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JUSTIFICATION OF INDICATOR SYSTEM OF SOCIAL AND ECONOMIC EFFICIENCY OF HIGH-SPEED URBAN TRANSPORT DEVELOPMENT STRATEGY

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Introduction. At the present stage of developing methodological approaches to assessment of social and economic efficiency, all the external effects of the project are divided into effects that can be estimated in value terms, and effects that cannot be expressed in monetary units. In turn, the latter are divided into effects that have a quantitative expression and effects, described only on a qualitative level. External effects, which can be estimated in monetary terms, are directly included in the calculation of the social and economic efficiency of the project in the form of additional inflows and outflows of money.

Problem. The conceptual basis for assessing the social and economic efficiency of new high-speed lines is the comprehensive consideration of all external effects from the implementation of the investment project (economic and non-economic) that do not affect the cost parameters of the project participants.

Objective. The aim of the work is to develop a system of indicators for assessing the social and economic efficiency of the strategy of the development of high-speed urban transport.

Methods. Study of existing methods of assessing social and economic efficiency, searching for disadvantages and advantages, exploring the advantages of magnetic levitation technology.

Results. The development of this system of indicators for magnetic levitation transport, which is distinguished by such advantages as the impossibility of derailment, greater route speed, hence less time travel, less noise and vibration than light-rail transport and metro, complete absence of dust, is especially important.

Conclusion. The proposed system of indicators for assessing the social and economic efficiency of the strategy of the development of high-speed urban transport takes into account all the advantages of magnetic levitation technology and makes it a priority when choosing high-speed urban transport.

Social and economic efficiency, external effects, high-speed urban transport, magnetic levitation.

Introduction

Evaluation of the economic efficiency of the strategy of high-speed urban transport is the final stage in the formation of the strategy. When developing the strategy, it is necessary to develop criteria for evaluating its implementation and evaluating the company's final state.

To be efficient, financial information should be optimal in terms of volume, timely, reliable, meaningful, should be related to the priority goals and objectives of the strategy.

In foreign practice, existing methods for evaluating the strategy: service life analysis, portfolio analysis, GE-McKinsey, benchmarking. Essentially, they are all related to the correspondence of specific strategies to the organisation's position in the market and its relative strategic capabilities.

But these methods have descriptive character and do not us allow to carry out a quantitative assessment of the social and economic efficiency of the strategy of high-speed urban transport. Therefore, in the thesis, a system of indicators for assessing the social and economic efficiency of the strategy for the development of high-speed urban transport is justified.

The paper analyses the existing methods for assessing social and economic efficiency and makes conclusions on that.

Calculations of commercial, budgetary, economic and social and economic efficiency of investment projects in railway transport are carried out mainly in accordance with the following methodological materials:

- methodological recommendations on assessment of investment projects (second edition) approved by the Ministry of Economic Development of the Russian Federation, the Ministry of Finance, State Committee for Construction, Architecture and Housing Policy № VK 477 of June 21st, (hereinafter referred to as the Set of Methods);
- methodological recommendations on assessment of investment projects on railway transport (annex to the Directive of the Ministry of Communications (today's Ministry of Transport of the Russian Federation) of August 31st, 1998, № V-1024u) hereinafter referred to as the Set of Methods № V-1024u;
- methods of calculation of indexes and application of criteria of efficiency of regional investment project, approved by the Ministry of Regional Development of the Russian Federation order of August 31st, 2008 № 117 (hereinafter referred to as the Set of Methods № 117);
- methods of index calculation and criteria application to investment projects efficiency claiming for state support at the expense of the Russian Federation Investment Fund, approved by the Order of May 23rd, 2006 № 139/82n (hereinafter referred to as the Set of Methods № 139/82n of May 23rd, 2006) of the Ministry of Economic Development and the Ministry of Finance of the Russian Federation;
- methods of assessment of social and economic efficiency of construction of new railways, approved by Senior Vice-President of JSC "RZD" B. Lapidus of August 29th, 2009 (hereinafter referred to as the Set of Methods of JSC "RZD" of August 29th, 2009).

Indicators of public efficiency take into account the social and economic consequences of implementation of an investment project for society as a whole, including both the immediate results and costs of the project, and "external": costs and results in related sectors of the economy, environmental, social and other noneconomic effects.

The current general scheme for assessing the social and economic efficiency of investment projects (given below) allows us to identify and define social efficiency as an economic category [1].

Some of the activities in the sphere of production and consumption stipulate direct costs or benefits for consumers and firms that are not directly involved in these activities. Accordingly, such results cannot be taken into account in the economic indicators of the producer of goods and services: costs, revenues, profits, etc. Underestimation of the costs and benefits of third parties leads to an overestimation, or to an underestimation of the volume of output of goods in comparison with the effective output from the public point of view. It is about the existence of so-called external effects (externalities).

The external effect is the costs and results of the project that have not been adequately reflected in the indicators of economic activity of economic entities participating in the project.

In the most general form, external effects can be divided into environmental (sometimes called technological), social, economic and public goods that do not have a price.

The ecological (technological) externalities are:

- pollution of soils, hazardous emission into the atmosphere and water reservoirs;
- non-efficient exploitation of natural resources deposits and agricultural lands;
- violation of the ecological (biological) balance of the territory;
- cutdown (increment) of forests, green plantations in urban settlements;
- explosions, fires dangers, etc;

External effects of a social nature include externalities directly related to the standard of living of the population (as opposed to technological ones, whose influence can be considered mediated). These may include:

- changes of population salaries, employment rate, service and commodities prices, consumer goods quality, quality and price of accommodation, accommodation provision, provision of housing and utilities services, culture, sports institutions, transport service, education and health care levels, labour conditions, number of work with hard and dangerous conditions, profession-related diseases and production injures, and crimes;
- economy or additional expenses of spare time of population at the expense of various factors.

External effects of economic nature are reflected in expenses and incomes of organisations and enterprises, that do not participate in the project. These may include:

- change in the value of land and real estate objects that are not related to the project, as a result of its implementation, costs for enterprises not participating in the project;
- creation and development of new productions (at the expense of providing transport, raw materials, innovative developments);
- compromising on transportation costs of health care enterprises, culture at the expense of the construction of a new road, etc.

One of the main ways to take into account externalities in investment design is to include them in the prices of manufactured goods and services and consumed resources. The process of adjusting market prices to calculate the efficiency of projects from a social standpoint (social and economic efficiency) is called the conversion of market prices. New, adjusted prices are also called economic prices, in the Western literature – shadow prices.

As sources of information for developing an assessment of the social and economic efficiency of the investment project for the construction of a new high-speed line the following sources have been considered:

- project materials in the scope of the feasibility study, justification of the investment of the project being considered;
- expert assessments of the degree of influence of the implementation of the investment project on the parameters of the social and economic development of the Russian Federation, the region, the industries and enterprises of interest, taking into account the significance of the project under consideration.

In calculations of social and economic efficiency, the target of new high-speed lines, their social significance and economic environment should be taken into account.

Realisation of construction projects of high-speed lines ensures achievement of a range of targets, generation of effects (including disadvantageous ones), which differ in the degree of their social and economic significance of the entire country, some regions, branches, participants of the project. The composition of goals, effects is stipulated by, to a large extent, ascribing the new railway line under consideration to this or that category, in accordance with the strategy. Separate goals, effects can be achieved, generated only during the construction and subsequent operation of certain categories of railway lines, for example, a significant reduction in the travel time for passengers carried by rail can only be achieved with the construction of railways specialised for high-speed traffic.

The economic environment of the project is determined by the boundaries of its influence on the economic, social, environmental spheres of society and is determined by the following factors:

- public importance of the railway line;

- line category;
- resource requirements for the construction of the line;
- the composition of the «recipients» of effects.

At the present stage of development of methodological approaches to assessment of social and economic efficiency, all the external effects of the project are divided into effects that can be estimated in value terms and effects that cannot be expressed in monetary units. In their turn, the latter are divided into effects that have a quantitative expression and effects, described only on a qualitative level. External effects, which can be estimated in monetary terms, are directly included in the calculation of the social and economic efficiency of the project in the form of additional inflows and outflows of cash.

The concept basis for assessment of the social and economic efficiency of new high-speed lines is the comprehensive consideration of all external effects from the implementation of the investment project (economic and non-economic) that do not affect the cost parameters of the project participants. External effects should be taken into account in value form and calculated using appropriate regulatory and specific characteristics. In the absence at the present stage of computational methods for the valuation of a number of external effects and generally accepted approaches to their accounting in the implementation of assessments of the social and economic efficiency of investment projects for the construction of new railway lines, one of the tasks is the systematisation and development of approaches to accounting externalities generated in the social and economic sphere of life of the Company in the implementation of projects for the construction of new public railway lines.

The set of methods of assessment of social and economic efficiency of new high-speed line is based on the following classification of external factors:

- economic;
- social;
- ecological.

Due to specifics of the innovative transport technology, the system of indicators of social and economic efficiency of the strategy has been supplemented and specified. The table suggests indicators for assessment of social and economic efficiency of high-speed urban transport development strategy.

The particular importance is the development of this system of indicators for magnetic levitation transport, which has advantages such as the impossibility of derailment, a greater route speed, therefore, less travel time, less noise and vibration than LRT and metro, complete absence of dust [2]. To assess the strategy for the development of high-speed urban passenger transport, three groups of indicators are proposed.

Indicators for assessment of social and economic efficiency of high-speed urban transport development strategy

Indicator	Indicators
Changes in time spent by passengers on their way, thousand rubles	$$\sum ESTT_i^t = \sum\left(P_{ijk}^t \times Vot_{ik}^t \times TC_{ij}^t\right) - \sum\left(P_{ik}^{t\,HSR} \times Vot_k^t \times TC_i^{t\,HSR}\right),$$ where *i* – connection; *j* – urban transport type; *k* – purpose of travelling; $ESTT_i^t$ – the effect of saving time on the way by passengers of all types of urban transport in the implementation of the MLT project in the year *t*; P_{ijk}^t – amount of passenger traffic on *i*-th connection on *j*-th type of transport with *k* purpose of travelling in the year *t* in “zero option”; Vot_{ik}^t – cost of time of passenger on *i*-th connection with *k* purpose of travelling in the year *t*; TC_{ij}^t – costs of passenger for time of travelling on *i*-th connection on *j*-th type of urban transport in the year *t*; $P_{ik}^{t\,HSR}$ – amount of passenger traffic on *i*-th connection with *k* purpose of travelling the year *t* during realisation of MLT project; $TC_i^{t\,HSR}$ – time costs of passenger for travelling on *i*-th connection on *j*-th type of urban transport in the year *t* during realisation of MLT project
The effect from reducing the harmful impact on the environment during the implementation of the MLT project, thousand rubles	$$EED = VED^0 - VED^{HSR},$$ where VED^0 – cost assessment of environmental damage in the "zero" option; VED^{HSR} – cost assessment of environmental damage during the implementation of the MLT project. With this approach being considered, the damage to the environment is formed from three components: $VED = VEmis + VCli + VN$, where $VEmis$ – cost assessment of emissions into the atmosphere; $VCli$ – cost assessment of hazardous impact on the climate; *VN* – cost assessment of noise pollution on the environment
Effect from increasing safety during realisation of MLT project, thousand rubles	$$\sum ES_i = \sum\left(Pkm_{ij} \times r_j^s\right) - \sum\left(Pkm_i^{HSR} \times r_i^{s\,HSR}\right),$$ where *i* – connection; *j* – urban transport type; *ES* – effect from increasing traffic safety during passengers travelling all types of transport during realisation of MLT project; Pkm_{ij} – amount of passenger traffic on *i*-th connection on *j*-th type of urban transport in the “zero option”; r_j^s – cost assessment of failure expenses on *j*-th type of urban transport; Pkm_i^{HSR} – amount of passenger traffic on *i*-th connection with *k* purpose of travelling in the year *t* during the realisation of MLT project; r_j^s – cost assessment of failure expenses during realisation of MLT project

The development of maglev transport systems are restrained by obsolete norms of their design which have not been renewed for many decades. These norms do not take into account today's rolling stock properties. Besides, creation of cutting-edge integrated light-rail systems is hindered by lack of national rolling stock [3]. Considering advantages of maglev transport (MLT), the priority task for Saint Petersburg is design and implementation of light-rail transport to be deployed on sections with heavy passenger traffic without access to metro transport [4, 5].

There are two categories of maglev transport defined by purpose and technical parameters:

- urban ground and underground as well as intercity transport with speeds up to 200 km/h;
- mainline transport with high and superhigh speeds up to 1000 km/h, if vacuum tube is deployed.

Urban maglev transport is aimed at connecting the city centre with suburbs, city districts and large transport hubs – railway, bus and metro stations, sea and river ports [6–12].

Mainline transport is intended for intercity travelling with speeds up to 400 km/h and for transcontinental travelling with speeds up to 1000 km/h.

The system of indicators is developed taking into account the specifics of innovative transport projects, namely the project of creating a magnetic levitation transport [13].

Change of the time spent by passengers on the way

The development of high-speed passenger transport contributes to the growth of the cultural level of people, the efficient use of free time and the economic efficiency of social production. In real conditions, the determined result of the activity of passenger transport can have both a social and economic effect. Increasing the speed of communication promotes the release of free time, which can be used to meet the cultural needs of citizens or recreation and at the same time to enhance professional qualifications, which will ultimately affect the growth of labour productivity.

Saving time as the most important indicator of the quality of transport services for the population is one of the components of the social and economic efficiency of the organisation of high-speed traffic. The economic sense of accelerating carrying a passenger is that it saves the time of his distraction from the sphere of material production, with the opportunities being created for the production of some part of the social product expressed by a certain value. Or, the passenger's personal time can be saved, which he could use to improve his cultural, educational or professional level. The more time is saved for a trip, the higher the probability of creating an additional social product, if the passenger spends his time saving productive labour. The cost of this additional product, which is a part of the national income and characterises the corresponding effect of reducing the time spent on transport. It should be noted that in recent years, the very shortened travel time is an incentive to use modern technology for productive, primarily managerial and entrepreneurial work. At the same time, the travel time reduced to 2-3 hours makes it possible not only to solve a number of production tasks, to prepare for business meetings and to enter the production process without pause. Therefore, not only saving time on business trips, but also a trip in high-speed mode allows 70–80 % of the time to use for professional functions [14].

The calculation of saving time spent on the way is carried out for passengers who switched to MLT from other modes of transport. The cost assessment of saving time is carried out using the cost of time depending on the purpose of travelling [15].

$$\sum ESTT_t^t = \sum\left(P_{ijk}^{t\ 0} \times Vot_{ik}^t \times TC_{ij}^t\right) - \sum\left(P_{ik}^{t\ HSR} \times Vot_k^t \times TC_i^{t\ HSR}\right),$$

where i – connection;

j – transport mode;

k – purpose of travelling;

$ESTT_t^t$ – the effect of saving time on the way by passengers of all types of urban transport in the implementation of the MLT project in the year t;

$P_{ijk}^{t\ 0}$ – amount of passenger traffic on i-th connection on j-th type of transport with k purpose of travelling in the year t in the “zero option”;

Vot_{ik}^t – time cost of passenger on i-th connection with k purpose of travelling the year t;

TC_{ij}^t – passenger’s time expenses on the way on i-th connection on j-th type of transport in the year t;

$P_{ik}^{t\ HSR}$ – amount of passenger traffic on i-th connection with k purpose of travelling in the year t during realisation of MLT project;

$TC_i^{t\ HSR}$ – passenger time expenses on the way on i-th connection on j-th type of transport in the year t during MLT project realisation.

The basis for estimation of the cost of time is the weighted average hourly wage rate in the cities considered. Differences in the cost of time depending on the purpose of travelling were set on the basis of world developments in this field, the results of a sociological survey and expert assessments.

The calculation of the cost of time was carried out as follows:

$$VoT_{ij}^{other} = \frac{dw_i + (1-d)w_j}{21 \cdot 8},$$

where VoT_{ij}^{other} – the cost of time for trips with non-business purposes (cultural, tourist, etc.) between *i*-th and *j*-th cities;

d – the weight coefficient, which takes into account, in the general case, an unequal share of the inhabitants of the cities in question in the total correspondence between them (it is assumed that if there is a noticeable difference in the population of cities, the proportion of the inhabitants of a smaller city will be higher);

w_i – average monthly nominal wage in *i*-th city;

21·8 – multipliers for conversion to hourly rate.

$$VoT_{ij}^{business} = 3,5 VoT_{ij}^{other},$$

где $VoT_{ij}^{business}$ – the cost of time for trips with business purposes between *i*-th and *j*-th cities;

3,5 – multiplier that reflects a higher cost of time when making business trips (adopted taking into account foreign experience and the results of a sociological survey that showed that passengers travelling with business purposes have an income level which is above the average one).

The forecast of the cost of time was based on the forecast of wages:

$$VoT_{ij}^{t+n} = VoT_{ij}^{t}\left(1 + 0,7\left(d\tau_i + (1-d)\tau_j\right)\right)^n,$$

where VoT_{ij}^{t+n} – the cost of time in $t + n$ year (the general approach to the calculation of the cost of time regardless of the purpose of the trip is applied);

τ_i – average speed of wage growth for *i*-th city;

0,7 – coefficient that takes into account the lag of the cost of time from the growth of wages (adopted taking into account foreign experience).

The effect of reducing the harmful impact on the environment during the implementation of the high-speed mainline project was calculated as follows:

$$EED = VED^0 - VED^{HSR},$$

where VED^0 – cost assessment of ecological impact in the “zero option”;

VED^{HSR} – cost assessment of ecological impact during realisation of high-speed mainline project.

In this approach, the damage to the environment is formed by three components:

$$VED = VEmis + VCIi + VN,$$

where *VEmis* – valuation of emissions into the atmosphere;

VCIi– evaluation of hazardous impact on climate;

VN– evaluation of noise pollution of the environment.

The evaluation of the noise pollution of the environment is of particular importance, since the magnetic levitation transport has a lower noise level, namely 65 dB, in contrast to other modes of transport, usually greater than 70 dB.

Evaluation of noise pollution is determined as:

$$\sum VN_i = Pkm_{ij} \times r_j^N,$$

where Pkm_{ij} – amount of passenger traffic on *i*-th connection on *j*-th transport mode;

r_j^n – evaluation of noise pollution per one passenger-kilometre.

The evaluations of emissions of pollutants into the atmosphere and the harmful effects on climate are determined similarly.

The redistribution of passenger traffic by mode of transport as a result of the creation of MLT will lead to a change in the load on the environment due to changes in emissions of pollutants into the atmosphere and changes in noise pollution.

Ecological damage is estimated on the basis of specific indicators of environmental damage per passenger-kilometer by mode of transport. The use of foreign studies is explained by the lack of similar Russian developments. Environmental damage caused during the construction of the MLT is included in the capital costs. The effect of reducing environmental damage is defined as the difference between the assessment of environmental damage for the “zero” option and the implementation of the MLT project.

The effect of improving safety during the implementation of the MLT project was calculated as follows:

$$\sum ES_i = \sum \left(Pkm_{ij}{}^{0} \times r_j^S \right) - \sum \left(Pkm_i{}^{HSR} \times r_i^{S\,HSR} \right),$$

where *i* – connection;

j – transport mode;

ES – effect from enhancing safety during passengers travelling all types of transport during MLT project realisation;

$Pkm_{ij}^{\ 0}$ – amount of passenger traffic on *i*-th connection on *j*-th type of transport in the "zero option";

r_j^S – evaluation of failure expenses on *j*-th type of transport;

$Pkm_i^{\ HSR}$ – amount of passenger traffic on *i*-th connection with *k* purpose of travelling in the year *t* during MLT project realisation;

r_j^S – evaluation of failure expenses during MLT realisation.

The evaluation of the effect of improvement of the safety of passenger traffic is determined on the basis of the specific indicators of damage from accidents per passenger-kilometer by mode of transport and the distribution of passenger traffic by mode of transport in the "zero" option and in the implementation of the MLT project.

Specific indexes of damage for MLT are estimated by foreign counterparts.

Conclusion

The proposed system of indicators for assessment of social and economic efficiency of the high-speed urban transport strategy development takes into account all the advantages of magnetic levitation technology and makes it a priority when choosing high-speed urban transport.

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