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Improving road maintenance management practices in Russia

N.A. Popov[1]
N.A. Osokin[1]
[1] Financial University under the Government of the Russian Federation

ABSTRACT

The level of transport infrastructure development is one of the key determinants of economic growth. In 2018, 67.1% of all transported goods in Russia were delivered via road transport. However, Russia's motor transport system has yet to come close to fulfilling its full potential – 57.6% of public roads do not meet regulatory maintenance requirements. The prevailing statistics highlights the task of ensuring the safety of roads. This issue is especially relevant during winter months, when the roads experience maximum climatic and physico-chemical effects. This article analyzes the road safety system of the constituent entities of the Russian Federation, considers the main regulatory documents governing the activities of road work suppliers and executive authorities in the field of road maintenance. The authors analyzed the best foreign practices in road maintenance policy. The main result of the study is the proposal to introduce a mechanism for servicing roads using a performance based contract to replace to cost based road maintenance contracts, which are the most widely applied in Russia.

KEYWORDS:

road maintenance, performance-based contracts, state policy, anti-icing materials.

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1. INTRODUCTION

It is difficult to overestimate the importance of transport infrastructure for any economy in the world. A developed transport network is a key factor in achieving sustainable socio-economic growth, increasing the volume of foreign and domestic trade, reducing transport and transaction costs, and ensuring the free movement of the population [Maltsev, 2017]. Improving the quality of transportation between territorial units has particular relevance for countries with a large land area, due to the need of creation of a single economic space. The historical features of Russia, which defined the vector for the transport infrastructure development at the stage of its formation, are currently manifested through a high regional disproportion in the level of transport accessibility, low quality of the road network and a low degree of integration into the world transport space [Shvelidze, 2018]. It is impossible to ensure a competitive advantage in the world market in the long-term perspective without solving the existing problems of communication routes.

Russia's transport system is one of the most developed in the world. The length of railway tracks is 86 thousand km (3rd place in the world), roads make 1529 thousand km (5th place). The transport and logistics complex of Russia in 2018 provided 7.0% of gross value added and 0.19 percentage points of GDP[1]. growth. The volume of goods transported in 2018 increased by 2.4%, the cargo turnover of Russian transport – by 2.8%. The main volume of cargo transportation in 2018 was accounted for by road transport – 5.5 billion tons, or 67.1% of the total volume of goods transported[2]. In the structure of cargo turnover, the volume of which in 2018 reached 5.6 trillion ton-kilometers, pipeline (47.3% of the total volume) and rail (46.0% of the total volume) types of transport are leading[3].

Despite the growth of the main indicators of cargo transportation in Russia, today we can not talk about the full use of our country's transport potential. According to the World Economic Forum, Russia ranks 41st and 69th among 141 countries examined in terms of development level of the road network and railway density[4]. Similar results are given by the World Bank's assessment: the value of the Logistics Performance Index (LPI) for Russia is 2.76 points out of 5, which corresponds to the 75th position in the corresponding ranking of countries in the world[5]. The consequence of the poor quality and insufficient level of development of the transport network is significant economic losses. According to experts, the Russian economy loses up to 3% of GDP

[1] Cargo transportation in Russia: review of current statistics / / Bulletin on current trends in the Russian economy. 2019. September. URL: http://ac.gov.ru/files/publication/a/24196.pdf.
[2] Overview of the Russian transport sector in 2018. URL: https://assets.kpmg/content/dam/kpmg/ru/pdf/2019/05/ru-ru-transport-survey-052019.pdf.
[3] Overview of the cargo transportation industry in Russia 2019. URL: https://www.ey.com/Publication/vwLUAssets/ey-transportation-services-2019-rus/$FILE/ey-transportation-services-2019-rus.pdf.
[4] The global competitiveness report 2019. URL: http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf.
[5] International LPI. Global rankings 2018. URL: https://lpi.worldbank.org/international/global?sort=asc&order=Country#datatable.

Figure 1. Dynamics of the level of road maintenance in the Russian Federation (%)

Source: Regions of Russia. Socio-economic indicators-2017. URL: https://www.gks.ru/bgd/regl/b17_14p/Main.htm.

annually due to the unsatisfactory state of roads [Tvardovsky, 2015, p. 12]. Recognizing the importance of all components of the transport infrastructure, in this article we will focus on the existing problems and proposals for improving the safety system of the road network.

In Russia, the issue of establishing reliable and uninterrupted transport links both internally and between regions is becoming more and more urgent. Presidential Decree No. 204 from 07.05.2018 "On National Goals and Strategic Objectives for the development of the Russian Federation for the period up to 2024" determines the modernization of the road safety system as one of the key components of improving the quality of the road network of the Russian Federation. The improvement of the state policy in the field of road safety can be considered as the main mechanism for ensuring a qualitatively new level of transport communication in the country.

2. THE SYSTEM OF ENSURING THE SAFETY OF HIGHWAYS IN RUSSIA

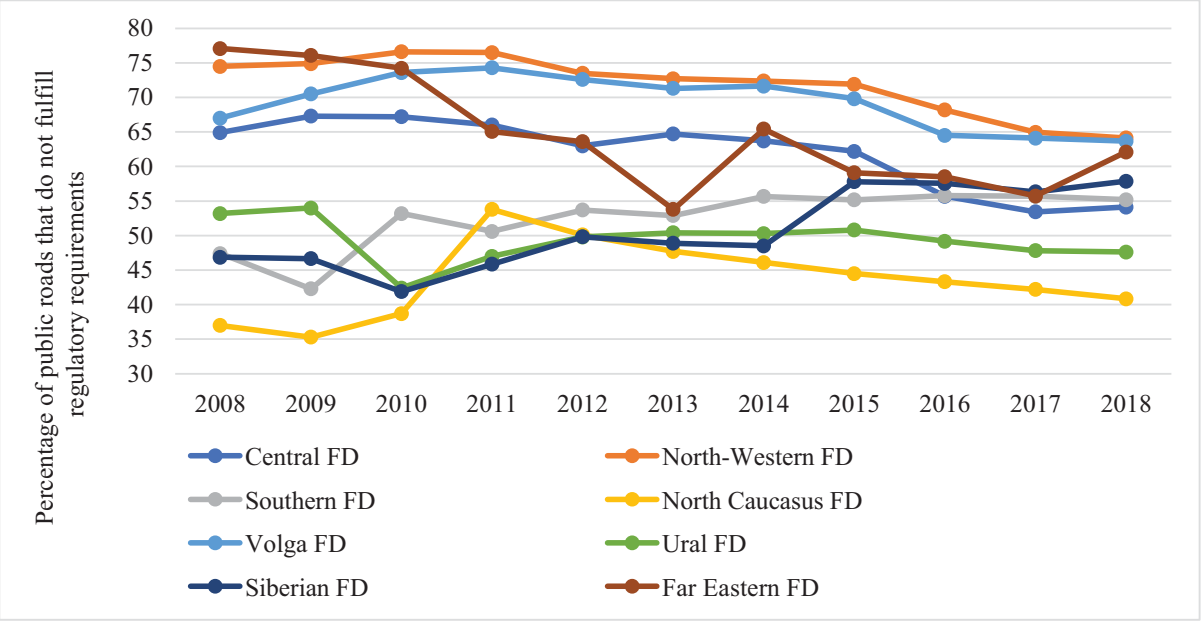
In Russian practice, the preservation of highways is understood as the state of integrity of the highway as a technical structure and property complex, ensuring the maintenance of its operational properties and safe use[6]. In the national system of state statistics, the main indicator that characterizes the level of safety is the percentage of highways that do not fulfill regulatory requirements. According to the procedure for assessing the technical condition of highways[7] the degree of compliance of the highway with regulatory requirements is carried out by calculating two groups of parameters:

- permanent (during operation, they do not change significantly, for example, the width of the roadway, the dimensions of the approach, etc.);
- variables (they change during the use of the road, for example, the longitudinal flatness and the rut of the road surface).

Permanent features and characteristics are laid down in the design of highways and can be significantly changed only during reconstruction or major repairs, which eliminates the possibility of taking preventive measures to ensure safety without significant capital investments and significant design changes. When considering the issue of road safety, the group of variables that can be directly affected in the process of maintenance and support of the operational properties of roads is of the greatest interest. The assessment of these parameters and characteristics for the compliance of highways with regulatory requirements should be carried out in accordance with interstate standards and approved

[6] Federal Law No. 257-ФЗ of 08.11.2007 "On Highways and Road Activities in the Russian Federation and on Amendments to Certain Legislative Acts of the Russian Federation" / / ConsultantPlus. URL: http://www.consultant.ru/document/cons_doc_LAW_72386/.
[7] Order of the Ministry of Transport of the Russian Federation No. 150 of 27.08.2009 "On the procedure for assessing the technical condition of highways". ConsultantPlus. URL: http://www.consultant.ru/document/cons_doc_LAW_96170/.

Fig. 2. Dynamics of the level of maintenance of roads of regional or inter-municipal significance in the federal districts of the Russian Federation (%)



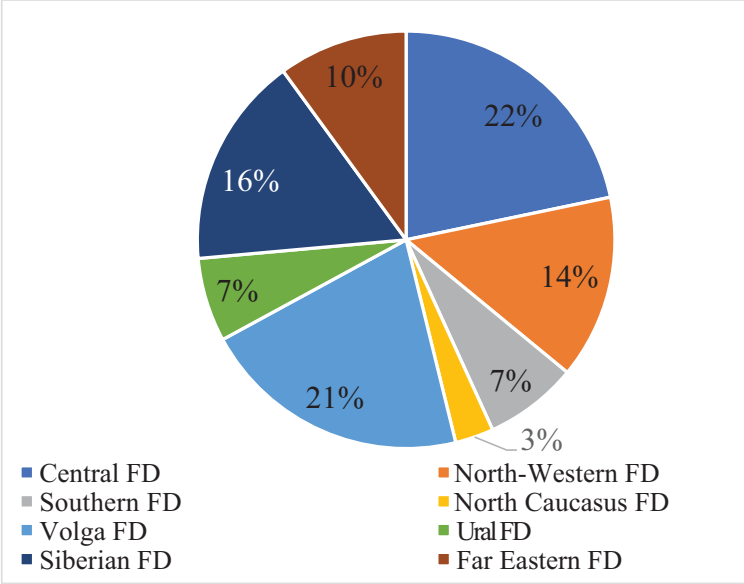
Source: Regions of Russia. Socio-economic indicators-2017. URL: https://www.gks.ru/bgd/regl/b17_14p/Main.htm.

national standards (GOST)[8]. All documents regulating the conduct of research do not take into account the influence of weather and other external factors, which significantly distorts the final result. This problem becomes most relevant in the autumn-winter period. Thus, the formation of a snow track on the roadway can lead to skidding and difficulties in driving a vehicle; the coupling characteristics of the road surface largely determine the level of road traffic safety, and the unsatisfactory condition of the roadsides is the reason for the cars to leave the roadway. In addition, the weather conditions themselves can cause deterioration of the road surface. In the autumn-winter period, precipitation is accompanied by a regular change of positive environmental temperatures to negative, and vice versa. Water at the transition of the ambient temperature through 0°C expands and narrows the cracks on the roads, which are formed during the entire service life of the roadway. The number of such cycles depends on the level of road surface wear after the end of the autumn-winter season. Measures to reduce the potential damage to roads from weather conditions are actively practiced abroad. For example, in Germany, special attention is paid to filling cracks with bitumen mastic and replacing seams during the current servicing of roads[9].

An important factor that determines the level of safety of roads in the autumn-winter period is the technology of winter maintenance applied on the road section and the anti-ice materials used, in particular. To define the degree of destructive impact on the road surface of a separate type of anti-icing materials, the index of corrosion activity is used. The most widely used conventional reagents include sodium chloride (NaCl), calcium chloride ($CaCl_2$), and magnesium chloride ($MgCl_2$). The study [Rozov et al., 2017] notes that chlorides have a high corrosion activity and lead to accelerated physical wear of metal and concrete elements of roads, as well as have a negative impact on the environment. To reduce losses from the use of traditional anti-icing materials, innovative reagents can be used that have less aggressive chemicals in their structure, for example, sodium formate (HCOONa), potassium acetate (CH_3COOK), calcium-magnesium acetate (CMA).

[8] ГОСТ 32825-2014Automobile roads of common use. Road surfaces. Methods for measuring the geometric dimensions of damage. URL: http://docs.cntd.ru/document/1200117775.
ГОСТ 33101-2014. Automobile roads of common use. Road surfaces. Methods for measuring evenness. URL: http://docs.cntd.ru/document/1200127196.
ГОСТ 33078-2014. Automobile roads of common use. Methods for measuring clutch of a car wheel with a coating. URL: http://docs.cntd.ru/document/1200123715.
ГОСТ 32729-2014. Automobile roads of common use. A method for measuring the elastic deflection of non-rigid road surfaces to determine the strength. URL: http://docs.cntd.ru/document/1200113444.
ГОСТ 33161-2014. Automobile roads of common use. Requirements for diagnostics and certification of artificial structures on highways. URL: http://docs.cntd.ru/document/1200127495.
ГОСТ 33220-2015. Automobile roads of common use. Requirements for operational condition. http://docs.cntd.ru/document/1200123498.
ГОСТ Р 50597-2017. National Standard of the Russian Federation. Automobile roads and streets. Requirements for the operational condition allowed under the road safety conditions. Control methods // ConsultantPlus. URL: http://www.consultant.ru/document/cons_doc_LAW_285670/.
[9] Erhaltung von Straßen. URL: https://www.bmvi.de/DE/Themen/Mobilitaet/Strasse/Erhalt-Strassen-Bautechnik/erhalt-strassen-bautechnik.html.

Figure 3. The share of the federal district in the total length of regional or inter-municipal public roads that do not fulfill regulatory requirements



Source: Regions of Russia. Socio-economic indicators-2017. URL: https://www.gks.ru/bgd/regl/b17_14p/Main.htm.

3. THE LEVEL OF ROAD PERSISTENCE IN RUSSIA

From 2008 to 2018, the cumulative average annual growth rate of the share of roads that do not meet regulatory requirements throughout Russia was –0.77%[10], which indicates a gradual improvement in the condition of highways (Figure 1). However, it is worth noting that there are significant differences in the level of development of the road network between individual regions. So, as of 2018, the share of public roads that do not meet regulatory requirements in Moscow was 3%, and at the same time in the Republic of Mari El this figure was 98.6%. Such a variation in the level of development of the road network may be one of the reasons for the existence of high disparities in the regional development of Russia.

Within the federal districts, the indicator under consideration tends to gradually decrease, but the positive dynamics is not typical for all territorial entities (Fig. 2). For example, the percentage of common roads that do not fulfill regulatory requirements for the Siberian Federal District increased by 11 percentage points. Such dynamics deserve special attention not only from the regional authorities, but also from the relevant federal agencies. A significant decline in the condition of highways reduces the investment attractiveness of the regions within the district and the standard of living of the population of the relevant territories.

In absolute terms, the total length of roads of regional or inter-municipal significance of general use that do not fulfill regulatory requirements is 294 thousand km. At the same time, 58.3% (171.4 thousand km) of non-normative roads are located in the Central (23.1%, 64 thousand km), Volga (18.9%, 61 thousand km) and Siberian (16.3%, 48 thousand km) federal districts (Fig. 3). The current situation is explained by the high length of highways in these federal districts. At the same time, it is worth noting that the total share of these federal districts in the total population of the country is 58.58% (86 million people), in the total volume of GRP in 2016 – 60%[11]. This fact may indicate a significant impact of these territorial entities on the socio-economic situation of the country. Thus, it can be noted that the issue of road safety management at the regional level requires a differentiated approach.

4. STATE POLICY OF STIMULATING THE PRESERVATION OF HIGHWAYS

In the framework of the Federal project "System-wide measures of development of the road sector" included in the national project " Safe and High-quality Highways "[12], declared, in particular the establishment of mechanisms of economic incentives the safety of roads of regional and intermunicipal value. All the safety measures outlined in the federal draft can be divided into two groups:

[10] Regions of Russia. Socio-economic indicators - 2017 г. URL: https://www.gks.ru/bgd/regl/b17_14p/Main.htm.
[11] Regions of Russia. Socio-economic indicators - 2017 г. URL: https://www.gks.ru/bgd/regl/b17_14p/Main.htm.
[12] National project " Safe and high-quality highways». URL: http://rosavtodor.ru/about/upravlenie-fda/nacionalnyj-proekt-bezopasnye-i-kachestvennye-avtomobilnye-dorogi.

- creation of weight and dimension control points on roads of federal, regional or inter-municipal, local significance: 753 units until 2025 in 75 subjects of the Russian Federation;
- amendments to regulatory legal acts and documents of technical regulation in terms of strengthening responsibility for non-compliance with the weight and dimensional parameters of vehicles and load control.

In addition, the widespread introduction of digital technologies and mechanisms for the development and operation of the road network can be considered as indirect measures to ensure the safety of roads. The development and scaling up of road infrastructure development measures based on advanced technologies is a priority of the federal project, as evidenced by the target indicators:

- • the share of contracts for the implementation of road activities within the framework of a national project involving the use of new technologies and materials included in the Register of New and Best Technologies, Materials and Technological Solutions for reuse;
- the share of contracts for the implementation of road activities within the framework of a national project that provide for the performance of works on the principles of a life cycle contract, that is, combining various types of road works into one contract.

The capabilities of digital technologies are designed to optimize traffic and reduce the number of places where accidents occur. Life-cycle contracts, the best technologies and materials, which are the main mechanisms for the development and operation of the road network, are necessary to reduce the cost of designing, building and commissioning road sections as a single set of works. All measures are aimed at achieving the goals of the project "Safe and High-quality Highways", in particular, to increase the share of roads that meet regulatory requirements from 43.1% in 2017 to 50.9% in 2024 (Figure 4), as well as to reduce the death rate as a result of road accidents from 13 to 4 people per 100 thousand for the same period[13].

It is worth noting that the mechanisms of economic incentives considered in the framework of the federal project are aimed at ensuring the safety of highways solely at the expense of penalties without offering economic incentives. In order to ensure the integrated development of road infrastructure to the existing system, along with the listed mechanisms, additional tools are proposed to provide economic incentives to improve the quality of road service and maintainance.

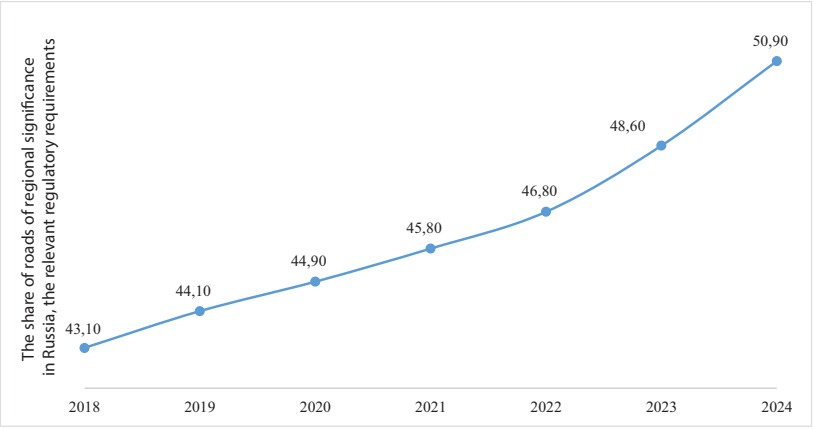
1. Complex reform of the road safety system:
   - incentive contracts for road maintenance companies based on a target-setting mechanism.
2. Implementation of a system of economic incentives within the existing system of road safety:
   - independent assessment of the economic feasibility of road maintenance technologies;
   - operational monitoring of the level of road safety.

5. PROPOSALS FOR IMPROVING THE STATE POLICY IN THE FIELD OF ENSURING THE SAFETY OF THE ROAD NETWORK

5.1. INCENTIVE CONTRACTS FOR ROAD MAINTENANCE COMPANIES BASED ON A TARGET SETTING MECHANISM

The national project "Safe and High-quality Highways" sets targets for the implementation of the practice of life cycle contracts (LCC). Legally, the concept of LCC is defined in Federal Law No. 44-ФЗ from 05.04.2013 "On the Contract System of procurement of goods, works, and services for State and Municipal Needs" as a contract that provides for

Figure 4. Target indicators for the share of regional roads in Russia that fulfill regulatory requirements (%)



Source: Federal Law No. 44-ФЗ of 05.04.2013 "On the Contract System of procurement of goods, works, and services for State and Municipal Needs"» // ConsultantPlus. URL: http://www.consultant.ru/document/cons_doc_LAW_144624/.

[13] Federal Law No. 44-ФЗ of 05.04.2013 "On the Contract System of procurement of goods, works, and services for State and Municipal Needs"» // ConsultantPlus. URL: http://www.consultant.ru/document/cons_doc_LAW_144624/.

the purchase of goods or work (including, if necessary, the design and construction of an object that should be created as a result of the work), subsequent maintenance, repair, and, if necessary, operation and (or) disposal of the delivered goods or object created as a result of the work. Such agreements assume that the state sets the direction for enterprises towards the implementation of state plans and programs. However, the responsible executors (contractors) independently determine the list of decisions on the implementation of the targets of these plans [Nikitin et al., 2019]. Decree of the Government of the Russian Federation No. 1087 from 28.11.2013 "On determining the cases of concluding a Life-cycle Contract"[14] establishes that a LCC in the field of highways can be concluded when performing works on the design and construction of highways (sections of highways).

Regional executive authorities are taking the initiative to expand the list of types of work that can be included in the LCC. However, at present, the territorial bodies of the Federal Antimonopoly Service and the Ministry of Finance have not formed a unified position on the procedure for concluding "extended" contracts. In addition, there are limited opportunities for contracting organizations to obtain bank guarantees for a period exceeding three years, which also raises questions about the availability and economic feasibility of using LCC for service companies.

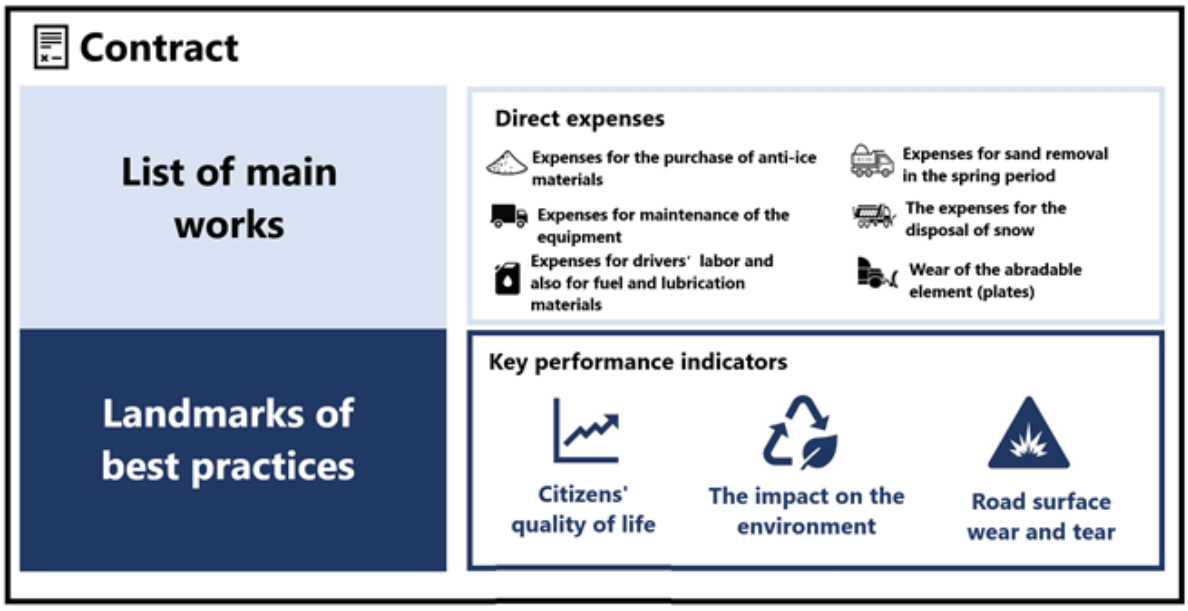
In Western countries, the task of transferring road maintenance work to contractors has been successfully solved by the extensive use of contracts based on targets for twenty years. This approach is called Performance (Output) Based Maintenance, outsourcing based on targets. The system for concluding long-term contracts has been implemented and is actively used in Norway, Sweden, the United States, Canada and a number of other developed countries.

Target-based outsourcing is based on payment for maintaining the road in a condition that meets the established standards. At the same time, the contract does not regulate the issues of cost and scope of work. The form of payment is a fixed rate (usually monthly) or a one-time (advance) payment. The widespread adoption of this model of contracting can be explained by the possibility of improving the maintenance of the roadway while maintaining the same resource provision.

The use of target-based outsourcing implies a complete transfer of responsibility for operational decision-making to the contracting organization. At the same time, contractors have indirect economic incentives to improve the quality of road services. In particular, there is the potential to increase profits through more efficient work or the use of innovative methods. The savings that arise from the use of target-based outsourcing compared to traditional service contracts in some countries can reach 40%[15].

The authors of this paper propose to use the target-based outsourcing approach as a basis for developing recommendations for improving the current contract system in the field of winter road maintenance in the Russian Federation. On the one hand, such a measure will potentially reduce the costs of concluding contracts for the maintenance of highways with contractors and conducting procurement procedures by the executive authorities of the subjects of the Federation and municipal authorities. On the other hand, companies will be interested in improving the quality of work performed to minimize the risk of carrying additional maintenance costs and increase the level of profitability of their core activities.

Рис. 5. Описание стимулирующего контракта содержания автомобильных дорог



[14] Decree of the Government of the Russian Federation No. 1087 from 28.11.2013 "On determining the cases of concluding a Life-cycle Contract"// Garant. URL: http://base.garant.ru/70522166/.
[15] Policy Paper on Infrastucture. URL: https://www.ebrd.com/documents/admin/policy-paper-on-infrastructure-making-district-heating-happen-pathways-to-financial-sustainability.pdf.

The key performance indicators (KPIs) under this mechanism are proposed to be expressed in the following groups of indicators:

– ensuring the proper quality of life of citizens;
– road surface wear and tear;
– the impact on the environment.

A schematic description of the incentive contract is shown in Figure 5.

It is expected that by implementing such a mechanism, road maintenance companies will be motivated to use best practices in ensuring proper quality of maintenance. Of particular importance is the list of KPIs, on the basis of which the work of service companies will be evaluated. The proposed list of indicators is presented in Table 1.

Within the framework of the "Quality of life of citizens" factor, the authors propose to assess the frequency and severity of road accidents due to unsatisfactory road conditions. This indicator significantly affects the quality of life of citizens at the micro level, and can also have significant macroeconomic consequences.

Based on the article [Rozov, 2017a], KPIs were developed within the framework of the factors "road surface wear" and "environmental impact". The main indicator of the aggressiveness of the impact of deicing materials on the road surface is, as already mentioned, its corrosive activity. KPIs are based on tracking the impact of deicing agents on the condition of the roadway.

The anthropogenic impact of road maintenance operations on the ecological situation is proposed to be considered from the point of view of the impact on the water quality in adjacent drainage systems and changes in soil characteristics. The most dangerous components of deicing materials for the water system are the concentration of sodium and chlorine. These indicators are particularly relevant in the context of the implementation of the national project "Ecology", which includes the federal project "Clean Water". Studies of ROSDORNII [Rozov et al., 2017a; 2017b] show that the most innovative technological solutions allow not only to exclude, but also to favorably affect the soil of roadside territories (due to the use of kalium in the composition of reagents). The introduction of KPI for the degree of soil salinity can create the necessary economic incentives for service companies to use the best practices of road maintenance. This will improve the safety of not only the road surface, but also the territory surrounding the highway.

One of the key problems of ensuring the safety of roads of regional and inter-municipal significance is the low level of reactive maintenance on the part of contractors. Subject to

Table 1
Description of key performance indicators

Factor	Indicator	Unit of measurement	Data source
Citizens' quality of life	Percentage of road accidents due to poor road maintenance	%	State Inspection of Traffic Safety
	Percentage of people injured as a result of road accidents due to poor road maintenance		
	Percentage of deaths as a result of road accidents		
Road surface wear and tear	Corrosion activity of the reagents used	mg/ (cm^2*day)	Federal Service for Environmental, Technological and Nuclear Supervision (Rostekhnadzor)*
	Specific weight loss of the road surface after 10, 15, 20 freeze-thaw cycles	g/cm^3	Rostekhnadzor*, Rosdornii
The impact on the environment	The concentration of natrium in the drainage systems adjacent to the roads	mg/l	Federal Service for Supervision of Natural Resources * Rosprirodnadzor
	The concentration of chlorine in the drainage systems adjacent to the roads		
	Degree of soil salinity	The pH value of the water extract in the fertile soil layer	Federal Service for Supervision of Natural Resources Rosprirodnadzor

* Data collection on the relevant indicators can potentially be carried out by the listed authorities.

the implementation of the system of performance indicators, operational control will allow companies to minimize the wear and tear of the road surface. Such control can primarily increase the speed of repair of microcracks formed during overloading of the roadway [Voskresensky, 2010], with the use of bitumen-based polymers [Ismagilov, 2017]. It is proposed to set specific target values for each KPI at the regional level.

It is worth noting that the implementation of the described approach in Russian practice is impossible without a comprehensive reform of the road safety system, which should be aimed at solving the following tasks.

1. Formation of a regulatory framework for the financing and implementation of long-term contracts for the maintenance of roads by contractors.
2. Creating conditions for the development of private business in the field of road maintenance.
3. Refusal of the model of the preferential position of state budgetary institutions in determining the contractor for the repair and maintenance of highways.
4. Create an information field and widely spread information about the benefits of incentive contracts through outsourcing based on targets.

5.2. INDEPENDENT ASSESSMENT OF THE ECONOMIC FEASIBILITY OF ROAD MAINTENANCE TECHNOLOGIES

At present, the standards of financial costs for road maintenance measures for regional and inter-municipal roads are approved at the level of the constituent entities of the Russian Federation. These standards are calculated on the basis of the road maintenance technology used in each particular city. Often, at the regional level, there is an insufficient level of funding for the maintenance of roads and road maintenance. Most administrative-territorial units use outdated technological solutions for road network maintenance, which were used before the entry into force of the new version of GOST R 50597-2017[16], which significantly tightened the quality standards of the work under examination.

Currently, not held mandatory independent assessment approved by the regional authorities and municipalities of the cost standards and applied technologies of road maintenance. To assess the direct and indirect costs of maintaining road facilities in order to select the optimal version of the work package, it is proposed to create a model toolkit that involves the comparison of at least three technological alternatives.

In accordance with the Decree of the President of the Russian Federation of 07.05.2018 No. 204 "On national goals and strategic objectives of the development of the Russian Federation for the period up to 2024", the need to stimulate technological innovation is identified among the priority development targets of the Russian Federation. In this context, it is suggested that winter containment technologies involving the use of solid and two-phase multicomponent reagents should be included in the list of comparable alternatives. These types of anti-icing materials are the most innovative, because they have the best performance indicators for combating winter slippery conditions and have a minimal impact on the road surface and the environment[17].

On the basis of an independent assessment of the economic efficiency of various alternatives, taking into account direct and indirect effects, it is proposed to justify the use of road maintenance technologies. It is expected that such an assessment will be conducted on an annual basis. This frequency is explained by the need to take into account changes in the cost parameters of more innovative technologies. Thus, a mechanism is being formed to encourage the territory to use innovative solutions in road maintenance. A conceptual description of the mechanism is presented in Figure 6.

In addition, the model toolkit should also evaluate the feasibility of combined technologies. The introduction of innovative technologies in road maintenance often requires additional capital expenditures. For example, in the case of using innovative reagents for winter maintenance of highways, service companies should also have specialized equipment at their disposal that will allow the effective use of the appropriate type of deicing materials . Thus, a complete transition to a more innovative technology can be carried out within a few years (in the case of winter road maintenance – as the vehicle fleet is updated).

The use of such tools in practice will also allow you to objectively form the initial maximum price of contracts for the maintenance and maintenance of highways per unit of serviced area (RUB/m^2), concluded with specialized enterprises and organizations. Determining the standard level of costs per unit of serviced area will minimize the risk of underfunding of services for the maintenance and maintenance of highways. In addition, an objective assessment of the cost of road maintenance and maintenance services will provide an additional incentive to improve the operational efficiency of enterprises that maintain roads.

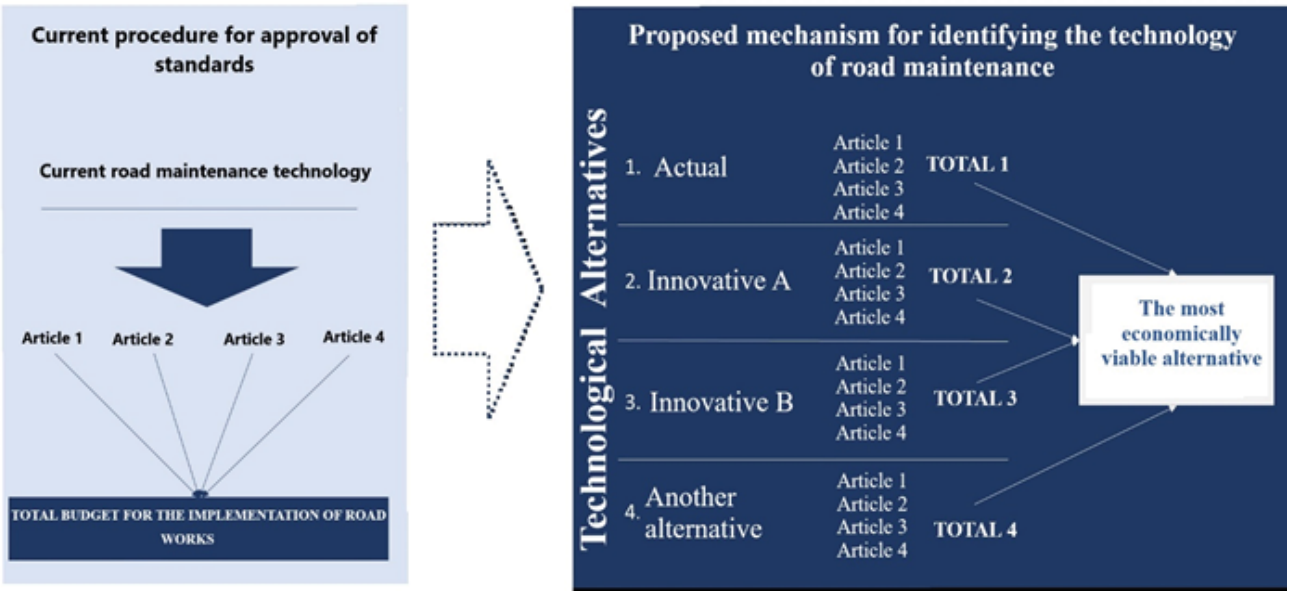
5.3. OPERATIONAL MONITORING OF THE LEVEL OF ROAD SAFETYΓ

Winter maintenance works represent the greatest difficulty in ensuring the safety of highways. This fact is due to a significant set of operations and a large number of technological alternatives. The main documents regulating the winter maintenance of roads are currently:

– INDUSTRY ROAD METHODOLOGICAL DOCUMENT 218.5.001-2008 “Methodological recommendations for the protection and cleaning of roads from snow”;
– INDUSTRY ROAD METHODOLOGICAL DOCUMENT “A guide to dealing with winter slippery roads”;

[16] GOST R 50597-2017. National Standard of the Russian Federation. Automobile roads and streets. Requirements for the operational condition allowed under the road safety conditions. Control methods// ConsultantPlus. URL: http://www.consultant.ru/document/cons_doc_LAW_285670/.
[17] Anti-icing material Bionord - myths and realities.URL: https://roszimdor.ru/press-tsentr/gilfanov-rustam-khalefovich-publikacii-priglashennykh-ehkspertov/protivogololyednyy-material-bionord-mify-i-realnost/.

Figure 6. Description of the proposed mechanism for determining the most appropriate road maintenance technology



– INDUSTRY ROAD METHODOLOGICAL DOCUMENT 218.5.006-2008 "Methodological recommendations for the use of environmentally friendly anti-ice materials and technologies in the maintenance of bridge structures".

These documents are aimed at ensuring the transport and operational condition of highways that meet the requirements of GOST R 50597-2017. The main attention is paid to the organization of works on cleaning roads from snow and ice, the interaction of contractors engaged in winter road maintenance, and responsible authorities; ensuring road safety conditions in winter. The main disadvantage of the current methodological system for maintaining the technical and operational characteristics of the road in winter is the insufficient level of control over the effectiveness of measures for winter road maintenance. The main criterion for assessing the quality of work performed on the winter maintenance of the road is the amount of work, while improving the safety of road traffic is not guaranteed.

The solution to this situation can be the introduction and regulation of monitoring the condition of the roadbed in the winter period by measuring the coefficient of adhesion of automobile wheels to the road surface after carrying out measures to clean the roadbed. The introduction of this measure will make it possible to monitor the results of winter maintenance work in the operational mode in terms of their impact on improving traffic safety.

According to the current standards, the coupling coefficient is measured only at positive air temperatures on the dry surface of the road. The minimum value of the coefficient is 0.3, which is regulated by GOST R 50597-2017 " Automobile roads and streets. Requirements for the operational condition allowed under the road safety conditions. Control methods". In winter conditions, the measurement of the coefficient of adhesion is not provided, but any snow and ice deposits significantly reduce its value and lead to a disproportionate increase in the number of road accidents[18]. Such disadvantages in the control system can lead to significant macroeconomic losses on the part of the state, as well as a decrease in the quality of life of citizens.

According to GOST R 50597-2017, it is proposed to provide for three types of monitoring of the coefficient of clutching in the winter period.

1. Preventive. It is carried out in case of receipt of meteorological information about a potential snowfall. On the basis of preventive monitoring, it is proposed to determine the need for sprinkling deicing materials on days with a negative temperature of Celsius.
2. Reactive. After the implementation of routine work on winter maintenance, the quality of the operations performed is defined.
3. Routine. It is carried out regularly, for example, before the beginning of the peak workload on road facilities.

Determination of the coefficient of clutch on the road before the start of measures to combat winter slipperiness in conjunction with information about weather conditions, traffic intensity, etc. it will allow you to set the optimal set of works on a certain section of the road. On the one hand, this measure will improve the safety of road traffic, on the other-to optimize the costs of contractors for carrying out regulated work by reducing the cost of labor, reagents and fuels and lubricants materials.

[18] Winter road maintenance on the eye and on the line.URL: https://roszimdor.ru/press-tsentr/novosti-struktury/zimnee-soderzhanie-dorog-na-glaz-i-po-lineyke/.

6. CONCLUSION

The current state of the road network of the Russian Federation subjects limits the realization of the country's economic potential. One of the promising areas in the field of improving the quality of roads is to improve the system of their safety. Existing and prospective mechanisms for ensuring the safety of highways are reduced to monitoring the weight and size parameters and tightening certain provisions of regulatory legal acts, that is, they are based on penalties. The lack of economic incentives for service organizations significantly reduces the interest of the last in improving the quality of road services.

Within the framework of this article, three initiatives were proposed to improve the state policy in the field of ensuring the safety of the road network:

- incentive contracts for road maintenance companies based on a target setting mechanism;
- independent assessment of the economic feasibility of road maintenance technologies;
- improvement of the system for monitoring the level of road safety under the life cycle contract.

The proposed initiatives can become a tool for solving the following main tasks.

1. Increase in useful life without carrying out repair measures.
2. Reducing the costs of the executive authorities of the subjects of the Russian Federation and municipal authorities.
3. Reducing the number of road accidents and improving the quality of life of the population.
4. Reducing the negative impact of reagents on the environmental situation of the territory.
5. Traffic stabilization and reduction of traffic overload.

Thus, the improvement of state policy in the field of preservation of the road network of constituent entities of the Russian Federation may lead to improvement of the quality of roads and the increase of the economic potential of the territories.

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ABOUT THE AUTHORS

Nikita A. Popov
Research associate, Center for Industry Research and Consulting of the Financial University under the Government of Russian Federation.
Research interests: IT-technologies in the operational efficiency of business, digitalization of production, crisis and arbitration management.
E-mail: NiAPopov@fa.ru

Nikita A. Osokin
Deputy director, Center of Sectoral Research and Consulting Financial University under the Government of the Russian Federation.
Research interests: econometric analysis, performance management, economy of sports.
E-mail: NAOsokin@fa.ru