, traffic intensity, transportability, and safety. Let us explain in more detail what needs to be taken into account when solving optimization problems. Settlements differ in scale, which is also reflected in the type of roads. These include the width of traffic lanes on the roads, the design of turns, the regulation of lamps, ditches, etc.criteria.

Conclusion

The analysis presented in the article shows that modern urban transport systems face several critical challenges, including uneven traffic flow distribution, congestion, limited road capacity, and the continuous growth of passenger mobility. Addressing these issues requires the application of advanced and scientifically grounded approaches, among which traffic flow modeling plays a key role. Simulation-based modeling enables a comprehensive analysis of transport systems, allowing for the identification of existing deficiencies and the testing of various management scenarios before their practical implementation. This contributes to improving traffic organization, optimizing traffic signal control, redistributing traffic flows, and enhancing transport infrastructure efficiency. Furthermore, decision-making based on reliable statistical data significantly increases the effectiveness of transport system management. The results obtained through modeling help reduce travel time losses, improve road safety, and enhance the overall quality of transport services provided to the population.

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