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Basic Methodology of Traffic Management for the Street and Road Network of a Large City with Traffic Lights Regulation

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ABSTRACT

The objective of the article is to develop a system of principles and methods aimed at improving management of transport flows on the street and road network of a large city with traffic lights regulation. The suggested methodology is based on the methods used in Russia and abroad to improve road traffic safety and quality, results of a survey of experts in the field of road design and traffic management, monitoring at regulated crossings, and analysis of road accidents in the city of Volgograd.

The primary customer property of a regulated crossing is road safety. Elimination of causes of road traffic accidents associated with road traffic, structural geometric, signalling, and technical conditions is the most important task regarding a regulated crossing. Enhancing road traffic quality at low levels of network load supposed considering demand for transportation, increase in travel comfort, coordination, and flexibility of traffic lights operation. High degree of network load supposes that more attention is paid to traffic capacity of the street and road network elements, restrained access of vehicles to areas of greater congestion, increased duration of a green light cycle (for more than 120 seconds, if this does not affect traffic safety and network congestion degree).

Keywords: *road traffic safety, road traffic quality, regulated crossing, street and road network.*

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Studies conducted in France [1, p. 11] have shown that in a large city out of 1 hour of driving time the driver spends: 15 minutes on braking, 10 minutes on stopping at crossings in front of traffic lights, 16 minutes on starting and accelerating the car, and only 19 minutes on direct driving along the route. That is, only a third of time is used efficiently by drivers.

Other developed countries have faced the problem of overload of the street and road network (SRN) of the cities before Russia, so it is natural to address foreign experience in improving efficiency of SRN operation [2; 3].

At low levels of network load, first, demand for transportation, increase in travel comfort, coordination, and flexibility of traffic lights (TL) operation are focused. High degree of network load supposes that more attention is paid to traffic capacity of the street and road network elements, to restraining the access of vehicles to areas of greater congestion, to increased duration of a green light cycle (for more than 120 seconds, if this does not affect traffic safety and network congestion degree).

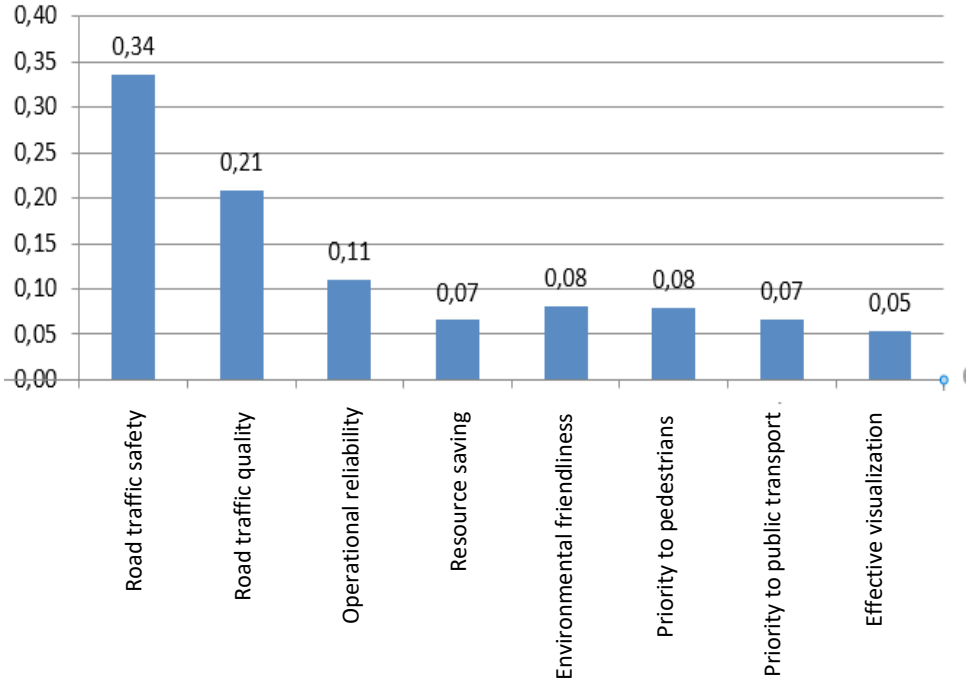
If in Germany the values of such customer properties as «road traffic quality» (RTQ, service level), «road traffic safety» (RTS) are equal or close [4, p. 6], then for Russia where accident rates are relatively high (18,8 deaths per 100 thousand inhabitants [5, p. 36]) RTS should be significantly more important than RTQ, and this was confirmed some years ago by the results of an expert survey conducted by the author (Pic. 1).

Following the standard [7], sites of SRN of Volgograd where accidents had been most frequent for 11 months of 2018 were identified. Pic. 2 shows the results of the analysis of distribution of points of frequent road accidents by types of sections of SRN.

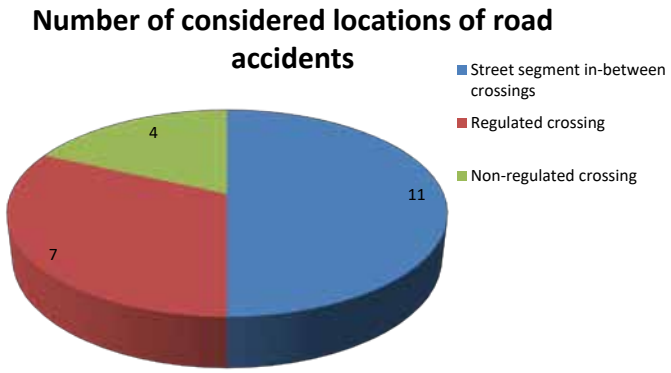
The share of road accidents at regulated intersections is equal to 32 %. Given the concentration of road accidents at those regulated crossings, the most important task is to develop recommendations and measures to improve road traffic safety at them.

Principle 1. Road traffic safety at regulated crossings is a priority (the goal is to achieve zero accident rate regarding accidents caused by road, signalling, technical, structural, and geometric conditions).

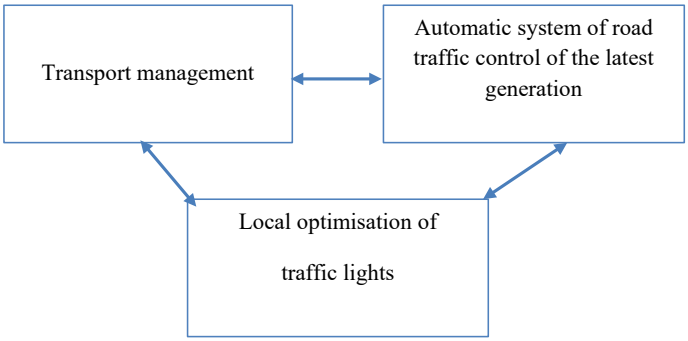
If in Volgograd TL are mostly operated in a rigid single-program mode and are rarely coordinated (except for some street segments), then in Germany flexible regulation, ensuring



Pic. 1. Relative importance of customer properties regarding regulated crossing (results of experts' survey) [6].



Pic. 2. Locations of most frequent road accidents in Volgograd for 11 months of 2018.



Pic. 3. Structural chart of control of transportation flows in case of overload (traffic congestion) using traffic lights.

priority for public transport, and network management are widespread. Only a third of traffic lights in Germany are controlled through a rigid mode [8, p. 352]. Two of three TL work in a flexible mode.

Principle 2. Under the conditions of low and medium load on regulated crossings we need optimization of travel comfort (coordination of traffic lights, [a «green road»]) and adaptability of regulation.

Psychologist A. Maslow (1908–1970) believed that a person in modern conditions is driven, first, by the need to reduce stress and maintain internal balance. Obviously, long delays in front of regulated crossings result in stress for drivers and passengers and in loss of internal balance. Overload is inevitable in human life. At the same time, a person, like a vehicle or other machine, cannot exist for a long time in a state of overload. Transport congestion (peak of traffic intensity) needs to be eliminated for the driver could recover. Therefore, it is necessary to strive for speedy elimination of the overload condition.

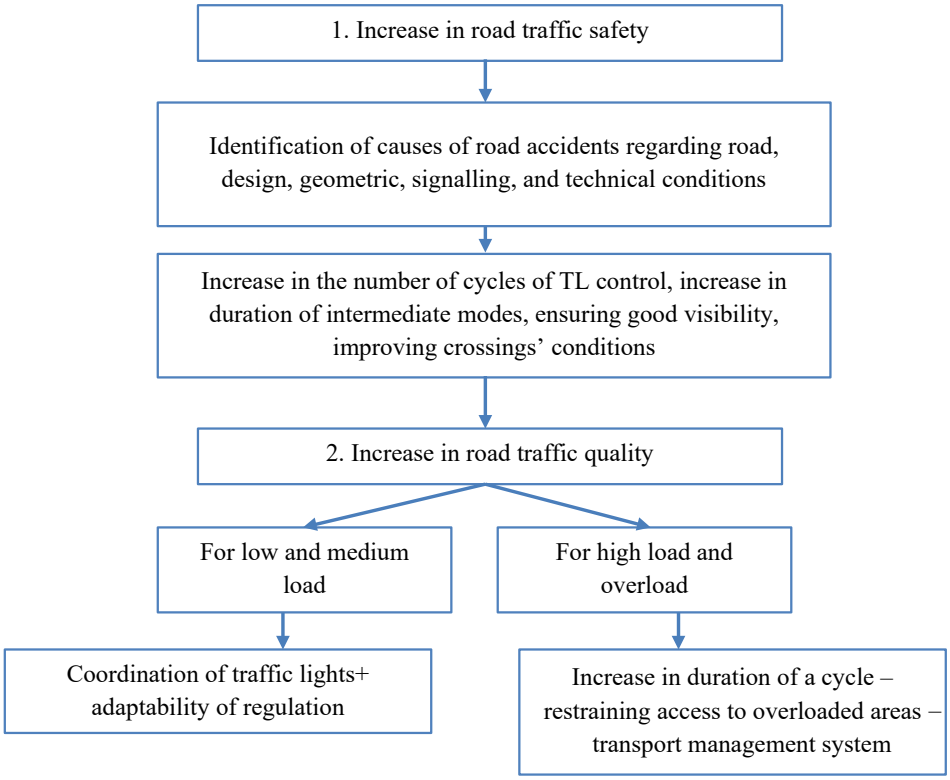
Based on the system analysis of transport flow management methods at the city's SRN [2], the following system is proposed to increase the efficiency of operation of traffic lights during congestion (Pic. 3).

Local optimisation may consist in increasing the number of different traffic light modes, extending duration of the traffic light mode and of the control cycle (even over recommended value of 120 seconds if this does not affect road traffic safety and does not provoke network congestion).

Principle 3. Under the conditions of traffic congestion if possible we should increase duration of the control cycle, regulate or restrain access of vehicles into overloaded areas, and use a transport management system.

As part of transport management, based on the assessment of lengths of queuing lines in front of traffic lights [9], the drivers should be provided with information for they could decide on the choice of further route.

Suggestions. Based on the system analysis of the methods used in Russia and abroad to improve road traffic safety and traffic quality,



Pic. 4. Basic methodology of management of transport flows in a large city with traffic lights.

of results of expert surveys and field observations, the following principles of a basic transport flow management methodology in a large city are proposed particularly regarding traffic lights operation (Pic. 4).

The proposed methodology requires further detailed development and verification for operating conditions of the Russian road transport.

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