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Implementation of infrastructure projects for the development of railway transport hubs: Empirical analysis

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Abstract

The key tool for economic growth and overcoming restrictions is the implementation of major infrastructure projects in the field of railway transport. Infrastructure projects aimed at organising passenger and freight rail traffic form a wide range of social effects, such as saving travel time, improving transportation safety, reducing emissions of harmful substances and noise levels, increasing physical activity, improving social integration and organising a barrier-free environment, agglomeration effects and an increase in subjective well-being.

At the same time, such projects are very capital-intensive and often cannot be implemented in full due to limited funding. Especially this factor plays a significant role in the current conditions of sanctions pressure. The combination of these factors leads to the need for comprehensive risk management when deciding on the implementation of an infrastructure project for the development of railway junctions.

Thus, the purpose of this study is to identify risks in the implementation of infrastructure projects, assess the identified risks and formulate recommendations for their reduction.

Keywords: infrastructure projects, transport hub, railway, risk analysis, railway network.

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铁路运输枢纽发展的基础设施项目的实施：实证分析

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摘要

实施铁路运输方面的重大基础设施项目是经济增长和克服制约因素的关键工具。旨在组织客运和货运铁路交通的基础设施项目会产生广泛的社会效应，例如：旅行时间节省，运输安全改善，污染物排放和噪音水平减少，体育活动增加，社会包容性提高，无障碍环境创造，聚集效应和主观物质福利的提高。

然而，这类项目是高度资本密集型的，往往由于资金的限制而无法完全实施。在目前的制裁压力环境下，这一因素尤为重要。这些因素的结合导致了在决定发展铁路枢纽的基础设施项目时，需要进行全面的风险管理。

因此，本研究的目的是识别基础设施项目实施过程中的风险，评估所识别的风险，并制定减少风险的建议。

关键词：基础设施项目，运输枢纽，铁路，风险分析，铁路网。

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Introduction

The relevance of this study is primarily due to the fact that the key tool for economic growth and overcoming restrictions is the implementation of large infrastructure projects in the field of railway transport.

In a previous study [Kuzmin, 2020] the following areas for the implementation of infrastructure projects were identified:

- Modernisation of railway infrastructure in order to increase the speed of rolling stock. This direction of development is critical for increasing the average section speed of trains, which directly affects the speed of movement of goods or passengers [Tsypleva, 2017].
- Development of multimodal terminal and logistics centers. The development of these centers can improve the convenience of using the railway infrastructure for both passengers and consignors and consignees. In addition, the strengthening of the multimodal infrastructure will help to increase the degree of integration of rail transport into supply chains, reduce the travel distance and, in general, increase its attractiveness in relation to road and sea transport [Vinokurov et al., 2018b].
- Development of transport hubs. This direction in railway infrastructure development projects is one of the main ones for achieving positive agglomeration effects, such as increasing employment, wages, etc. [Assessment of large..., 2013].
- Modernisation of border crossing infrastructure. The movement of trains often slows down when passing borders. This is due to many factors, ranging from differences in the diameter of the railway track and electrification parameters of the railway network to the inefficiency of the customs document flow at the border crossing [Vardomsky, Turaeva, 2018].
- Implementation of digital platform solutions. The digitalisation of railway networks can not only increase the efficiency of the transport system, the throughput of nodes, but also have a beneficial effect on all market participants, as it will significantly increase the convenience of use for passengers and shippers and will make it possible to more effectively introduce rail transport into logistics chains.

Infrastructure projects aimed at organising freight traffic generate the following social effects:

– saving travel time;
– improving the safety of transportation;
– reduction of emissions of harmful substances and noise level (when choosing alternative options).

In turn, infrastructure projects aimed at organising passenger traffic form an even wider range of social effects:

– saving travel time;
– improving the safety of transportation;
– reduction of emissions of harmful substances and noise level (when choosing alternative options);
– beneficial effects of public transport due to increased physical activity;
– social integration and barrier-free environment;
– subjective wellbeing – the perception of the world around us, or the level of happiness [D'Acci, 2014; Value of rail.., 2017; Transport infrastructure.., 2019; Linder and Kuznetsova, 2020].

Making a decision on the implementation of major infrastructure projects requires a thorough analysis of the socio-economic effects that accompany the implementation of such projects, as well as the development of the most effective tools to improve the socio-economic level of development of territories through the implementation of infrastructure projects for the development of railway transport hubs.

At the same time, such projects are very capital-intensive and often cannot be implemented in full due to limited funding. This factor plays a particularly significant role in the current conditions of sanctions pressure. The combination of these factors leads to the need to evaluate not only potential socio-economic effects, but also to carry out comprehensive risk management when deciding on the implementation of an infrastructure project for the development of railway junctions.

Thus, the purpose of this study is to identify risks in the implementation of infrastructure projects, assess the identified risks and formulate recommendations for their reduction.

1. Research methodology

Any ongoing project, as well as the activities of organisations involved in the implementation of the project, is subject to risks caused by both internal and external factors and impacts that generate uncertainty as to whether the project objectives will be achieved, as well as the timing in which they will be achieved.

In a highly turbulent world economy, modern companies are exposed to various threats and risks that affect their development. This is largely due to the processes of competition, digitalisation, global changes in the political and economic situation [Kuznetsova, 2020]. Under the current conditions, modern companies are forced to form new methods and approaches to ensure the development of their risk management processes in a dynamically changing external and internal environment.

However, before proceeding to risk analysis, it is necessary to form a common understanding of the term "risk". The analysis of existing standards in the field

of risk management[1] and research [Ekaterinoslavsky et al., 2010; Green, 2016] allowed us to consider various formulations of the definition of risk and, based on the definitions presented, to conclude that the risk includes many aspects:

– the possibility of occurrence of an event;
– the probability of occurrence of an event;
– the event may affect the results of economic activity, the implementation of strategies;
– an event can be both a potential threat and an opportunity for development.

Based on the results of the analysis, the definition used in the work was formed: risk is the impact of uncertainty on the achievement of goals, where the influence of uncertainty means a deviation from the expected result or event (positive and / or negative).

To date, in the world practice of risk management, an approach to standardisation and unification of the area of risk management has been established. There are various risk management standards that involve managing the risks of industrial organisations according to certain algorithms. There are also a number of documents describing risk management in project implementation.

It should be noted that the goals can be different in content (in the field of the financial condition of the organization, reputation, ecology, etc.) and purpose (strategic, organisational, related to the development of the project, specific products and process)[2].

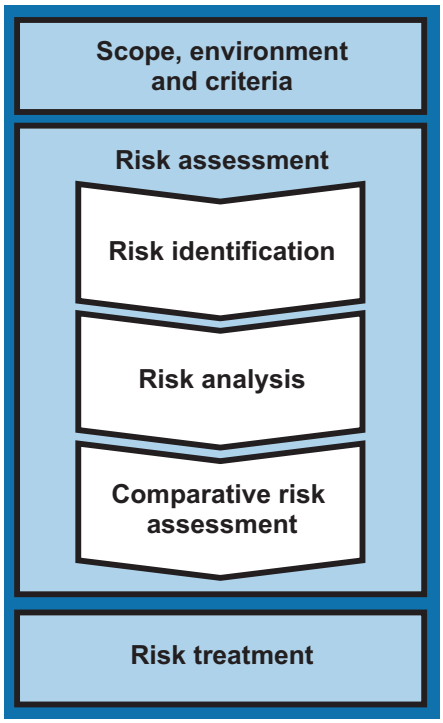
The ISO 31000:2018 Risk management – Principles and guidelines was taken as the basis for the risk management standard in this study. This standard forms a methodological basis for risk analysis[3].

Risk management involves risk management within the framework of the full process (cycle) of risk management, presented in Fig. 1.

Definition of the scope. For risk analysis, it is necessary to determine the specifics of the area of analysis. One of the most important aspects are the factors of the external and internal environment that affect the object under study. When analysing, it is important to understand in what external and internal conditions the subject operates, including:

– the external environment associated with doing business, social and environmental activities, legal and regulatory requirements, cultural factors, competition, financial situation and government policies at the international, national, regional or local levels;
– key trends and motivations that affect the achievement of the objectives of the organisation or project;

Fig. 1. Diagram of the risk management cycle



Source: Compiled by the author based on ISO 31000:2018.

– the significance of external stakeholders and their perception of risk.

It is equally important to determine the internal features:

– the organisation's capabilities in terms of resources and information in the area of risk;
– information flows and decision-making processes;
– internal stakeholders;
– the goals and objectives of the organisation, as well as the strategies needed to achieve them;
– the organisation's perception of the risk and its significance to the organisation;
– policies and processes of the organisation;
– standards and applied comparative models adopted by the organisation;
– organisational structures (eg management systems, distribution of functions and responsibilities).

The object of risk analysis in this work is the implementation of infrastructure projects for the development of railway transport hubs. As noted earlier, the main goal of implementing such projects is to increase the socio-economic

[1] Enterprise risk management – Integrated framework Committee of Sponsoring Organizations of the Treadway Commission (ERM-COSO) (w.y.). https://www.coso.org/Pages/default.aspx.
ISO 31000:2018. Risk management – Principles and guidelines. http://www.iso.org/iso/catalogue_detail%3Fcsnumber=43170.
Risk management standard – Federation of European Risk Management Association (RMS-FERMA). https://www.ferma.eu/.
GOST R 51897-2011. Risk management. Terms and Definitions. M.: Standartinform, 2011.
[2] http://www.iso.org/iso/catalogue_detail%3Fcsnumber=43170.
[3] Id.

level of development of territories, expressed in improving the level of services for consignors and consignees, increasing business activity in the project implementation region, increasing wages and living standards, reducing emissions of harmful substances and the level noise and other direct and indirect effects.

Thus, the external environment for the implementation of infrastructure railway projects is formed by a wide list of stakeholders. These are, for example, regional authorities that decide on the need to implement an infrastructure railway project, regulatory authorities, as well as business and business entities of the region, together with residents and workers whose well-being is directly affected by the implementation of the project.

The internal environment consists primarily of companies developing an infrastructure project and subsequent supervision of its implementation, employees implementing these projects, the equipment and software systems used that form the architecture of the railway network.

Risk identification. The purpose of risk identification is to find, recognise and describe risks that can help or hinder system participants from achieving their goals. When performing identification, the following factors and the relationships between them should be taken into account:

- material and non-material sources of risk;
- causes and events;
- threats and opportunities;
- vulnerabilities and abilities;
- changes in the external and internal environment;
- indicators of emerging risks;
- the nature and value of assets and resources;
- consequences and their impact on the objectives;
- limited knowledge and reliability of information;
- factors related to time;
- prejudices, assumptions and beliefs of the persons involved (stakeholders).

At the same time, in order to identify the risk, it is extremely important to correctly determine the external and internal environment of the organisation. The study of the organisation's external environment may include, but is not limited to:

- social, cultural, political, legal, regulatory, financial, technological, economic and environmental factors at the international, national, regional or local levels;
- the main factors and trends affecting the objectives of the organsation;
- relationships with external stakeholders (stakeholders), their perceptions, values, needs and expectations;
- contractual relations and obligations;
- the complexity of existing relationships and dependencies on external stakeholders.

The study of the organisation's internal environment may include, but is not limited to:

- vision, mission and values;
- management;
- management, organisational structure, roles and responsibilities;
- strategy, goals and policies;
- the culture of the organisation
- standards, directives and models adopted by the organisation;
- capabilities, available resources and accumulated knowledge (e.g. capital, time, people, intellectual property, processes, systems and technologies);
- data, information systems and information flows;
- relationships with internal stakeholders, taking into account their opinions and values;
- contractual relations and obligations;
- interdependencies and relationships.

Brainstorming, structured and semi-structured interviews, the Delphi method, scenario analysis, consequences and probability matrix, Ishikawa diagram, etc. can be used as risk identification methods.[4]

For the purposes of this work, the next section will review materials on the implementation of railway infrastructure projects in Russia and the world for the primary identification of risks, as well as in-depth interviews with experts for risk verification.

After verification and formation of the risk register, an assessment will be carried out on a sample of experts in order to determine the strength of the impact of risks and develop measures to reduce them.

2. Risk identification

For primary identification, the risks associated with the implementation of measures to develop the railway infrastructure were analysed based on analytical reviews of consulting companies [Overview of the freight transportation industry.., 2018; Transport infrastructure.., 2019; COVID-19.., 2020] and scientific research [Vardomsky, Turaeva, 2018; Vinokurov et al., 2018a, Kuzmin, 2020; Nalbandyan, Khovalova, 2020]. In order to further assess and develop recommendations to reduce the negative impact of possible risks, risks were identified that affect both the implementation of infrastructure railway projects and the achievement of socio-economic effects from implementation.

1. Risks from the demand side for rail freight and passenger transportation services. This type of risk is significant for the revenue side of infrastructure projects for the development of railway networks, as it has a direct impact on the revenue side and payback.

The risk of growth in the cost of transportation due to the growth of transport tariffs. At the moment, the tariff

[4] http://www.iso.org/iso/catalogue_detail%3Fcsnumber=43170.

system is relatively inflexible, and the tariffs are quite high (including in comparison with road transport). There is also a lack of adaptation of the tariff to demand.

In addition, there is a negative impact from increased fees for transportation in special containers, which repels a significant part of shippers from choosing rail transport. The above factors reduce the competitiveness and attractiveness of railway transport in comparison with other types.

The risk of reduced mobility of the population. One of the factors that significantly affected the transport and logistics industry in 2020 was the spread of a new coronavirus infection COVID-19. To slow the spread of the disease, restrictions on movement, stay in offices, and strict social distancing rules were introduced. In the transport and logistics industry, these restrictions have led to disruptions in a wide range of areas:

- Violation of operating modes of taxis, buses, metro, commuter trains and long-distance trains;
- complicating operational activities due to the transfer of part of the staff to a remote work mode, as well as ensuring social distancing measures;
- the emergence of barriers and restrictions in cargo transportation, a decrease in the volume of transported goods due to disruption of companies in global supply chains [COVID-19.., 2020].

In addition to reducing the mobility of the population at the time of the COVID-19 outbreak, the forced measures to organise remote work significantly accelerated the digitalisation of many sectors of the economy and made it possible to introduce the technologies necessary for remote work in a wide range of companies.

The result of surveys of the leaders of the largest companies showed that the impact of COVID-19 will have long-term consequences: 61% of experts believe that the digitalisation and automation stimulated by the pandemic will inevitably lead to a decrease in the number of employees in offices and, as a result, a decrease in the volume of commuting.

The trend towards a decrease in the mobility of the population has aggravated due to the complication of the external geopolitical situation and the introduction of restrictions on crossing borders.

Risk of insufficient level of cargo traceability. When sending cargo, there is currently no way to track it along the way, and even more so to track its condition, which negatively affects the safety of cargo transportation. The optionality of location tracking systems increases the risk of theft and breach of property.

The impact of this risk can be reduced through the implementation of satellite navigation, as well as industry 4.0 technologies, such as:

- Blockchain (facilitating transactions and increasing transparency of the supply chain);
- Internet of things (tracking the location of the shipment and its status);
- Big Data analysis [Overview of the industry.., 2018].

Similar traceability issues are seen with trucking companies. In the current regulatory legal framework of the Russian Federation, equipping road transport with navigation and tracking systems is necessary only for trucks carrying dangerous and special goods, bulky goods, as well as municipal solid waste.

The risk of increased resource intensity of transportation and transport costs. During the implementation of the measures provided for by the infrastructure project, a number of irrational decisions can lead to increased costs both during the implementation of the project and during subsequent operation. Also, an increase in the resource intensity of transportation and transport costs is possible in the event of a change in prices for the maintenance and operation of rolling stock, an increase in the cost of services of co-contractors for freight and passenger transportation, as well as changes in prices for the operation and repair of infrastructure facilities.

This risk is exacerbated by the unstable macroeconomic environment. To date, the most probable and severe risks are noted in the part of the high-tech equipment markets. Strengthening international competition in these markets, a shortage of some products (for example, silicon semiconductors), as well as sanctions restrictions can undermine procurement chains and lead to a number of serious consequences for the development of Russian industries, including shifting the implementation time of some projects “to the right”, reducing the profitability of these projects or even making it impossible to implement them.

The combination of the above listed factors can lead to a decrease in the level of competitiveness, a reduction in the volume of passenger and freight traffic and, as a result, a decrease in economic and social effects.

The risk of disproportion in the pace and scale of the development of road transport. Road transport plays a significant role in both passenger and freight traffic, and is one of the main drivers of socio-economic development in the regions along with rail transport.

The main number of movements occurs within the region, which is home for residents. The Central transport hub is characterised by the phenomenon of pendulum migration due to trips between Moscow and the cities of the Moscow region. Commuter travel is followed by trips to nearby regions [Linder, Litvin, 2020].

Pipeline and railway transport prevails in the volume of cargo turnover of the Russian Federation: cars occupy the 3rd place (4.6% of cargo turnover in 2018), significantly lagging behind the indicators of railway transport (46.1% of cargo turnover in 2018).

A study by the Center for Infrastructure Economics (hereinafter – CIE) notes that the motorisation trend can be described by an S-shaped logistic curve, where the level of saturation is determined by the characteristics of the regional infrastructure.

For 2018, the level of motorisation in the Moscow region was estimated at 300 cars per 1000 people, which is lower than the level of European countries, where motorisation reaches values of 500-550 cars. Thus, the saturation level has not yet been reached, and the level of motorisation will continue to grow. However, the work of the CIE revealed that the explosive growth rate has already been passed (and fell on the period from 2000 to 2017) and further average annual growth rates should be expected at the level of 2.2% [Transport infrastructure.., 2019].

Thus, despite the growth in motorisation and the use of cars for passenger and freight transport, the scale of this development will be relatively small.

The risk of increasing the competitiveness of air transportation and trucking. In addition to the previously mentioned inflexible and relatively high level of tariffs leading to the loss of part of the volumes on the short and medium leg, there is a threat of increased competition from air carriers and road carriers, including dumping by road carriers in the presence of the possibility of tax evasion and going into the shadow zone.

2. The risk of a shortage of qualified personnel. A low level of competencies, violations of discipline, etc. can seriously reduce not only the level of the development of an infrastructure project and its implementation, but also the quality of services provided and the level of maintenance of the railway infrastructure after the completion of the project. The innovative and technological development of the industry also requires an influx of highly qualified personnel [Trachuk, Sayapin, 2014].

3. Financial risks. These risks are caused by an underestimation of the required amount of financing, an increase in interest rates for replacement funds, a decrease in the availability of financing [Trachuk, Linder, 2016] and are inherent in infrastructure projects in themselves, however, they are increasing due to an unfavorable macroeconomic environment.

Risk of reduced or no private investment. The development of railway infrastructure can be carried out more efficiently through the organisation of public-private partnerships. However, the timing of the implementation of activities is relatively long, and the uncertainty is high. The combination of these factors can scare away private investors and lead to a reduction in funding to cover the costs of infrastructure development measures [Linder, Arsenova, 2016].

Risk of reduced public investment in railway infrastructure. However, in addition to the risk of not attracting private investment, there is a risk of reducing public investment.

4. Risk of infrastructure restrictions. The obsolescence of infrastructure facilities, the irrationality of their location, the inconvenience of use and the lack of multimodal opportunities can significantly reduce the socio-economic effects of the development of railway networks. An outdated and inefficient infrastructure leads to a decrease in the speed of cargo handling, an increase in the waiting time for shippers and consignees, a decrease in the speed of movement, reliability and safety of transportation, which will lead to customer dissatisfaction and a decrease in traffic volumes.

To verify the identified risks and form the Risk Register for the implementation of infrastructure projects for the development of railway transport hubs, preliminary telephone interviews were conducted with 15 experts implementing infrastructure solutions in the field of railway tracks and hubs, regional authorities, and consulting agencies.

In this case, the experts meet one of the following criteria:

1) the expert occupies a managerial position in a subdivision of an organisation engaged in the implementation of infrastructure projects for the development of railway transport hubs;
2) the expert is a competent consultant specialising in railway infrastructure projects;
3) the expert is a representative of the regional authorities responsible for the implementation of railway infrastructure projects.

Based on the results of the interview, a Register of Risks for the Implementation of Infrastructural Projects for the Development of Railway Transport Hubs was formed (Table 1).

Thus, a list of the main risks inherent in projects for the development of railway networks has been formed, and the factors leading to the realisation of these risks have been compiled. The next step in the study will be to assess the strength of the impact of these risks on the success of the implementation of infrastructure projects.

3. Assessment of the power of risk influence

To further assess the power of risk influence from the Register of Risks for the Implementation of Infrastructure Projects for the Development of Railway Transport Hubs, a quantitative analysis was carried out.

After verification of the model and the questionnaire, the questionnaires were sent to 195 experts selected according to the qualification criteria given in the previous section. 123 experts responded, the response to the questionnaires was 63%. Such a percentage of response and the size of the final sample can be considered a good result, sufficient to build a regression equation. The characteristics of the sample are presented in Table. 2.

Table 1
Register of risks for the implementation of infrastructure projects for the development of railway transport hubs

№	Name of risk	Risk factors
1. Demand-side risks for rail carrier services		
1.1	Risk of growth in transportation costs	High level of tariffs
1.2	The risk of reduced mobility of the population	Lack of dynamic pricing
1.3	Risk of insufficient level of cargo traceability	Increased fees for the transportation of certain goods
1.4	Risk of increased resource intensity of transportation and transport costs	Increasing the share of remote employees, reducing commuting
1.5	The risk of disproportion in the pace and scale of development of road transport	Reduced mobility as a result of the pandemic
1.6	The risk of increasing the competitiveness of air transportation and trucking	Reduced mobility due to external macroeconomic pressures
2. Risk of shortage of qualified personnel		
2.1	The risk of a shortage of qualified personnel in the implementation of the project	Lack of competencies for the development of an infrastructure project
2.2	Risk of shortage of qualified personnel during operation	Lack of competencies to oversee the implementation of an infrastructure project
3. Financial risks		
3.1	Risk of reduced or no private investment	Implementation timelines are relatively long and uncertainty is high, discouraging private investors
3.2	Risk of reduced public investment	Decrease in public investment due to potential reduction in funding for infrastructure projects
3.3	Other financial risks	Growth in interest rates on debt financing
4. Risk of infrastructure restrictions		
4.1	Risk of infrastructure facilities inefficiency	Irrational location of infrastructure facilities
4.2	Risks of lack of multimodal opportunities	Inconvenience of using infrastructure facilities

Table 2
Sample characteristic

Characteristics of the respondents	Number of respondents (persons)	Share of respondents (%)
Age of the company implementing infrastructure projects:		
less than 5 years	25	20
from 5 years to 10 years	37	30
over 10 years	27	22
Consulting companies	19	16
Regional authorities in the field of transport	15	12

Source: compiled by the author.

Respondents were asked to fill out questionnaires based on the Likert scale with steps from 1 to 5, where 1 - the risk did not have a significant impact on the effectiveness of the implementation of the infrastructure project, 7 - the risk had a critical impact on the implementation of the infrastructure project.

In order to perform a quantitative analysis and calculate the strength of the influence of the risks of implementing infrastructure projects for the development of railway transport hubs, a regression equation was formed:

$$Y=\beta_0+\beta_{1.1}\times Mark_1+\ldots+\beta_{1.6}\times Mark_6+\beta_{2.1}\times Comp_1+\beta_{2.2}\times Comp_2+ +\beta_{3.1}\times Fin_1+\ldots+\beta_{3.3}\times Fin_3+\beta_{4.1}\times Infr_1+\beta_{4.2}\times Infr_2+\varepsilon_i. \quad (1)$$

The list of variables described in the specification of the regression model is given in Table. 3.

Based on the results of the regression analysis, the forces of influence of risks from the Register of risks of the implementation of infrastructure projects for the development of railway transport hubs on the achievement of socio-economic effects from their implementation were assessed. The results of the quantitative stage of the study are given in Table. 4.

Thus, the analysis made it possible to assess the strength of the influence of the risks of implementing infrastructure projects for the development of railway transport hubs on the achievement of socio-economic effects from their implementation. The next step in the study is to analyse the obtained forces of influence and develop recommendations for reducing risks.

4. Risk Mitigation Recommendations

In the group of risks from the side of demand for railway freight and passenger transportation services, the risk of increasing the competitiveness of air transportation and road transportation has the greatest influence ($\beta_{1.6}$ = 0.423). OHowever, despite its high power of influence, the competent implementation of infrastructure railway projects can be the most effective measure to mitigate it. Based on this, the main ways to manage this risk can be: the introduction of a more flexible tariff system, increasing the attractiveness of railway

Table 3
List of regression model variables

Risk category	Variable	Characteristic of the variable
–	Y	The resulting indicator characterising the socio-economic effect from the implementation of infrastructure projects for the development of railway transport hubs
Demand-side risks for rail carrier services	$Mark_1$	Risk of growth in transportation costs
	$Mark_2$	The risk of reduced mobility of the population
	$Mark_3$	Risk of insufficient level of cargo traceability
	$Mark_4$	Risk of increased resource intensity of transportation and transport costs
	$Mark_5$	The risk of disproportion in the pace and scale of development of road transport
	$Mark_6$	The risk of increasing the competitiveness of air transportation and trucking
Risk of shortage of qualified personnel	$Comp_1$	The risk of a shortage of qualified personnel in the implementation of the project
	$Comp_2$	Risk of shortage of qualified personnel during operation
Financial risks	Fin_1	Risk of reduced or no private investment
	Fin_2	Risk of reduced public investment
	Fin_3	Other financial risks
Risk of infrastructure restrictions	$Infr_1$	Risk of infrastructure facilities inefficiency
	$Infr_2$	Risks of lack of multimodal opportunities

Source: compiled by the author.

Table 4
The strength of the impact of the risks of implementing infrastructure projects for the development of railway transport hubs

Independent indicators	Nonstandardised Coefficients	Standardised Coefficients
Constant (β_0)	0.201 (0.019)	
Demand-side risks for rail carrier services		
Freight cost risk $Mark_1$	0.356** (0.085)	0.382**
The risk of reduced mobility of the population $Mark_2$	0.302*** (0.078)	0.333*
Risk of insufficient level of cargo traceability $Mark_3$	0.258** (0.063)	0.264**
Risk of increased resource intensity of transportation and transport costs $Mark_4$	0.287** (0.056)	0.291**
The risk of disproportion in the pace and scale of development of road transport $Mark_5$	0.097** (0.015)	0.101**
The risk of increased competitiveness of air and road transport $Mark_6$	0.423* (0.116)	0.446**
Risk of shortage of qualified personnel		
The risk of a shortage of qualified personnel in the implementation of the project $Comp_1$	0.325** (0.082)	0.364***
Risk of shortage of qualified personnel in operation $Comp_2$	0.278** (0.063)	0.286***
Financial risks		
Risk of reduced or no private investment Fin_1	0.367** (0.094)	0.385**
Risk of reduced public investment Fin_2	0.452*** (0.103)	0.501***
Other financial risks Fin_3	0.621** (0.124)	0.639***
Risk of infrastructure restrictions		
Infrastructure risk $Infr_1$	0.434** (0.099)	0.457**
Risks of lack of multimodal opportunities $Infr_2$	0.359** (0.087)	0.380*
Adjusted R^2	0.735	
Number of observations	123	

Note. * – $p < 0.10$; ** – $p < 0.05$; *** – $p < 0.01$. Standard errors are given in parentheses.
Source: compiled by the author.

transport in the eyes of the consumer through infrastructure modernisation, improving the quality of service and the speed of transportation.

The need to introduce a flexible system of tariffs is also confirmed by the high impact of the risk of growth in the cost of transportation due to the growth of transport tariffs ($\beta_{1.1} = 0.356$). This risk can be managed by timely interaction with the federal executive authorities in the field of tariff regulation, as well as by changing the tariff system to ensure greater flexibility and timely response to the market situation.

The risk of reduced mobility of the population has a moderate influence ($\beta_{1.2} = 0.302$). At the same time, it seems possible to reduce this risk only by increasing the attractiveness, reliability and convenience of using rail transportation relative to other transport.

Also, the risks of insufficient level of cargo traceability ($\beta_{1.3} = 0.258$) and the risk of increasing the resource intensity of transportation and transport costs ($\beta_{1.4} = 0.287$). have a moderate influence. Based on this, when implementing infrastructure projects for the development of the railway network, it is necessary to ensure the implementation

of tracking systems in railway networks. In addition to containing the risk of theft and damage to property, this measure will increase competitiveness in comparison with road carriers. Planning costs, taking into account possible changes in the cost of resources for the operation and repair of railway networks and rolling stock, can significantly reduce the risk of increasing the resource intensity of transportation and transport costs ($\beta_{1.5} = 0.097$). Since, despite the growth in motorisation and the use of cars for passenger and freight transportation, the scale of this development is relatively small, the development of rail transport, railway infrastructure, as well as improving the convenience and safety of using railway networks can reduce the risks from the spread of road transport.

In the group of risks of a shortage of qualified personnel, both risks have a moderate impact: $\beta_{2.1} = 0.325$ for the risk of a shortage of qualified personnel during project implementation and $\beta_{2.2} = 0.278$ for a shortage of qualified personnel during operation.

As measures to manage the last risk, the development of a personnel motivation system, increasing the comfort of working conditions, conducting career guidance, as well as increasing the level of employee discipline can act.

To minimise the first risk, it may be useful to strengthen interaction with representatives of consulting companies, since they have a wider expertise in designing railway junctions as parts of urban and agglomeration infrastructure, which allows choosing the most effective implementation paths when developing infrastructure solutions and leading to greater public satisfaction regions where these projects are being implemented.

In addition, the risk of staff shortage in the long term can be reduced through cooperation with flagship universities for the railway industry.

The group of financial risks has the greatest power of influence. Other financial risks received the highest rating ($\beta_{3.3} = 0.621$), due to the current macroeconomic situation. The risks of reducing private ($\beta_{3.1} = 0.367$) and state ($\beta_{3.2} = 0.452$) funding received comparatively lower estimates. A public-private partnership programme can become the most effective tool for reducing the risks of a funding gap, since it is this model that makes it possible to achieve a synthesis of the competencies of private investors and their experience with the ability of the state to provide subsidies, benefits, targeted financing or other assistance that allows to achieve maximum efficiency in the implementation of infrastructure projects.

Attracting private investors can be more successful if the state is involved as a guarantor and facilitator in the course of implementing the activities envisaged by the project. The state is able to create favorable conditions and support for investors in the form of access to infrastructure, easing the tax regime and providing bank guarantees.

It is also necessary to interact with the relevant federal executive authorities as part of the justification of the economic and social feasibility of the project being implemented.

The risks of infrastructure restrictions have a moderately high impact force: $\beta_{4.1} = 0.434$ – for the risk of inefficiency of infrastructure facilities and $\beta_{4.2} = 0.359$ – for the risk of lack of multimodal opportunities. These values emphasise how important it is for the implementation of infrastructure development projects to correctly introduce new transport hubs into the existing infrastructure, while simultaneously expanding the possibilities of multimodal interaction. It is also important to provide railway networks with digital binding, which will increase their convenience, efficiency and transparency for users.

Conclusion

Infrastructural projects for the development of railway transport hubs are among the most important for increasing the level of socio-economic development of the territories. At the same time, due to the high capital intensity and complexity of implementing such projects, including under conditions of external geopolitical pressure, they are associated with a wide range of risks. In this study, risks were identified in the implementation of infrastructure projects, the identified risks were assessed and recommendations were made to reduce them.

At the first stage, the risk management methodology was described, as well as the main stages of the study, their content and methodological background. Further, by analysing the literature and conducting in-depth semi-structured interviews, a list of risks inherent in infrastructure projects for the development of railway transport hubs was formed. 13 risks were identified, divided into four groups: risks from the demand side for services, risks of a shortage of qualified personnel, financial risks and risks of infrastructure inefficiency. Then a quantitative analysis was carried out through a survey of experts, which made it possible to determine the strength of the influence of the identified risks on the achievement of positive socio-economic effects.

At the end of the work, a list of recommendations aimed at reducing risks and facilitating the maximisation of positive socio-economic effects is presented.

References

Vardomsky L.B., Turaeva M.O. (2018). *Development of transport corridors of the Post-Soviet space in the context of modern geopolitical and economic challenges* (scientific report). Moscow, Institute of Economics RAS. (In Russ.)

Vinokurov E.Yu., Lobyrev V.G., Tikhomirov A.A., Tsukarev T.V. (2018a). *Transport corridors of the Silk Road: The potential for growth in cargo flows through the EAEU*. Report No. 49. St. Petersburg, The Eurasian Development Bank. https://eabr.org/analytics/integration-research/cii-reports/transportnye-koridory-shelkovogo-putipotentsial-rosta-gruzopotokov-cherez-eaes/. (In Russ.)

Vinokurov E.Yu., Lobyrev V.G., Tikhomirov A.A., Tsukarev T.V. (2018b). *Transport corridors of the Silk Road: Analysis of barriers and recommendations for the direction of investment*. Report No. 50. St. Petersburg, The Eurasian Development Bank. https://eabr.org/upload/iblock/304/EDB-Centre_2018_Report-50_Transport-Corridors_Barriers-and-Investments_RUS.pdf. (In Russ.)

Ekaterinoslavskij Yu.Yu., Medvedeva A.M., Shchenkov S.A. (2010). *Business risks: Diagnostics, prevention, management.* Moscow, Ankil, 2010. (In Russ.)

Kuznetsova M.O. (2020). Strategic sustainability of industrial companies: Approaches to understanding and risk analysis. *Strategic Decisions and Risk Management*, 11(2): 196-205. (In Russ.)

Kuzmin P.S. (2020). Possibilities of increasing the competitiveness of rail freight transportation along the transport corridors of the Russian Federation. *Strategic Decisions and Risk Management,* 11(2): 160-171. DOI 10.17747/2618-947X-2020-2-160-171. (In Russ.)

Linder N.V., Arsenova E.V. (2016). Instruments for stimulating innovative activity of holdings in industry. *Scientific Works of the Free Economic Society of Russia,* 198(2): 266-274. (In Russ.)

Linder N.V., Kuznetsova M.O. (2020). Interaction with stakeholders as a factor of increasing the competitiveness of Trans-Eurasian container rail freight along transport corridors: Results of an empirical study. *Modern Competition,* 14, 3(79): 89-105. (In Russ.)

Linder N.V., Litvin I.Y. (2020). Improving the competitiveness of trans-eurasian container rail cargo transportation along transport corridors from the far east to the western border of the Russian Federation. *Innovative Development of the Economy,* 4-5(58-59): 110-113. (In Russ.)

Nalbandyan G.G., Khovalova T.V. (2020). Identification of barriers to the use of digital platforms by SMEs and development of proposals for overcoming them. *RISK: Resources, Information, Supply, Competition,* 4: 104-108. (In Russ.)

Overview of the cargo transportation industry in Russia (2018). EY Company. https://assets.ey.com/content/dam/ey-sites/ey-com/ru_ru/topics/automotive-and-transportation/ey-overview-of-the-cargo-industry-in-russia.pdf. (In Russ.)

Evaluation of large infrastructure projects. Tasks and solutions. Developments within the framework of the projects of the Center for Strategic Research (2013). Moscow, Foundation “Center for Strategic Research”. https://www.rzd.ru/api/media/resources/c/1/121/71717?action=download&ysclid=lbgw6i6bcw498247297. (In Russ.)

Transport infrastructure and economic growth: Report of Center for Infrastructure Economics (2019). Moscow, Pero. (In Russ.)

Trachuk A.V., Linder N.V. (2016). Liquidity limitation influence on industrial companies’ investments in investigations and development and effectiveness of innovative activity. *Strategic Decisions and Risk Management,* 1: 80-89. https://doi.org/10.17747/2078-8886-2016-1-80-89. (In Russ.)

Trachuk A.V., Sayapin A.V. (2014). Practice of forming innovation strategy in Russian companies. Personnel involvement experience. *Strategic Decisions and Risk Management,* 1: 64-73. https://doi.org/10.17747/2078-8886-2014-1-64-73. (In Russ.)

Tsypleva N. (2017). Speed is a Priority. *Gudok [Beep]*, 155(26294), September 6. http://www.gudok.ru/newspaper/?ID=1385773&archive=2017.09.06. (In Russ.)

COVID-19. Challenges and their impact on the transport and logistics sector (2020). Roskongress, June 20. (In Russ.)

D'Acci L. Monetary, subjective and quantitative approaches to assess urban quality of life and pleasantness in cities (Hedonic price, willingness-to-pay, positional value, life satisfaction, isobenefit lines) (2014). *Social Indicators Research,* 115: 531-559. DOI: 10.1007/s11205-012-0221-7.

Green P.E.J. (2016). E*nterprise risk management: A common framework for the entire organization.* Oxford, Butterworth-Heinemann.

Value of rail: The contribution of rail in Australia: A report commissioned by the Australasian Railway Association (ARA) (2017). Deloitte Touche Tohmatsu, November.

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