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Assessment of Effectiveness of Sustainable Transport Development

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ABSTRACT

The traditional assessment of efficiency of operations and of development projects of transport systems is based on a mercantilist approach that considers efficiency of activities according to the «cost–income–profit of economic entities» pattern. In this case, non-systemic, external results are usually not considered, while they can be many times higher in value terms than the internal results obtained by economic entities. External results are often seen outside the realm of purely economic relations. This is especially evident in the infrastructure sector, the material basis of which is formed by transport and logistics. To some extent a crisis of economic doctrine has arisen. An ecological crisis is being observed due to unrestrained anthropogenic activity. The concentration of people and production activities in cities has become the cause of the urbanization crisis. Growing inequality has led to an exacerbation of social contradictions. As a result, mankind has faced a complex crisis of civilization. Sustainable development was recognized as the main means of resolving the crisis. Sustainable transport development being primarily an infrastructure field of activity, serves as the foundation for building sustainable development of the economy and social sphere. The sustainable development goals set by the world community under the auspices of the UN can only be achieved through the comprehensive assessment of effectiveness of management decisions (cumulative accounting of all internalities and externalities). Transport has become a pioneer in sustainable development of territories and cities. The approach to a comprehensive assessment of effectiveness of sustainable development determines the reform of economic and fiscal relations in the future according to the principle of the Pigou tax.

The objective of this article is to explore ways to improve assessment of effectiveness and methodology of sustainable development of transport organizations and transport systems. The article substantiates the relevance and directions of improving the methodology for a comprehensive assessment of the results of transport activities and presents analytical models for a comprehensive assessment of its effectiveness. The promising tasks for continuation of research and development are associated with justification and legal legitimation of the use of cost estimates of various external results of improving transport, as well as with development of a system for monitoring of information necessary for a comprehensive assessment of sustainable transport development.

Keywords: transport, efficiency, assessment, sustainable development, methodology.

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Background. At present, probability and frequency of crises of various nature are increasing. The scale of such crises can be so significant that a global threat to development of civilization could arise. The deterioration of the ecological situation, aggravation of social problems, and the crisis of urbanism are well known factors. The rapid development of information technology (IT) has exacerbated the problem of professional readiness of personnel to work in a cognitive production environment. Traditionally used methods of economic management showed that they have constraints: the mercantilist concept of management, based on the economic interests of the investor and production workers, operating in the categories «cost–income–profit», came into conflict with socially significant interests and humanistic ideals. The current situation in the broad sphere of social relations actualizes the need to search for new approaches to development of anthropomorphic activity and for other methods for assessing effectiveness of production, economic and social activities able to comprehensively consider all the kinds of final results and interests of people and society. The UN member states, including Russia, adopted the 2030 Agenda for Sustainable Development on September 25, 2015, which includes 17 goals aimed at eliminating inequalities, poverty, preserving natural resources and ensuring human well-being. The agenda sets 169 tasks and indicators (indices) to assess the achievement of goals [1].

For objective reasons, the transport sector of the national economy was among the pioneers on the path of sustainable development.

The *objective* of this article is to study and present the results of developments in the field of methodology for assessing effectiveness of sustainable development of transport organizations and transport systems.

Global crises in the system of public relations

The global exacerbation of contradictions between the unrestrained anthropogenic activity, on the one hand, and stability of the environment, as well as the balance of social relations, on the other hand, was predicted more than 100 years ago by the founders of the noospheric doctrine, who were *douard Louis Emmanuel Julien Le Roy* (1870–1954), *Pierre Teilhard de Chardin* (1881–1955), Russian scientists academician *V. I. Vernadsky* (1863–1945) and academician *N. N. Moiseev* (1917–2000), and their disciples [2; 3]. At present, predictions of negative consequences of uncontrolled anthropogenic activity are coming true, which has begun to threaten the existence of civilization.

The ecological crisis has led to climate change on the planet, to threat of a shortage of clean water, accelerated extinction of species and a reduction in the population of flora and fauna, irreversible geological shifts, pollution of significant areas of land and free water. The growth rate of emissions of harmful substances outstrips the growth rate of the world's population. For example, from 1960 to the present, carbon emissions have increased by 4,5 times with a population growth of 20 %. Particularly serious pollution is observed in urban areas. Cities are point sources, concentrators of unacceptable environmental pollution: more than 70 % of GDP is created in cities; this consumes up to 80 % of the energy produced; emissions of toxic substances into the atmosphere of cities make up about 85 % of their total volume. The resolution of the problems that caused the ecological crisis largely depends on implementation of a balanced transport policy [4–7].

The aggravation of social relations occurs due to uneven socio-economic development of society in different countries, deepening gap between rich and poor, residual influence of antagonistic class and racial «theories», gender inequality, provision of social guarantees blurred in common words, shortcomings in development of culture, medicine and education. At present, according to the UN Secretary General A. Guterres, a pandemic of inequality has arisen and a complex crisis is developing, and efforts of all countries should be directed to overcome its manifestations [8].

Attracting investments into the economy and social sphere, leveling the differences between different groups of the population and implementation of the concept of «smart cities» provide the potential for resolving many social contradictions [9].

Insufficient quality of training of specialists and the lack of decent jobs for them led to a decline in the prestige of education, while it is the main means of building a modern cognitive economy of knowledge. According to a survey of citizens, although higher education contributes to career growth, in Russia it does not have a significant impact on material well-being. Education is becoming less accessible, and there are fewer people willing to pay for education [10].

The urbanization crisis is closely related to environmental, social and economic crises. Cities occupy only 1 % of the land, but more than half of people live in them (in Russia, about 74 %), and by 2050 it is predicted that the share of urban inhabitants of the planet will exceed 70 % [11; 12].

The growth of settlements has always generated a request for creation of new types and systems of transport that provide a reasonable time for transportation of people and timely delivery of goods to consumers.

Currently, motorization of the population has led to insoluble traffic congestion and a decrease in quality of transportation services for passengers by public transport. Streets and roads in large European cities occupy an average of 10 % of the territory (20 % in Moscow) of scarce and expensive urban land. For comparison, the specific area of the city's territory occupied by a bus passenger is about 40 times smaller than that of a passenger car [13–15].

Time spent on daily travel by urban residents is increasing up to the limit allowed by sanitary and psychological standards. This significantly reduces quality of life in cities.

The traditional potential of methods for solving urbanization problems has exhausted itself, therefore, in order to find innovative ways of developing urban systems, the UN Conference on Housing and Sustainable Urban Development «Habitat III» was held on September 17 and 18, 2014 in New York [9; 16].

The general patterns of emergence of economic crises have been studied by Keynesian and neo-Keynesian economic schools. Against the background of environmental and social crises, a crisis of the *economic doctrine* based on predominant consideration of the interests of investors and business entities began to manifest itself. These persons always proceed from their commercial interests. Such interests are usually called internal (i.e. internal) results. An example of an internal result is the profit made. But when implementing business projects, there are also results manifested in the environment which is external to investors and economic entities. First, external effects are manifested through their environmental and social aspects. Often, external results, called externalities, in terms of value, are many times higher than internal results. The uneven development of markets for various goods, the use of «free» resources and the lack of clearly specified rights to resources of various nature, and the out-of-market reproduction of human capital are considered the primary reasons for emergence of externalities [17–19].

The theoretical basis for integrated accounting of internalities and externalities (positive and negative) can be the use of the so-called Pigou tax (*Arthur Cecil Pigou,* 1877–1959) [9]. The Pigou tax provides for legislative establishment of penalties when an economic entity exceeds the current mandatory standards of possible negative impact of a business project on the environment and the social sphere (if appropriate, on other public relations as well). These charges are made from profit and go to the budget. On the contrary, if an economic entity proves that it carried out its activities with less negative consequences compared to the established standards, then it has the right to receive incentive payments from the budget or the corresponding exemption from established taxes (tax benefits) from the budget.

Currently, tax revenues to the budgets of the Russian Federation, its constituent entities and municipalities are depersonalized, and distribution of these funds for implementation of state and municipal obligations is in no way tied to the corresponding tax flows. Thus, the potential feedback between the performance results of tax residents and incentives to achieve socially significant results are not used in the system of taxation. The introduction of the Pigou tax will require a reform of tax legislation, and will provide an opportunity to activate this feedback, which will

significantly increase the regulatory role of taxes for the social and economic development of the country.

Sustainable development and the role of transport in its implementation

Global crises are sources of concern of the world community, the scientific community, and politicians in all the countries. Through the efforts of almost all UN members, and under the auspices of that global organization several representative conferences were prepared and held, at which the concept of sustainable development was formed. The final documents were adopted [20–24].

Concern for preserving the environment is also in the field of vision of the world community: on December 12, 2012, the Paris Agreement was adopted in accordance with the UN Framework Convention on Climate Change of December 12, 2012 (the application of this agreement in Russia was legitimized by the decree of the Government of the Russian Federation of September 23, 2019). The directions of development of educational activities for the purpose of sustainable development are defined in the UNESCO declaration [25].

Established in the scientific community and in political circles, the phrase «sustainable development» in its literal translation to Russian does not quite adequately convey the semantic content of the corresponding concept. Sustainable development (also called harmonious development) is understood as a balanced process of economic and social transformations, exploration of natural resources, in which investments, scientific and technological progress, institutional changes and personal development are mutually coordinated in order to preserve the natural heritage in the interests of ensuring a decent quality of life of the present and future generations. The classical approach to sustainable development is based on the triad: economy–ecology–social balance. Sustainable development presupposes adoption of managerial decisions aimed at achieving the optimal (rational) combination of the elements of this triad. Comparison of the concepts of noospherism and sustainable development shows that sustainable development is a dynamic interpretation of the noospheric approach, its practical implementation [13].

As follows from the above, implementation of sustainable development of urbanized spaces is most relevant [3–8]. According to the basic principle of urban planning, founded by the great architect and urbanist of 20th century *Le Corbusier* (1887–1965, named at the birth *Charles-Edouard Jeanneret-Gris*), no city can grow faster than its transport develops [13].

By analogy, it is fair to extend this principle to mainline modes of transport that transport passengers and goods outside urban areas, since in this case transport performs the same type of logistics functions, being the material basis of the infrastructure of the economy and social sphere. Mainline transport also has an impact on the environment, in connection with which numerous international conventions and acts of national legislation have been adopted. Therefore, development of the world economy, development of the economy and social sphere of the country and its regions cannot proceed faster than development of mainline transport.

Transport has now become a pioneer in implementing sustainable development. The dominant role of transport in sustainable development is not accidental, as it is explained by a complex of objective reasons:

- transport carries out transportation of almost all citizens and serves all commercial and non-commercial organizations, public and municipal sectors. Therefore, transport directly affects the interests of everyone;
- transport refers to capital and labor-intensive industries (in Russia the economic activity «Transportation and storage» attracts about 24 % of fixed assets and 7,3 % of employees occupied in the national economy [26]);
- transport component in the final price of Russian domestic products, according to expert estimates, is approximately twice as high as in some countries (no statistical record of this indicator is kept). For example, for railway transportation of goods, the share of logistics costs in Russia's GDP is about 20–24 %, and in some other countries is about 10 % [27].
- this reduces competitiveness of domestic producers, also taking into account that their products are not yet deeply processed (such products are much cheaper than complex technical products and products of deep processing, as a result of which the transport component significantly affects the final price of products);

• urban transport has a significant impact on the urban environment, ranked first among various suppliers of these pollutants in terms of carbon and greenhouse gas emissions into the atmosphere of cities. Lands of the cities used for transport infrastructure take 10–20 % of the scarce urban area, «sealed» with a road surface [13];

• transport and construction of the routes are financed from the budget, which makes it necessary to carefully assess the effectiveness of spending the corresponding funds. The share of budget funding for urban route passenger transport covers almost 40 % of the costs of transport organizations [28]. Large-scale projects for development of transportation routes are also being implemented due to participation of the budget in their financing;

• road transport (road and urban ground electric transport in aggregate) is the most dangerous man-made source of harm to human life and health;

• for transport, the use of innovative technologies is especially effective (electric traction and regenerative braking, IT, IoT (Internet of Things), transport telematics, control automation, etc.), which produces a noticeable impact on the quality of transport services while reducing the overall costs of carriers.

Significant scientific and practical results in the field of sustainable development of urban transport have been obtained in Europe. The European has developed guidelines for implementing sustainable development in urban and suburban areas. The development of urban transport must be carried out in accordance with *Sustainable Urban Mobility Plans* (SUMPs). The plans are developed based on general principles and approaches, considering national legislation. The analysis of fulfillment of SUMPs is carried out according to 20 evaluation criteria [4; 6; 13; 14; 29].

In Russia, sustainable development planning is carried out considering European experience [6; 13; 19]. The main efforts are aimed at implementation of transport planning with state and municipal support for passenger transportation on regular routes. The legal basis for such support is established by the Federal Law of July 13, 2015 No. 220-FZ «On organization of regular transportation of passengers and luggage by road and urban land electric transport in the Russian Federation and on amendments to certain legislative acts of the Russian Federation». The development of planning documents for regular transportation is entrusted to the executive authorities.

Currently, transport planning, in fact, is limited to development of lists of routes for regular transportation followed by their division into routes with regulated and unregulated tariffs. For the first of these two groups of routes, the executive authorities set tariffs and corresponding budget surcharges for carriers. Fares for travel and baggage on routes with non-regulated fares are set by the carriers themselves.

Methodology for assessing efficiency of sustainable transport development and topical tasks of its improvement

Efficiency (form Latin word *effectivus*) characterizes the ratio of results to the costs of achieving them, that is, it is a relative characteristic. The effect expresses the achieved result in absolute form [30].

Economic effects and efficiency can be considered as universal measures of utility, and also serve as equivalents of non-economic effects and efficiency. For comparability of equivalents of effects and efficiency of different nature, cost estimates of costs and benefits are used. For example, reduction in travel time of passengers as a result of improved transport performance may be subject to passenger-hour valuation. We emphasize that when using value estimates, there is no question of trading the corresponding useful result. Therefore, it is necessary to distance the value estimates of something from the economic categories of value and price.

When determining the economic effect and efficiency, the results and resource costs are expressed in monetary terms, guided by the principles:

• comparability of indicators (bringing all indicators and standards used in the calculations to single basic conditions, including through discounting over time);

• independence of determining the results of implementation of various measures; the prospects of the comparison base, for which the indicators planned for the period (year) of implementation of the event are taken without considering the impact of the event in question.

Non-economic effects (externalities) are not taken into account in calculations of economic efficiency, since stakeholders who are recipients of such effects are not included into the group of investors and operators.

However, in practice, externalities that are the dominant (in terms of value) results of operation of transport systems. Numerous publications in the field of management use the concept of an organization's mission, which is usually referred to as meaningful social and environmental result. Despite the good intentions expressed in references to the mission of the organization, civil law requires that in the charters of all commercial organizations, the goal would be associated with the declared receipt of income, profit (but not the mission). Therefore, the mission of the organization serves as a «fig leaf» of the mercantilist goals of business executives.

The doctrine of externalities, as mentioned above, was developed by A. Pigou [31]. In Russia, this concept is being developed by many researchers. The leading position belongs to the scientific school created at Lomonosov Moscow State University by Professor A. D. Sheremet (1929–2020) [32]. External effects are now considered in practice. For example, Russian environmental legislation establishes payment for the use of natural resources, sanctions for excess emissions of pollutants, and presumption of environmental hazard for economic entities. This practice, according to the concept of sustainable development, will be constantly expanded by the legislator.

It is generally accepted to quantify the economic performance of investments: by the internal rate of return (actual rate of return on investment); by net present value (NPV) [17; 18]. The calculation of these performance indicators is automated in *Microsoft Excel* and *OpenOffice.org Calc* spreadsheets.

The analysis of the essence of a comprehensive assessment of efficiency of sustainable development of transport systems showed that the methods for calculating the internal rate of return and net present value can serve as initial analogs for constructing a comprehensive assessment methodology.

It is proposed to evaluate the complex result in value terms R_Σ according to the following dependence:

$$R_\Sigma = NPV + E_{ecol} + S_{soc} = \\ = -IC + \sum_{t=1}^{N} \frac{CF_t}{(1+i)^t} - E_0 + \sum_{t=1}^{N} \frac{E_t}{(1+i)^t} - \\ - S_0 + \sum_{t=1}^{N} \frac{S_t}{(1+i)^t}, \quad (1)$$

where NPV is net present value (internal economic result of investors and economic entities of the transport system), thousand rubles (or other monetary units);

E_{ecol} is value of the discounted total external environmental result, thousand rubles;

S_{soc} is value of the discounted total social result, thousand rubles;

$t = 0, 1, 2, ..., N$ is conditional number of the settlement period (for example, a year; zero period is beginning of investments in implementation of the transport system development project);

i is discount rate;

CF_t is total cash flow during the investment period with the conditional number t (the algebraic sum of all cash inflows and outflows during this period), thousand rubles;

IC are investments during zero period, thousand rubles;

E_0 is total cost of environmental resources incurred for implementation of the project during zero period of time in value terms, thousand rubles;

S_0 are total expenditures of social resources made for implementation of the project during zero period of time in value terms, thousand rubles;

E_t is total discounted flow of environmental resources during time period t в in value terms, thousand rubles;

S_t is total discounted flow of social resource during time period t in value terms, thousand rubles.

At the same time:

$$E_{ecol} = \sum_{m=0}^{M} E_{(t=0),m} \cdot d_m + \sum_{t=1}^{N} \sum_{m=0}^{M} E_{t,m} \cdot d_m = \\ = \sum_{t=0}^{N} \sum_{m=0}^{M} E_{t,m} \cdot d_m; \quad (2)$$

$$S_{soc} = \sum_{m=0}^{M} S_{(t=0),m} \cdot f_m + \sum_{t=1}^{N} \sum_{m=0}^{M} S_{t,m} \cdot f_m = \\ = \sum_{t=0}^{N} \sum_{m=0}^{M} S_{t,m} \cdot f_m, \quad (3)$$

where $E_{(t=0),m}$ is consumption of an ecological resource of the form $m = (1, 2, ..., M)$ during zero period, presented in natural accounting units;

$E_{t,m}$ is consumption of an ecological resource of the form $m = (1, 2, ..., M)$ during time periods $t = (1, 2, ..., N)$, presented in natural accounting units;

d_m is cost estimate of the considered unit of an ecological resource of the form $m = (1, 2, ..., M)$;

$S_{(t=0),m}$ is consumption of a social resource of the form $f = (1, 2, ..., F)$ during zero period, presented in natural accounting units;

$S_{t,m}$ is consumption of a social resource of the form $f = (1, 2, ..., F)$ during time periods $t = (1, 2, ..., N)$, presented in natural accounting units;

f_m is cost estimate of the considered unit of a social resource of the form $f = (1, 2, ..., F)$.

The considered methodology for calculating the integrated efficiency allows evaluating the cumulative results obtained during operation of transport organizations and systems, as well as projects for their improvement. The methodology also provides opportunities for a phased transition to the use of the idea of the Pigou tax, which will provide feedbacks between socially significant effects and taxation of economic entities. This will enable the transition from a mercantilist economy aimed at generating profit for the investor to the sustainable development economy in the interests of present and future generations.

The development of a methodology for assessing the efficiency of sustainable development actualizes research and development. According to our estimates, in order to develop lists of the main environmental and social indicators of sustainable development, methods for their scientifically grounded calculation, and methods for valuation of the effects obtained, more than 100 research works in the economic field should be completed.

Conclusion. An integrated approach to development of a methodology for assessing the efficiency of transport organizations and systems, as well as projects for their improvement in accordance with the concept of sustainable development, puts forward the following tasks as topical areas for applied research and development:

• structuring lists of typical environmental and social effects, the results of which should be applied for determining integrated effectiveness;

• development of a methodology for accounting for the impact of transport organizations and systems on environmental and social effects;

• economic, technological and legal justification of the cost estimates of each of the environmental and social changes taken into account in order to transfer the results obtained into the value of the corresponding effects;

• development of a system for monitoring the initial information for performing efficiency calculations;

• legal legitimization of the accounting results collected by the monitoring system and methods for calculating integrated efficiency;

• training of specialists for administration of transport and executive authorities, taking into account the innovative changes associated with transition to sustainable development of the transport industry;

• gradual transformation of the legal framework for implementation of incentives for economic entities in accordance with the principles of the Pigou tax (mainly in the areas of civil, budgetary and tax legislation).

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