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THE ROLE OF INFORMATION TECHNOLOGIES IN THE SUSTAINABLE URBAN TRANSPORTATION SYSTEM MAINTENANCE РОЛЬ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ В ОБЕСПЕЧЕНИИ УСТОЙЧИВОСТИ ГОРОДСКИХ ТРАНСПОРТНЫХ СИСТЕМ

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Abstract. *The paper is about the role of information technologies in the sustainable urban transportation system maintenance. The most significant problems of urban transport related are presented. The principle of information entropy to evaluate information flows is offered. The author point out that information technology must cover information logistics coordination that allows one hand, to improve transport logistics coordination by providing residents some services without unnecessary movements to the service center using special technology; on the other - timely and unimpeded access to natural and legal persons to information.*

Key words: *sustainable urban transportation, intelligent transport systems, information management*

1. Introduction.

A sustainable urban transportation system requires strengthening various features of the system including mobility, accessibility, affordability, social equity, efficiency, safety, security, convenience, low carbon, comfort, and people- and environment-friendliness. In order to achieve all these elements, various challenges need to be addressed in an integrated manner.

In 1987, the Brundtland Commission published its report, *Our Common Future*, in an effort to link the issues of economic development and environmental stability. In doing so, this report provided the oft-cited definition of sustainable development as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’. It is necessary to develop the mechanism of providing decision support systems in public and private organization for urban sustainable transportation maintenance. Because not only does IT change the way organizations are structured, it also profoundly affects the way managers control their organizations. By control, we mean how people and processes are monitored, evaluated, given feedback, and compensated or rewarded.

The objective of the research is to study the role of information technologies for maintenance sustainable urban transportation. The most significant problems of urban transport related to (Irina Makarova, Rifat Khabibullin, Eduard Belyaev and Vadim Mavrin, 2016):

- urban transportation reliability: citizens will use public transport if they trust it. The credibility to provide services, schedules and the way of message serves the most important to the user;

- urban transportation comfortableness: people are in need of services.



- difficulties of parking: since most of the time vehicles are in the parking lot, car ownership growth has led to increased demand for space for parking; as a result, there are problems associated with the use of available space, particularly in the central areas of the city;

- commuter transportation over longer distances, people are spending more time to get to work from the suburbs and back. One of the most important factors causing this trend, related to the availability of housing because housing which are located further away from the central areas of the city (which focuses on the majority of jobs), is more affordable. Thus, suburban passengers are ready to sacrifice their time for affordable housing;

- traffic congestion: traffic congestion is one of the most common traffic problems in large metropolitan areas with populations, as a rule, exceeding the threshold of one million inhabitants. They associated, in particular, with the motorization and wide dissemination of cars, which leads to increase of demand for transport infrastructure;

- distribution of cargoes: globalization and the materialization of the economy leads to increase of the number of transported cargoes in the cities. Since the freight transportation are usually carried out using the same infrastructure, which are involved in the carriage of passengers, freight mobility in cities is becoming more problematic;

- loss of public space: the majority of roads are in public ownership, and access to them is free. The increase of traffic flows intensity has a negative impact on society; it comes to markets, public meetings, parades, games and social interaction. These activities were gradually supplanted by appearance of cars. In some cases, they were transferred to the shopping malls, in other cases they were abandoned at all. Traffic flows affect life and character of residents' interaction and their use of street space;

- IT and intelligent transport systems which improve public transport, because operators are able to improve the quality of their services due to the presence of accurate information about the location and movement of vehicles. In addition, passengers can receive updated information on the respective web sites, stations and other information points;

- using land: transport, especially road transport, affects nature use of the territories. From 30 to 60 % of the territory of any major metropolitan area can be set aside for transportation due to excessive dependence of residents from some types of public transport. In addition, similar nature of the use of land for transportations also confirms the strategic importance of transport in economic and social development of cities.

- mismatch of public transport needs: many public transport systems or their elements either overloaded or underloaded. During rush hours the tightness creates discomfort for drivers, while the system itself is trying to cope with the increased demand for transportation. Insufficient number of passengers determines the financial instability of many transport services, particularly in the suburbs;

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2. Sustainability urban transportation system.

Urban transportation system is one of the most important supporting systems and includes external transport facilities and non-urban routes and commuter links, urban street and road network. Basic functions of this subsystem are: organization of the public, and other intercity transport, organization of external passenger and freight transportation.

Effective performance of the transportation urban subsystem will ensure the flows' movement in the shortest time and at the lowest cost. This can be performed in the framework of the transportation subsystem functioning, where the whole range of services is minimized with respect to loss of time, socio-ecological and economic resources, and all the necessary related services will be provided for customers. Problems associated with insufficient transport services and uncertain transportation terms, may adversely affect the logistics maintenance of the urban sustainable development as a whole.

The sustainability of transport systems in large cities and megapolises is determined by the stability of their constituent subsystems, as well as the stability of relationships between them. This stability is ensured, to a considerable extent, the quality of governance. Now for the management of large systems, which also include transport, special instruments are created, such as decision support systems, expert systems and management information systems. Such systems are designed for the purposes of strategic management, as well as for solutions for local tactical tasks. Rational control allows not only to improve economic performance, but also to solve social tasks on improvement of transport service of the population and reduce the negative impact of the transport complex on the environment (Irina Makarova, Rifat Khabibullin, Eduard Belyaev and Vadim Mavrin, 2016.).

3. Information technologies in the sustainable urban transportation system maintenance.

Modern information technologies, such as decision support systems, expert systems, and others provide the ability to effectively analyze the technical and economic projects, process modeling, preparation and presentation of results for subsequent decision-making. The use of modern information technology can improve the efficiency of cargo delivery by enabling rapid access to information about the subjects and objects of delivery (Olga Zhuravleva, 2013).

Information technology must cover information logistics coordination that allows one hand, to improve transport logistics coordination by providing residents some services without unnecessary movements to the service center using special technology; on the other - timely and unimpeded access to natural and legal persons to information.

The functioning of information technologies is impossible without information support. Therefore, the setting up logistics coordination of information flow in the city and metropolitan area e-government activities should be launched:

Information management will contribute to:

- 1) intensification of the pace in providing the requested information to the



public, the business community, investors

- 2) establishing practice of feedback and public consultation
- 3) eliminating problems that have arisen in the city and metropolitan area, highlighted by public in tight schedule;
- 4) providing the services by local authorities to individuals and legal entities through electronic means in simple and convenient manner without time and space constraints
- 5) development of e-market for organization of bidding procedures for goods and services purchasing;
- 6) creation of virtual accreditation, that enable online access of journalists to activities which are provided by local authorities;
- 7) increasing of life quality by improving social services, health services subsystem, providing guaranties for legal and socio-ecological-economic security, spreading possibilities of urban educational and cultural subsystems;
- 8) establishing of a modern system of public relations for local authorities.

As the up to date information acquisition to the subsystem serves as a determinant of qualitative functioning of the letters and rapid adaptation to changing environmental conditions it appears appropriate to determine the optimization model information flows coordination in the city and metropolitan area.

According to our research we use the principles of information entropy to evaluate information flows. The coordination of information flows is influenced by the bandwidth of the network communication channel. In particular, for comparison, the speed of speech or reading is 120-200 words per minute, that is 2-3 words per second. Assuming that the words on the average consist of 5 sounds (letters) that can be coded automatically by 8-bit code, we find that the information bandwidth of the audio channels (for example, voice telephony in terms of the transfer of useful information) is $3 * 5 * 8 = 120$ bps. That is, the telephone connection is extremely inefficient for the transfer of large amounts of management information. Paper mail correspondence is even less effective as the bandwidth of this channel decreases in proportion to the increase in the time of sending correspondence.

The optimal information bandwidth management network of urban and rural areas will be achieved when:

- 1) communication is between all participants is at the maximum bandwidth;
- 2) communication is a network one with a minimum number of intermediaries that can cause loss of information (for example - reprinting messages with the possibility of making additional copies to bugs);
- 3) entropy is proportional to the width of the channel.

The theoretical (scientific) results are: principles and functions of the mechanism of providing of the intelligent IT systems in public and private organizations for maintenance of the sustainable development of cities and metropolitan areas. The practical (applied) results projects are model of optimization information flows, infrastructure of the intelligent IT systems.

According to such criteria optimization model will be as:

$$V_k \text{ (k bit /t)} \rightarrow \max \quad (1)$$



$$V_k = \frac{8 \times k}{t}, \quad (2)$$

where V_k is the bandwidth
 k is the characters quantity in a message
 t is the transmission time of messages (s).

In order to increase speed of management decision making, installation of fast communication channels in the city should be combined with “administrative cloud” (specialized centers with qualified staff), that provide consultations on legal, economic and management issues. By doing that “administrative cloud” lessen the load on local government because person on the elective post cannot use fluently the whole scope of urgent issues. “Administrative cloud” shall perform as specialized center for providing services by local government.

4. Conclusions.

Urban transportation system is one of the most important supporting systems and includes external transport facilities and non-urban routes and commuter links, urban street and road network. It is necessary to provide information technologies in the sustainable urban transportation system maintenance. Information technology must cover information logistics coordination that allows one hand, to improve transport logistics coordination by providing residents some services without unnecessary movements to the service center using special technology; on the other - timely and unimpeded access to natural and legal persons to information.

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