The transport skeleton as a part of spatial planning of Tatarstan Republic

Introduction

The Transport strategy of Russia [1], developed one year ago became a major landmark in development of transport branch, which unlike other branch strategy considers spatial planning to the greatest degree. For the first time it is declared that mission of transport is beyond branch efficiency and it is directed on achievement of indicators of sustainable development of the country, including its spatial development.

Developing the Strategy of development of transport of Tatarstan Republic [2] the problem was put to realize the following innovative approaches:

1. To solve a problem of spatial dissociation of Tatarstan due to achievement of normative accessibility;
2. To define Minimal Transport Standard (MTS) – set of parameters of sustainable development of the territory, depending on transport systems functioning directly. MTS defines the minimal transport conditions of quality of life, including spatial, for which the state is responsible and which allow to create equal *starting* conditions in different places. It is also connected with reform of budgeting when the competition for financial resources between departments leads to more effective achievement of parameters of MTS;
3. To calculate a new parameter of transport security (instead of simplified, for example, indices of Engel/Golts) - Integral Transport Accessibility (ITA) which is analogue of a parameter of reliability. It includes not only technical, but also topological reliability, and is measured in potential expenses of time. The direct estimation of reliability of topology of a network as resource of social and economic development of territory is used for increase of efficiency of investment projects. The probabulity of connectivity acts as a global parameter of topological reliability of territory, factor of cyclicity - as local index [3].

Minimal Transport Standard

Minimal Transport Standard (MTS) - set of parameters of final consumption of transport services on which conditions of a life in region (especially spatial) are depended.

Unlike intermediate and branch parameters (such as intrabranch profitability, output of road industry), describing work of the transport itself, in MTS are used the parameters describing the environment of quality of life and depending on final results of transport operating.

For the consumer of transport services (passengers, owners of a transport vehicles) it is not so important, how many sectors of a network are reconstructed or repaired, what profitability of the road repair-building organizations, commercial loading of airplanes etc., but what advantages it gives to it personally. That is, consumer properties of certain routes are important to it: speed of movement (an expense of time), safety, comfort. And also consumer properties of the Uniform transport network of all types of transport (such as accessibility, connectivity and so on).

The number of parameters of MTS and their value are defined depending on strategic parameters of development of region, namely:

- gross domestic product per capita;
- life expectancy in region;
- a level of charges of the regional budget directed on social needs;
- a level of ecological safety;

- horizon of planning, considering, that MTS should reflect valuable orientations of a society in long-term prospect;
- existing and potential levels of social and economic development of territory;
- a share of the populated (economically settled) territory, instead of a total area.

The one part of indicators of MTS (see table 1), such as a level of transport discrimination of the population, the specific lost fund of a free time, mobility with the social and cultural purposes is the parameters directly influencing on environment of quality of life of region, other part - freight capacity of economy (share of transport work in gross domestic product (gross regional product)), budgetary profitability of transport branches, the parity of expenses for an infrastructure and a transport vehicles - define a macroeconomic situation. The majority of parameters of MTS corresponds to the indicators, accepted in the international community [4]. Liquidation of a difference between actual and planned (accepted) values of MTS is an ultimate goal of development of a transport-road sphere. That is, results of development of a transport network from a position of consumers of transport services should be estimated on MTS. Annually machinery of government of a transport sphere and its separate branches should show, in what measure the volume of the spent budgetary means (on repair, the maintenance, reconstruction and construction of sectors of transport networks) promoted an improvement of the above-named parameters. Foremore MTS acts as the real mechanism of a regulation of use of various resources for achievement of mission of Strategy.

It is obvious, that normative values of parameters of MTS will be various for subjects of the Russian Federation, considering their variety of existing and potential levels of development. Below the Minimal transport standards of Arkhangelsk area (the North of European part of Russia) and Tatarstan Republic (the middle Volga region) are resulted.

Table 1.

Minimal Transport Standards of Arkhangelsk area and Tatarstan Republic

№	**Indices**	Recommended values	Actual values	Recommended values	Actual values
		Arkhangelsk area (1999)		Tatarstan Republic (2003)	
1	Transport share in total pollution, %	18,35	26	9,5	70,0
2	Share of motor transport in total transport pollution, %	70	80	61	96,5
3	Transport network reliability (level of integral transport accessibility), %	80,5	88,92	100	86,9
4	Level of transport discrimination of population, %	5,3	25,6	0	19,3
5	Free time lost, (hours per person-week)	2,7	7,5	0	2,97
6	Accident level due to bad roads, (per 100000 trips)	0,87	2,77	0,01	0,15
7	Freight capacity of economy, (t-km/1 USD of GDP)	2,85	8,7	0,1	0,98
8	Annual population mobility for social and cultural purposes only, (person-km)	620	208	460	232
9	Ratio of infrastructure expenditure to transport vehicles (all modes) costs,%	70/30	70/30	70\30	50\50
10	Share of public transport in passenger transportation, %	87	95	85	82
11	Muscular (non-motorised) transport (e.g. bicycles) in urban and suburban traffic, %	14	0,075	27	0,1
12	Effectiveness of transport financing (% net contribution to GDP)	> 1	2,1	> 1,7	1,45

Integral Transport Accessibility and topological reliability of a network

The need for a new parameter of transport security reflects needs of business and state planning, first of all, for development of a transport infrastructure. Today the practice of feasibility study in management of projects is widely developed. However 99% from them are separate (individual) projects, such as construction of the bridge, rehabilitation of road, etc. We discuss network projects, otherwise, the project of a network of roads or all infrastructure of region, the country - *as one object*.

In network projects the multiplicate effect is many times more, than in individual projects. A basis of such effects, sharply raising interest of investors is the topology of a network [5].

To estimate a topological effect in networks the resource concept of an estimation of spatial structure has been developed. The configuration of borders and topology of objects is considered as one of kinds of resources of territory similarly to minerals or human potential. It is necessary to answer only a *simple* question, especially interesting to the investor: what topology brings more money?

Unfortunately, the spatial planning cannot answer this question *directly* today. The majority of parameters and methods, such as the nearest neighbourhood, ranges of Voronova-Direxle, fractals, have the simplified (elementary) character. At the best, these parameters answer a question, how much this or that configuration differs, but do not answer a question, how much this or that topology is favourable at cost or on save of time.

It is obvious, that a parameter of transport security of territory - so-called indices of Engel/Golts when the length of communications divide on the area or the population of territory - have inconsistent character. Engel has thought up the indicator in 1899. And nevertheless, many ministries use it till now.

One of the reasons of unavailability to reflect the cost of configurations is an accent on external forms. In our opinion, more correct is the following thesis: the configuration of external borders is formed by the internal context. The external condition acts only as restriction (barrier).

For an estimation of a resources of configurations we use the modified theory of reliability of technical systems and the graph theory [6].

Representations about reliability were theoretically originally issued in complex technical systems (first of all radio-electronic), where the problem of search of the reasons of refusals and ways of their overcoming was put. Two directions of an estimation of reliability were generated. The first - in systems with prevalence of a technical component (electric power industry, communication, water supply, pipeline transport) where eventually have departed from the basic parameter of reliability of radio-electronic systems (probability of non-failure operation) in favour of factors of security, for example, the electric power. The second - in nontechnical systems (biological, planning, economic). The account of specificity of considered systems are dominated here as for these systems other purposes (for example, for biosystems - long duration has no special value in itself, and reliability of self-reproduction which in many respects is predetermined by information redundancy, including at a genetic level is important). At a resource estimation of a graf of a network the ability of territorial system to carry out the specific function on spatial linkage together of diverse objects also can be estimated by means of a parameter of reliability of functioning of transport - factor of security a transport network. The given factor is defined under the formula:

$$K = \frac{ITA_{actual}}{ITA_{norm}}, \qquad (1)$$

where ITA - the integral transport accessibility including two kinds of reliability - technical and configuration (on a graf of a network).

$$\text{ITA} = \frac{S_i * (1 + K_i) * (1 - T_i)}{V_n}, \quad (2)$$

where S_i – the average shortest weighted distance from the given point up to all others;

K_i – coefficient of a variation of the shortest routes;

T_i – coefficient of cyclicity;

V_n – normative speed on the shortest routes.

Integral Transport Accessibility characterizes reliability of functioning of a transport network from positions of interests of consumers. ITA includes technical reliability of each sector of a network (on each type of transport there is 5-7 parameters reflecting its specificity) and reliability of a tracing (figure) of a network. The last shows global consequences of failure of each local sector of a network. ITA is measured in average weighed expenses of time necessary for achievement of any point of region from any another. Potentiality of the given measuring instrument consists in it. In terms of the theory of reliability ITA shows probability of achievement on the given network of a region of any point with set (normative) speed. The quotient of normative and actual ITA is a level of transport security of region the Uniform transport network.

For a network as a whole the modified formula of a polynom is used (3)

$$P_3(G) = \sqrt[N]{\prod_{i=1}^{n} [1 - (\pm[1 - m_{ij}])^k]}, \quad (3)$$

there m_{ij} – reliability of each edge ($0 \le m_{ij} \le 2$); $P_3(G)$ represents compound probabilities of connectivity of each edge [7].

As shows the analysis of the formula (3) size of each factor sharply comes nearer to 1 with increase in number of neighbours (k), that is outputs outside from the given part, even at rather low reliability of edges: for example, expressions ($1 - 0{,}424^{12}$) и ($1 - 0{,}882^{11}$) are approximately equal.

The transport skeleton of Tatarstan Republic

The transport skeleton as a part of spatial planning of Tatarstan Republic is a necessary condition for maintenance of sustainable development of republic. Thus, it will guarantee *equal starting conditions* of a competitive life of people.

The new program (for 25-30 years) of spatial planning is being prepared in Tatarstan Republic. The transport device of territory is a component of the program. The aim of the development of transport is achievement of normative parameters of sustainable development of republic, and also increase of a level of its capitalization due to transport. As is known, not any riches become the capital. It is necessary to create accompanying conditions, including transport (accessibility), that natural, material and human resources become the capital (and the territory on which they are located, would become attractive for investors and convenient for a life).

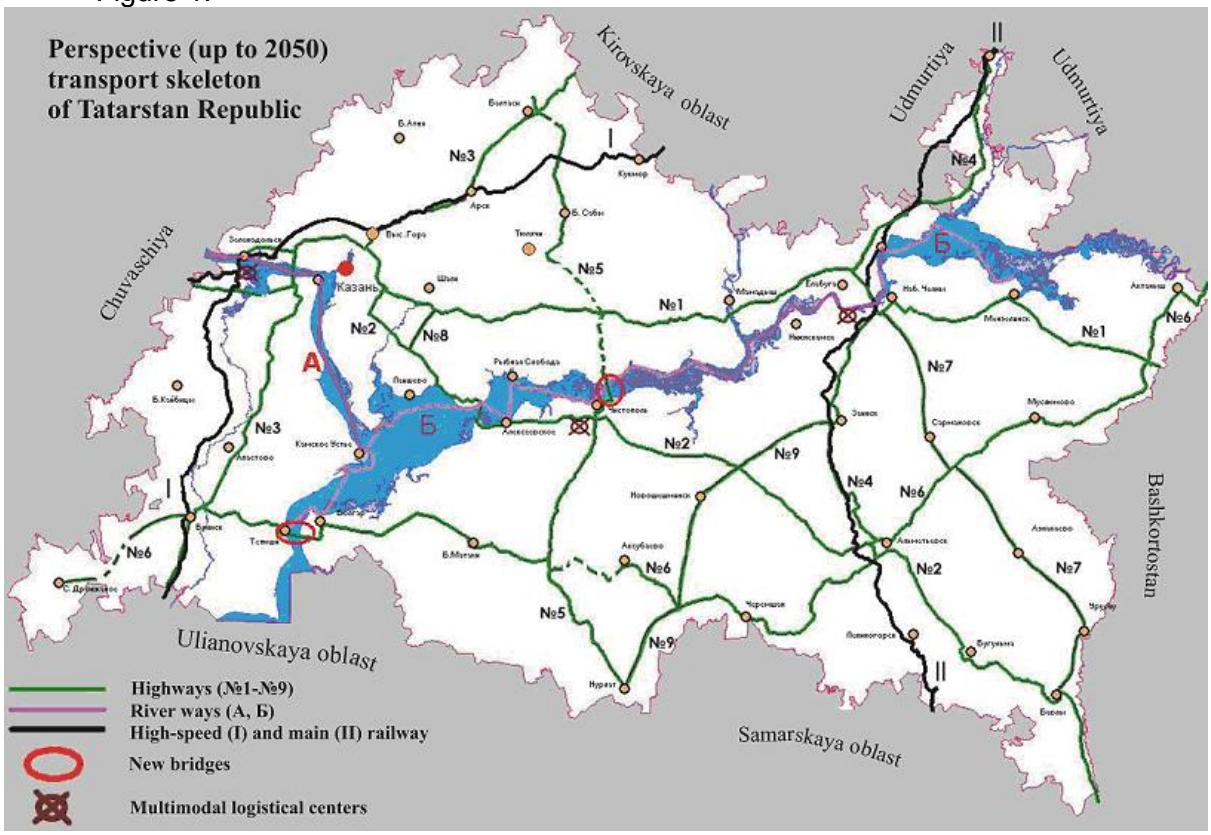
The main decision of a transport part of the new program is the transport skeleton. It represents a network of highways, which divide republic on 26 big spatial cells. The network of local roads inside them allows each inhabitant to reach highway for 20-30 minutes. Further up to any point of republic no more, than for 2.5 hours (now – for 4.3 hours). Thus, if average technical speed today makes only 33.7 km/h, in the future it will reach 140 km/h (figure 1).

Cost of the above described project makes 10.7 billion dollars and is calculated till 2045. The project includes reconstruction of roads (1866 km) and construction of new roads (142 km).

In result the new territorial community incorporated by transport (the area of Tatarstan Republic makes 68 thousand sq. km) will be created. Thus, all population will have *equal*

starting conditions for a life. So, spatial planning really eliminates transport discrimination and guarantees rights for a competitive life.

Figure 1.



Conclusion

1. The share of topological reliability as a whole in general reliability of territorial (transport) systems reaches 15-20%.
2. The approaches connected with reliability in strategy of development of transport have found the practical expression in construction of perspective transport skeletons. They should be not superfluous. The perspective (up to 2050) transport skeleton of Tatarstan Republic has a total cost 380 billion roubles which realization will provide achievement of the Minimal transport standard. The last is a transport prototype of prosperity of a region.

Literature

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