Development of an algorithm for the introduction of innovative technologies in the construction of roads

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Abstract: This article provides an analysis of the current state of the road industry in Russia. There are factors that increase the demand for innovative road construction technologies. The authors have developed an algorithm for the introduction of innovative technologies in road construction. The algorithm developed by the authors will allow road construction enterprises to make informed decisions in choosing the directions of their development. It also enables an enterprise to more clearly identify its market positions and take measures to improve them, solve problems and increase the efficiency of its activities.

1. Introduction
Roads are a public good because anyone can use them. The quality of state and municipal management is assessed by the condition of the roads. The development of the economy of the region and the country directly depends on the development of the road network in a given area. Federal, regional and municipal authorities exercise control over this area of activity and its financing [1].

At the same time, it should be especially noted that the motorization of the population has grown significantly over the past 10-15 years. In 2007–2019 the number of own cars increased 1.6 times per 1,000 people. The number of public service buses has grown 2.4 times per 100 thousand people. Trucking industry grew 1.3 times (in 2019, the share of this transport in the total freight turnover reached almost 5%). All this increases the load on the country's road network. The study showed a decrease in bus passenger traffic. It is mainly due to the accelerated development of air transport, which is used by the population for the farthest movements across the country. The number of road traffic accidents, which are accompanied by injuries and deaths, remains quite high (although in 2007-2019 it was possible to reduce the value of this indicator by 2 times. This level is still noticeably higher than in most developed countries of the world) [2].

2. Theory
Currently, our country ranks among the ten countries with the worst roads. Each Russian region is funded differently. Therefore, it should be noted that the quality of the road depends on the well-being of the region. So, for example, Moscow and St. Petersburg have the most well-groomed roads in contrast to other parts of Russia [3]. For example, the annual volume of the road construction market
of St. Petersburg reaches 15 billion rubles. The northern capital spends an average of 3-4 billion rubles on major repairs, 6-7 billion rubles are spent on patching roads, and the rest of the money goes to construction [4].

The Russian leadership pays close attention to this problem. To improve the road situation in the country, the Federal Target Program "Development of the Transport System (2010-2020)" was approved. The total mileage of roads planned for reconstruction is 19,800 km. [5, p.39]

Table 1 shows the dynamics of the construction and repair of highways in Russia and the volume of financial support for these works over the past 3 years.

**Table 1. Dynamics of construction and repair of highways in Russia and the volume of financial support for these works [6]**

| Road budget line | 2017 | 2018 | 2019 |
|------------------|------|------|------|
| Repaired public roads with hard surface, thousand km, total | | | |
| federal significance | 19,20 | 19,29 | 23,47 |
| regional or inter-municipal significance | 8,84 | 8,44 | 7,63 |
| The total amount of financial support for the implementation of projects (programs) of the State Program of the Russian Federation "Development of the transport system", billion rubles. | 2018 | 2019 |
| Total amount of financing for the national project "Safe and High-Quality Roads", billion rubles. | | | 589,5 |
| Total funding | 430,2 | 575,9 | 548,1 |

Russia is a unique country that has individual climatic and territorial characteristics, seasonal freezing of soil, different population density and traffic intensity. All this requires the use of innovative developments of a different nature [6].

The following factors explain the need for innovative road construction technologies:
- a constant increase in the number of cars, an increase in the share of passenger cars with significant dynamic characteristics and trucks with increased axle loads. This is necessary to improve the consumer properties of the road and its quality [7];
- significant motorization and mobility of the population, the intensity of traffic flows. These indicators can significantly increase the level of road congestion and reduce traffic congestion that occurs in large cities. This is necessary in order to use improved traffic management systems and to develop highways and bypass roads that meet international standards;
- the high cost of all road-building materials and modern high-performance equipment at the same time with an increase in the repair and overhaul of roads. It will improve the pricing methods of road construction;
- the use of innovative ideas and projects for the construction and maintenance of highways. This contributes to the improvement of the quality characteristics of the roads and the quality of road works.;
- substantial repair and construction of district roads to connect settlements and road networks. This requires the study and use of economically viable technologies and materials, the preparation of new standards for the design, construction and operation of such roads.;
- basic consideration of traffic safety and environmental regulations in road construction.

It is obvious that the lack of innovative scientific activity will not give the harmonious development of all significant industries [8, 9].
3. Statement of the problem

Based on the analysis of the innovative activity of road construction in the Russian Federation, we present a number of problems:

- the main consumers of innovative products do not consider the application of innovations as one of the priority tasks of their practice;
- these properties have a direct impact on the construction cost of roads and the required amount of costs for their maintenance during operation;
- low length of reconstructed, under construction and repaired roads;
- Russian annual costs for the construction of one kilometer of roads are higher than foreign ones.

The main task is to develop an algorithm for the introduction of innovative technologies in road construction.

4. Results

As Russian Deputy Prime Minister Marat Khusnullin noted, in 2020 the volume of road infrastructure construction grew by 14% despite the coronavirus pandemic [10]. In the spring of 2020, this was made possible by the decision to continue road construction despite the epidemic. In 2020, Russian regions received almost 255 billion rubles for the construction and repair of roads as a part of the Safe and High-Quality Highway National Project. The mechanism of temporarily free funds allowed us to achieve such high rates. With the help of it, the regions received an additional 100 billion rubles for the repair and construction of roads.

In the short term, we can say that the coronavirus has positively influenced the current state and development of the road construction industry due to additional financial investments in this industry. However, in the long term, funding for the road construction market will be reduced. In 2020, the country's GDP, according to the Bank of Russia, will decrease by 4-5%. The fall in GDP caused by:

- final household consumption fell due to lower real incomes and restrictions imposed to contain the spread of coronavirus [11];
- the decline in investment activity of companies was reflected in the fall in investment in fixed assets.
- decline in industrial production.
- decrease in gross fixed capital formation.
- increase in the unemployment rate, etc.

It can be predicted that due to the fall in the country's GDP, the Government will not provide additional funding to the road industry. In the future, the growth rate of the road industry can range from 1% to 10% per year.

Road construction companies need to focus on certain aspects of their business to gain a competitive advantage in the market under restrictive measures [12,13].

The use of innovations can significantly change the situation and the rationale for decisions, because it affects both the quality characteristics and the cost of roads. From these positions, the following types of innovations can be distinguished:

- aimed at improving quality at constant costs;
- aimed at reducing costs with constant quality indicators;
- aimed at improving quality and reducing costs.

Among the listed types of innovations, the most attractive are innovations aimed at improving quality and reducing costs in road construction [14,15]. Considering that the introduction of innovative technologies should be systematic, we have developed an algorithm for the introduction of innovative technologies in the construction of roads (Figure 1).

The algorithm developed by the authors will allow road construction enterprises to make informed decisions in choosing the directions of their development and enable the enterprise to more clearly identify its market positions, take targeted measures to improve them and solve the problems of increasing the efficiency of its activities.
Thus, it should be emphasized that Russian road construction companies have a rather low level of competitiveness [16]. Every year, foreign companies are leaders in the road industry because they are interested in introducing innovative technologies. The introduction of innovative technologies allows the enterprise to increase its competitiveness.

Each business entity must constantly improve and introduce innovative technologies. The introduction of innovative technologies is necessary for any enterprise, regardless of its size, profit or age. Innovation is the engine of progress.

As a result, an enterprise that implements innovative technologies expects:
- improvement of transport and operational indicators of roads;
- longer service life;

**Figure 1.** Algorithm for the introduction of innovative technologies in the construction of roads

5. **Conclusion**

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As a result, an enterprise that implements innovative technologies expects:
- improvement of transport and operational indicators of roads;
- longer service life;
- improving road safety;
- best environmental conditions;
- cost reduction;
- the use of effective means of engineering equipment and road construction, as well as modern information technologies and communication systems.

References

[1] Getmanova I A, Zavarzina T S 2018 State and trends of development of road construction business in Russia. Collection of articles of the II International Scientific and Practical Conference "Modern directions of scientific research". Publishing house: Limited Liability Company "Center for Scientific Research and Consulting" (Samara) 54-58

[2] Blagodir A L, Grebenkina I A, Grebenkina S A 2020 Connected territories of the Russian Federation due to the creation of intelligent transport systems Legislation 1 77–85

[3] Rogov S 2013 Overview of the traffic market The risk granter 9

[4] Ignatieva A V, Pakhomov A V 2020 Implementation of national projects at the municipal level: first results and ways to improve efficiency. Municipal property: economics, law, management 1 11–17

[5] Roy O M 2015 Road construction as an object of public administration. National priorities of Russia 4 (18) 36-41

[6] Voroshilov N V 2020 Main results of the implementation of the national project "Safe and high-quality highways" in 2019. Municipality: economics and management 3 (32) 124-139

[7] Grasmik L V and Molodan I V 2014 The problem of competitiveness of road construction industry enterprises Actual problems of aviation and cosmonautics 10 (2) 300-301

[8] Khalturin R A 2011 State and experience of road network construction in Russia and abroad. Economic Sciences 1 (74) 223-226

[9] Letalov A 2016 The situation in the field of road construction and mechanical engineering E Vesti Available at: http://www.e-vesti.ru/ru/road-development-2016/

[10] More roads were built in 2020 than a year earlier. 2020 Rossiyskaya gazeta Available at: https://rg.ru/2020/12/25/v-2020-godu-postroeno-bolshe-dorog-chem-godom-ranee.html

[11] Danilenko M I 2020 Assessment of the competitiveness of the enterprise Bulletin of the Academy of Knowledge 4 (39)

[12] Kormakov L F 2019 Modernization of road transport infrastructure – the starting stage of the integrated development of rural areas Economy of agricultural and processing enterprises 9 75–80

[13] Svetnik T V 2014Transformation of the construction industry into an effective locomotive of economic growth Bulletin of Irkutsk state technical University [Socio-economic and social Sciences] 12 (95) 336-342

[14] Bykov D N, Khomkalov G V 2018 Construction materials market in competitive conditions Izvestiya vuzov. Investment. Construction. Realty 2018 3 (26)

[15] Samarakha A V 2018 Topical Trends of Improving Economy of Regions and Municipal Entities in Siberia Baikal Research Journal vol 9 3

[16] Svetnik T V 2017 Systemic nature of the hoodwinked investors’ problem in Russia Baikal Research Journal 2017 vol 8 4 DOI: 10.17150/2411-6262.2017.8(4).26