# Modeling of traffic flows with due regard to ecological criteria

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**Abstract.** The article deals with issues of ensuring the reliable and safe city transport system operation through the use of the rational management methods. To make evidence-based management decisions are encouraged to use worked out intelligent decision support system. It is shown that a comprehensive solution of the city transport system management contributes to the sustainable development of the region.
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## Introduction

Key criterion of sustainable development in the world is achieving of strategic balance between activity of a man and support of reproductive abilities of biosphere [1].

It is especially important for regional development because region is open, complex, dynamic, socio-ecological-economic system which is functioning under the influence of internal factors realized through the bodies of local self-government, and external factors determined by state economic and social policy [2].

## The problem of city transport system management

Significant growth of intensity of traffic in city streets results in deterioration of traffic capacity, growth of the number of road accidents and injured people, and serious deterioration of the level of transport service of the city. Analysis has shown that ecological and social costs (costs associated with local air pollution, road accidents and traffic jams) can amount to more than 10% of GDP of the region or a country and significantly exceed the sums necessary for initiation of transition to "green" economy.

Transport is the sphere where efficient and ecologically safe projects and solutions must be used which are able to provide sustainable development of city infrastructure, keeping balance between comfort life conditions and careful attitude to nature. However, by now measures on optimization and management of transport system of the city are based on intuitive and expert estimates which contain no evidence base [3]. These measures lag behind the development of transport system of the city and results in the following:

- incomplete and low-efficient transport solutions are made;
- economically non-efficient priorities are chosen while preparing plans of building of new roads, reconstruction of crossing-points, introduction of new routes of passenger transport, planning of park zones etc.

It is very difficult to forecast changes in intensity of automobile traffic in UDC of the city after reconstruction of road sections, building of new attraction centers, residential areas. A lot of probabilities must be taken into consideration. In most cases reconstruction of UDC is fulfilled without due regard to growth of intensity of traffic and density of flows and therefore such measures as broadening of the section of road network, building of new turnaround points, additional lines of traffic do not provide positive effect, and in some cases stand for deterioration of situation on the roads.

Growth of the number of automobile vehicles is not taken into account in building of population attraction centers either. When building approaches to the territory of newly built trade centers the degree of traffic of adjacent sections of UDC is not taken into account, and this brings problems for drivers and pedestrians, problems which result in growth of road accidents, probability of traffic jams [4].

## Intellectual transport system (ITS)

All this forms a bundle of problems which hinder functioning of transport system of the city. Complex solution of mentioned problems can be provided by the use of intellectual transport system engaging simulation when different parameters of UDC can be taken into consideration [5]. Analysis

with the use of proposed system can be done in several directions:

1. Analysis of real situations appearing in UDC (accidents, repairing works) in simulation model with due regard to average speed of traffic and density of traffic, time of waiting in queues.
2. Searching for optimal solution of a problem of management with the use of variable parameters (traffic light's switching time, number of lines etc.)
3. Forecasting of influence produced by changes in topology of UDC (construction of bypass roads, changes in types of crossing points, etc.) on key characteristics of transport flow.
4. Struggle against traffic jams on the roads.

The foundation of proposed system is multi-dimensional model of data (OLAP-cube) (Figure 1) [6,7].

Multidimensional intellectual model of data is established in the Center of control over situations on the roads and is used for collection, storage and formalization of road network parameters.

Measurements of analytical cube are as follows:

1. Model, brand and type of engine.
2. Season of the year.
3. Time of a day.
4. Average term of use of passing by cars.
5. Intensity of traffic.
6. Direction of traffic.
7. Average speed of flow.
8. Length of traffic jam and the number of stops.
9. General number of cars passing-by for an hour.
10. Number of road accidents for given period.

For correct reproduction by the model of real situations it is necessary to get operational information which enters the Center in on-line mode from different sources: servers of municipal enterprises, equipment for operational monitoring of traffic situation (GPS, GLONASS devices)

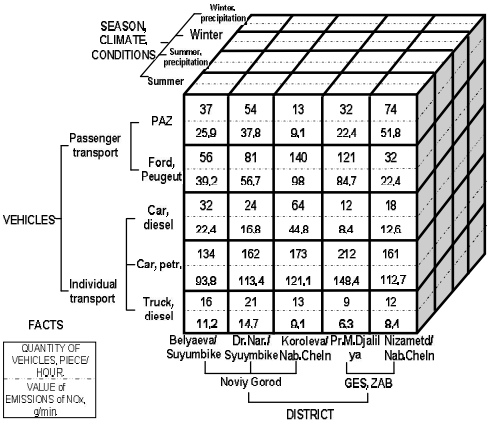


**Figure 1 OLAP-cube (measurement "type of a vehicle".**

Storage of information in OLAP-cube form and its further processing will allow to assess with high precision the dynamics of UDC parameters by different measurement (number of vehicles, section of the road, season, average speed, availability of a traffic light etc.) [8].

The next stage: packages of formalized data are conveyed to the system of simulation modeling for changing of model's parameters (Figure 2). Thus, stimulation model allows to take into account every-second changes in situations on the roads which is necessary for taking appropriate measures.

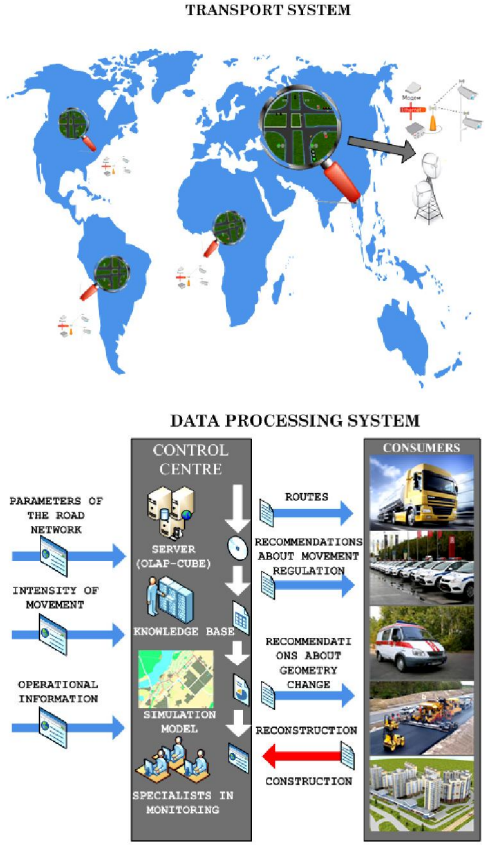


**Figure 2. Scheme of processing of information flows**

Development of simulation models is done with the use of the software product of Russian company "XJ Technologies" – Any Logic [9].

The key tasks in building model are as follows:

- Modeling of existing and forecasting of future transport flows;
- Modeling of all road network and public transport network;
- Analysis and evaluation of the rules and intensity of traffic;
- Scenarios "What will happen if ..."
- Platform for transport-information systems.

- Forecasting of traffic jams;
- Choice of optimal organization of traffic in crossing-points and evaluation of passing capability for every variant of traffic;
- Analysis of pass-through capacity and traffic in stop zone with giving priority to public transport;
- Optimization of traffic-lights operation;
- Analysis of bottle-necks.

Model of one of the sections of the city is shown in Figure 3. This model was built with the purpose of analysis of the pedestrians' safety level and optimization of the section with due regard to safety requirements. Assessment of parameters allowed to formulate solution - the necessity of traffic-light regulation on this section. Today this section in under re-construction.

ITS of the city is built from the models of UDC sections, combination of which allows to define the parameters of the network as a whole and develop solutions in the sphere of correction of some parameters. The most efficient solutions of the system are being processed and recorded into database from which, some time later, under request, the most appropriate result from those which are stored in the base will be taken. [10].

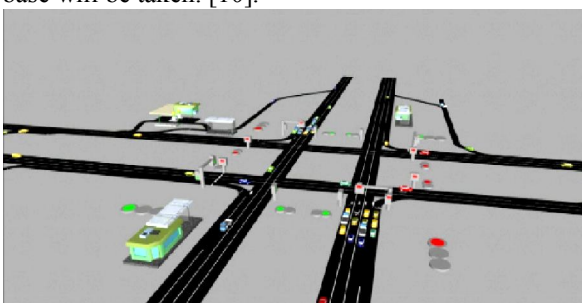

**Figure 3. - Model of the UDC section.**

## Conclusion

Developed algorithm of investigation of transport flows and information system for collection, storage, formalization and multidimensional analysis of monitoring data allows to improve efficiency and safety of transport system of the city. Simulation model of UDC and data base with solutions in regard to its problem sections allow to make recommendations on optimal transport flows management.

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