



# Risk Management for the Safe Use of Highly Automated Vehicles in a Metropolis: Systems and Legal Analysis



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## ABSTRACT

The article presents the results of a scientific study of current issues of risk management associated with ensuring safe operation of unmanned vehicles, obtained by the authors as a result of implementation of the second stage of a scientific project supported by the Russian Science Foundation. The conclusions presented in the article are based on the results of a study of legal and organisational problems of ensuring the safe use of unmanned vehicles in a metropolis, carried out during the first stage of the project.

The study confirmed the authors' assumption that solving the problem of ensuring the safe use of unmanned vehicles is possible based on scientific research into the risks arising during their

operation. It is substantiated that identification, differentiation, monitoring of risks determined by appearance of unmanned vehicles on highways is a necessary condition for development of a scientifically based system of legal measures of general and private prevention, including measures of legal liability for relevant offenses, based on categorisation of risks and threats of violation of mandatory requirements adopted to ensure transport safety and traffic management using this type of vehicle.

The fundamental provisions are analysed and comprehended underlying the application of the risk-based approach in homogeneous and single-type social relations.

**Keywords:** transport law, legislation, unmanned vehicles, transport safety, risk, risk-based approach.

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## INTRODUCTION

We should agree with the statement that human social activity and emerging activity practices are now increasingly associated with the widest introduction into the practice of social life and the use of high technologies and highly mobile or automated technical means [1, p. 62]. These processes are fully visualised in the functioning of the transport industry, which provides logistics processes necessary for functioning of other sectors of the economy, ensuring the connectivity of the country's territory [2, p. 45], defence capability and national security of the state [3, p. 101].

The introduction of innovative technologies is carried out against the backdrop of growth and the emergence of qualitatively new challenges and threats of both a technological, military, and social nature [2, p. 163]. We must agree with the opinion that the global civilisational «challenges that humanity faces are accompanied by a lack of ideas regarding its further movement. This fully applies to such a phenomenon as law» [4, p. 5]. A significant number of representatives of Russian legal science come to similar conclusions, the subject of their research is in various branches of legal knowledge [5, p. 18; 6, p. 9; 7, p. 5; 8, p. 278], which, in our opinion, only confirms the general nature of the statement according to which the use of high technologies naturally entails significant problems for legal science and the practice of law enforcement.

In the works of representatives of transport legal science, it has been repeatedly and quite thoroughly stated that development and increasingly widespread use of an automated driving system, commissioning of innovative vehicles is aimed, first of all, at solving a whole complex of problems that are significant for the modern economy, such as reducing transport costs by reducing the driver's wage fund and related costs, optimising the costs of maintenance, depreciation, repair and insurance of vehicles, saving fuel due to automatic driving style [9, p. 18], ensuring transport safety by minimising the influence of the human factor on road accidents [10, p. 71] etc.

However, there is also an «other side of the coin»: the introduction of highly automated cars

into the country's transport complex poses a number of serious challenges to the law as a public regulator [11, p. 15], which undoubtedly requires their consideration in the rule-making process [12, p. 131].

In this regard, it is necessary to critically evaluate the degree of compliance of adopted legal acts with the needs of practice, the principles of consistency and mutual conformity. Solving this problem will make it possible to formulate directions for further research and develop proposals for improving the system of legal regulation of relations related to introduction of unmanned vehicles, which can help solve problems not only of a theoretical but also of a practical nature that arose in the process of introducing fully automated cars into the Russian transport system.

The use of a risk-based approach can help solve this problem. This approach is based on a program-targeted approach and has become widespread in various spheres of public life, for example, in project activities, financial activity [13, p. 16; 14, p. 34]; budgeting and financial activities of the state [15, p. 48–49]; business processes [16, p. 39]; public administration and state control (supervision) [17, p. 54]; countering terrorism [18, p. 13] and corruption [19, p. 52; 20, p. 50]; preventing the spread of infectious diseases [1, p. 7; 21, p. 17; 22, p. 456; 23, p. 161] etc.

Understanding the significance of problems associated with typology, visualisation, monitoring and subsequent risk management in transport is demonstrated by a number of Russian and foreign researchers.

Thus, there is a justifiable interest in classification of risks and threats to information security that arise during the use of unmanned aircraft [5, p. 44], considering current issues of providing criminal legal protection in this area [24, p. 119]. It is noted that of particular importance is resolution of the issue of liability for external interference in the process of control and operation of the automated driving system of an unmanned vehicle.

There are attempts being made that deserve attention and support to form a conceptual basis for risk management in transport as a special type of management activity that has a staged

and systemic nature [16; 25, p. 34; 26. p. 19 and onwards].

The need to consider the probable risks of the safe use of transport facilities is considered in the interests of introducing a life cycle contract in the long-distance passenger complex [27, p. 88].

Specialists pay special attention to the study of compliance with humanitarian law when using various unmanned systems [28, p. 218; 8, p. 277], as well as monitoring the risks of their use in various environmental conditions [29, p. 118; 3, p. 98].

Foreign experts are actively exploring the risks associated with increasing costs caused by road congestion due to introduction of unmanned vehicle fleets, which significantly affect urban mobility [30], focusing special attention on problems associated with risks for high-quality urban spaces and active mobility of the population, noting that despite the expected future adoption of autonomous vehicles in cities, there are very few studies analysing the challenges that faces urban planning [31].

There are works of interest devoted to predicting the risk of road accidents considering various factors, including the risks associated with the increasingly widespread use of driverless cars, considering the issues of assessing the risk of an accident based on the history of driving trajectories, driving events and records of influence [32].

It is also not unreasonable to note the need to develop a methodology for assessing the risks of road accidents involving unmanned vehicles, connected and automated vehicles in general. Foreign experts propose to proceed from the fact that automated vehicles are transforming road transport, and as part of this transformation, vehicle insurers are one of the key stakeholders [33].

Analysis of the results of the impressive research activity of representatives of various scientific fields and schools, specialists in the field of transport, allows us to draw a conclusion about the relevance and significance of the problem that determined the purpose of the study, as well as to determine the range of insufficiently studied issues, which allows us to formulate research tasks and determine the

research methodology, formulate conclusions and justify the authors' conclusions, the implementation of which, in our opinion, can help minimise the risks to the safe use of highly automated vehicles.

The objective of the study, an important stage of which is outlined in the article, is to develop conceptual proposals for improving the system of legal regulation of risk management for the safe use of highly automated vehicles.

## RESULTS

### Initial Hypotheses

Using previously obtained results from the scientific literature, the authors proceeded in the research process from the hypothesis that the high degree of social, economic, and defence significance of the transport system for Russia [17, p. 52], vulnerability of elements of the transport complex to acts of illegal interference [34; 10, p. 71], strictly determines the need for in-depth scientific study of the sources of origin and typology of risks and possible threats to safe functioning of transport [10, p. 74], developing on this basis a system of legal regulation of transport relations using the tools of public legal regulation.

Previously, the authors also substantiated the thesis [35; 29], according to which the relationship between the emergence of innovative transport and the importance of legal support for the processes of their implementation and use [36, p. 263], the need for their legal regulation in the interests of ensuring transport safety in general [2, p. 46], minimising the risks associated with the increasingly widespread use of vehicles [37, p. 4], including those equipped with an automated driving system [38, p. 29], should be recognised as having a natural character and completely scientifically substantiated [35; 39].

At the same time, the results of a systems, legal and formal-dogmatic analysis of domestic normative legal acts and their projects indicate the incomplete adequacy of measures taken to resolve the relations that arise during implementation of innovative technology [38, p. 91]. We also previously substantiated the statement that rule-making activity in this direction is carried out with a significant delay



and with an insufficient degree of systematicity [38, p. 94].

Important for this study is the conclusion that it is necessary to use the potential of legislation on technical regulation, which should be considered precisely as the legal regulation of relations in the field of establishing, applying and fulfilling mandatory requirements for products, production, construction, installation, commissioning, operation and disposal, as well as in the field of application on a voluntary basis of requirements for these objects, and legal regulation of relations in the field of conformity assessment [34; 40, p. 35].

The authors substantiate the need and relevance from the point of view of social practice, feasibility and validity in the context of legal theory of using a risk-based approach to develop legal measures in the interests of ensuring safety of the use of unmanned vehicles, and therefore the study uses a historical and legal approach and tools of legal hermeneutics, methodology of formal-dogmatic and systemic approaches.

The results obtained in the process of research work allow us to assert with a sufficient degree of certainty that the high demand and potential applicability of the risk-based approach in various areas of public life is completely justified theoretically and supported by the needs of practice, since a scientifically sound and effectively functioning system of risk assessment and management in that or other area allows us to timely identify risk factors and take adequate measures of general and specific prevention to completely eliminate them or, at least, minimize them to an acceptable level that is permissible for normal functioning of the system.

The results of historical, semantic, semiotic analysis, accessible for study and appearing to be quite solid, obtained by numerous adherents of decision theory and game theory, free, in our opinion, the authors from the need for a detailed consideration of the category «risk», homogeneous and derivative terms and concepts, as well as the phenomena they designate within the framework of hermeneutics and epistemology.

At the same time, it should be borne in mind that it is precisely identification of common, coinciding in all concepts of the risk-oriented

approach in various fields of activity that allows us to isolate the typical essential features of the phenomenon we are studying, which are of fundamental importance. The need for this kind of research is seen in the importance of defining conceptual approaches based on which it is supposed to formulate the legal and organisational basis for applying a risk-based approach to identify the degree (measure) of threats to safety of the use of unmanned vehicles in the interests of subsequent development of management decisions to minimise them.

### **Risk-Based Approach to Organisation of State Control (Supervision)**

Within the framework of a systemic legal study of the risks of the safe use of highly automated (unmanned) vehicles, the most significant for comparative research in connection with the possible applicability of experience are, in our opinion, legal foundations of a risk-based approach in a number of areas, which include, first of all, legislation on state control (supervision).

It should, of course, be considered that long before implementation of the risk-oriented approach to organisation of state control and supervision, the risk management system was used in customs and tax control, however, both fundamental and procedural aspects of application of this approach were found most fully in the legislation on state control (supervision).

Probably, the concept of a risk-oriented approach in state control (supervision) can be considered homogeneous for a risk-oriented approach to identify the degree (measure) of threats to safety of the use of unmanned vehicles, which determines the significance of the results of the study of the system of legal regulation of control over compliance with mandatory requirements proposed below. To better update the stated approach in relation to the subject of the study, the analysis will be carried out considering the specifics of control (supervisory) activities carried out in order to ensure transport security.

According to p. 2 of Art. 1 of Federal Law of July 31, 2020, No. 248-FZ «On state control (supervision) and municipal control in the Russian



Federation» (hereinafter also referred to as the Control Law) state control (supervision), municipal control should be aimed at achieving socially significant results related to minimising the risk of harm (damage) to legally protected values caused by violations of mandatory requirements. Thus, an analysis of the legalised purpose of state control indicates that the category «risk» has an essential meaning that determines both the purpose and the method of exercising control.

Despite the establishment of general conditions for implementation of a risk management system at the legislative level in the provisions of Chapter 5 of the Control Law, the legal regulation of risk management in transport as a type of management activity is fragmented. In addition, there is no general theoretical and legal model of risk management in transport, which would serve as a conceptual basis for building appropriate systems on specific modes of transport, corresponding to organization of control (supervisory) activities of Rostransnadzor [Federal Agency of Transport Supervision], taking into account its new powers and the risks, which significantly increased quantitatively and changed in content, for ensuring safety both for the Russian transport system as a whole and for individual modes of transport.

#### Legal Risk management Mechanisms for Modes of Transport

Some legal mechanisms for risk management have been formed and implemented in certain modes of transport.

Thus, in railway transport the Interstate standard GOST 33433–2015 «Functional safety» is in force. Risk management in railway transport»,<sup>1</sup> in which risk management is understood as coordinated activities aimed at managing and directing an enterprise in relation to risks (clause 3.33). The risk management process includes the following stages: defining the scope; definition of risk criterion; risk identification; frequency analysis; impact analysis; determining the level of risk; risk assessment; risk treatment; monitoring and review of risk (clause 5.1).

<sup>1</sup> Put into effect by Order of Rosstandart dated December 4, 2015 No. 2108-st.

There are a number of standards in force in air transport, in particular, the National Standard GOST R 55846–2013 «Air transport. Aviation safety management system. Acceptable risk. Principles and methods for determining acceptable risk for government and service providers».<sup>2</sup> Risk management in air transport is a process similar to safety management, in the highly specialized direction of ensuring safety based on measuring the significance of risks, reducing the severity of consequences from the impact of risk factors on the system and avoiding the system from risk factors (clause 3.1.9).

It should also be noted that the basis of various risk management concepts is the provisions of the following GOST [state standards]: GOST R ISO 31000–2010 «Risk Management. Principles and guidance», approved by Order of the Federal Agency for Technical Regulation and Metrology dated December 21, 2010, No. 883-st; GOST R ISO 31010–2011 «Risk management. Risk assessment methods», approved by Order of the Federal Agency for Technical Regulation and Metrology dated December 1, 2011, No. 680-st; GOST 33433–2015. Interstate standard. Functional security. Risk management in railway transport, approved by Order of Rosstandart dated December 4, 2015, No. 2108-st, etc., at the same time, the study of local risk management models indicates the absence of a unified conceptual and category-conceptual approach to the issue of risk management in transport. In particular, the concepts developed by corporations<sup>3</sup> use such concepts as: risk factor, risk indicator, hazards, sources of risk events, etc.

The risk management concept formulated in railway transport has a staged nature. Thus, the risk management process in railway transport consists of the following stages: a) risk identification; b) risk analysis and assessment;

<sup>2</sup> Approved by Order of Rosstandart dated November 22, 2013 No. 1878-st.

<sup>3</sup> Order of JSC Russian Railways dated January 13, 2020 No. 18/r «On approval of the Methodology for assessing decision-making criteria when developing measures in cases of violation of traffic safety based on an analysis of risks in the field of traffic safety and reducing the severity of the consequences of road accidents at railway crossings».



c) impact on identified risks; d) monitoring and review; f) exchange of information and consultation (clause 2.10. MR).

At the same time, the methodology for identifying risks also involves analyzing the causes (risk factors, sources) of a risk event. Risk factors are understood as internal or external factors that, individually or in combination with other factors, can lead to risk realization. In addition, at the stage of risk analysis and assessment, for the purpose of further monitoring and review of risks, risk owners develop key indicators for identified risks (KIR) (clause 4.7.1. MR). KIR are used to provide early warning of the increasing likelihood of risk occurrence and take preventive measures to address the risk or recognize the fact of risk occurrence and take measures to minimize the consequences. They are not a description of the risk but serve as an indicator for considering the need to change current activities to address the risk.

#### Opportunities and Goals of Applying a Risk-Based Approach to Driving Unmanned Vehicles

As a result of the data obtained, we believe it is possible to assert that the use of the widely used risk-oriented approach seems to be the most adequate way to identify the degree (measure) of threats to safety of the use of unmanned vehicles for the purpose of subsequently developing legal measures and making management decisions in the interests of minimising them.

This approach allows for monitoring and visualisation of risks, their differentiation, which is the basis for development and subsequent implementation of measures, including those of a public law (administrative law) and private law (civil law) nature, aimed at preventing and eliminating or minimizing to an acceptable level the risks and safety threats of using unmanned vehicles in a metropolis.

We can conclude that the analysis of the fundamentals of minimising the risks of the safe use of unmanned vehicles involves identifying a set of principles for construction and operation of a system for managing these risks.

Construction of a risk management system associated with admission to operation of the subsequent use of unmanned vehicles, in addition to the general principle of consistency, according

to which management of this category of risks is considered as a component of more complex systems of specific significance, must have a certain structure, the property of adaptability, dynamism, sustainability, etc. It should be built on the basis of special principles, including scientific principles; comprehensiveness; objectivity; concreteness (situational), etc.

#### Brief Analysis of the Requirements of Private Principles: Differentiation and Legal Certainty

Considering the principle of differentiation, in our opinion, implies the need to typologize risks according to the degree of their significance for safety of using unmanned vehicles, identifying the degree of influence of the corresponding threats on road safety involving unmanned vehicles. Our highlighting of this principle is largely due to its special significance for resolving issues related to a comprehensive analysis of factors affecting safety of operating unmanned vehicles in megacities.

Legal certainty as a principle for constructing a risk management system associated with admission to operation of the subsequent use of unmanned vehicles presupposes the need for a clear and fairly rigorous regulatory legal settlement of all social relations arising in this case [11, p. 16; 12, p. 118;]. We are talking about the need to unambiguously establish in positive law procedures for identifying risk factors that arise in the process of admission to operation, operation of unmanned vehicles, risk monitoring, liability for relevant offenses, etc.

## CONCLUSIONS

The results of the study made it possible to confirm the high degree of practical applicability and usefulness of the risk-based approach to minimise the threats that arise during the process of admission to operation and operation of unmanned vehicles.

The formation of the latest concept of risk management in transport should be preceded by work on development of a general theoretical and legal model for managing risks arising in the process of admission to operation and operation of unmanned vehicles.

A critical understanding of paradigmatic foundations of the application of a risk-based approach in various spheres of social production

and socio-economic relations made it possible to determine the system and partly the structure, to formulate the principles of constructing a risk management system associated with admission to operation and the subsequent use of unmanned vehicles.

Legalization in positive Russian law, the practice of the activities of transport management bodies and subjects of transport relations of the proposals formulated based on the results of the study will allow, by optimising the risk management system and the integrated use of legal means, to minimise the risks of operating unmanned vehicles on public roads, which has not only scientific implications, but also applied significance for ensuring the efficiency and safety of their operation, can contribute to innovative development of the transport system in the context of ensuring development of the Russian economy, achieving national goals and strategic positioning of the Russian Federation in the modern world.

The author's conclusions presented in this article do not pretend to be complete and final, but, in our opinion, can serve as the basis for both scientific discussion and further research into the problems of legal support for the safe use of unmanned vehicles.

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