

The Use of Information and Communication Technologies in the Improvement of Logistics Solutions for the Transport of Coal

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Abstract:

The article describes the basics of coal transportation by rail in the Russian Federation. As a result of the study, barriers were identified, growth points were identified in the area of improving logistics solutions. It is shown that the main direction of solutions to problems in the field of coal transportation is the organization of transportation, which, however, can be solved by applying modern information and communication technologies. The authors emphasize the importance of the adopted decisions of the President and the Government of the Russian Federation in terms of the implementation of railway digitalization projects. The analysis of the prospects for the implementation of a digital approach to the optimization of logistics solutions for the transport of coal according to the methods of benefit-threat. The main environmental factors that shape the field of risk scenarios in the development of the coal industry in Russia are identified. As a result of the study, conclusions were formulated, the main directions of technical development were determined, the potential of their use in improving the client-oriented approach to the transport of coal by rail was clearly demonstrated.

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INTRODUCTION

Currently, energy is a multiplier of economic growth and the basis for the formation of industries. That's why, today in the world there is an increase in energy consumption. Coal is no exception. In this regard, there is a change and complication of the logistic processes of coal transportation. It is worth noting that this issue is described in the works of various scientists. Note that most of the publications are currently aimed at addressing the issues of coal consumption in China (PRC). As we can see at (Shealy and

Dorian, 2010), this is due to the growth of the economy and industry of China. Coal consumption is an important component of the development of China's energy sector, with which up to 80% of the country electricity is garnished. Moreover, immediate forecasts indicate that this need will only grow, which is explained by the very peculiarity of the energy structure of China and the distribution of its coal resources, which makes the transportation of coal a very important component of the energy system; at

the same time, coal transportation is a bottleneck for the Chinese economy (Kozan and Liu, 2012). To ensure the security of coal supplies, China has begun to create regional strategic coal reserves in some places, but transportation is still the main way to guarantee the security of supplies. At the same time, the necessary volume of supplies in the context of each province of China is the task of ensuring the energy security of the entire state. In this regard, important challenges are: firstly, the expansion of the carrying capacity of the national railway network, and secondly, the development of the transit potential of the main marine artery - the Yangtze River (Wan and Li, 2018).

It can be concluded that the structure of the choice of mode of transport for coal transportation is somewhat different from the experience of the PRC (Mou and Li, 2012). In particular, road transport plays an important role. The main logistical problem here is the issue of coal transportation costs. This is because the cost of transportation by road.

In the UK (another important player in the European energy market), the main mode of transport for coal transportation has long been rail. At the same time, problems arise in the functioning of transport systems related to the efficient use of the fleet of wagons, as well as in the field of operational management, technology for organizing transportation.

The development of the coal industry is an important aspect in the field of energy security in the Russian Federation. Coal The most important task for the transport system is to meet the needs of the regions. The geography of transportation depends on the location of the main production areas that have been removed from the places of final consumption: the Kuznetsk basin, Kansk-Achinsky, East Siberian, Far Eastern, Pechora.

Currently, rail is freight transport. At the same time, the process of organizing coal transportation is inefficient. Among the negative factors, the following should be highlighted:

- Shortage of transport opportunities
- Empty runs
- Outdated rolling stock
- Low efficiency of existing supply chains
- Weak organization of the process as a whole

An example of the organizational difficulties of the delivery process is the coal industry of the Kemerovo region. The region has been facing difficulties for several years in organizing the export of its products. In this case the problems are both organizational and infrastructural in nature. Mining companies' warehouses are full of coal. However, the existing management of them paradoxically does not allow to solve a specific economic problem.

As analysis has shown, all the world's "coal" powers have common difficulties associated with both the extraction and transportation of coal. One of the large shipments is ecology. Coal generation has become an open source of carbon in China (Yu et al., 2014). Currently, studies are underway to study factors affecting the carbon content in coal energy chains. The results show that China's air emission factor is 875 g / kW h-1, which is relatively low compared to other countries. Electricity consumption in the process of coal mining allows for carbon emissions in coal energy chains (Rioux et al., 2016). In addition, China should promote the construction of rail transportation in coal transportation (Cao and Cao, 2017). In this regard, an important task is the modeling of coal in a low-carbon transition. With the help of digital transformations. Coal transportation plays an

important role in the comprehensive development strategy of the provinces of China. Low economic development leads to a decrease in coal transportation by at least 48% by 2050 (Özfirat et al., 2017; Li and Chen, 2018). Meanwhile, the general coal transportation scheme will be simplified and concentrated. This amounts to 1,537.87.787 billion ton-kilometers per year by 2050 (-44). In addition, the low-carbon transition will also contribute to the transformation of power generation structures. In general, the amount of air emissions, according to 2010-2050, will decrease by 28% below. This strategy also requires the development of green corridors (Aditjandra et al., 2016). A similar direction is actively developing today, in particular in the European Union (EU), in which the development of transport systems is carried out in the framework of the concept of clean, clean and the use of transport. This strategy has received EU support. The strategy includes the development of the railway freight transportation system, the improvement of railway transportation points, the construction of vehicles, the growth of train productivity, their energy consumption, and the management of multimodal corridors. Such “green corridors”, developed as strategic results, can be of universal importance for the competent management of rail transport and the development of the railway network.

The third important issue is the change in transport infrastructure based on the transformation of the coal consumption map. As can be seen from the analysis, the bulk of demand is concentrated in the Asia-Pacific region, while the Russian Federation is one of the most sought-after suppliers of this type of energy source. This economic situation presents high-quality and special requirements for the development of transport

infrastructure, as well as for the development of infrastructure in coal-consuming countries. There are currently bottlenecks in its transport infrastructure. These bottlenecks are likely to appear not only in the domestic coal market, but also in global coal markets. Unusual transportation costs lead to new consumers.

Rail transport is currently the most efficient way to transport coal, and the network of coal rail transport is now becoming more sophisticated. Nevertheless, there are still “basic” problems, transparency in the regulation of the fleet of cars, the construction of supply chains in the message. This procedure is one of the main ones. For this, they turned to the experience of China and Russia, where this problem is felt especially acutely. Largely due to the digitalization and implementation of decision support systems. Such a system allows not only real-time monitoring of customer needs, but also integration with the inventory, unloading and transportation management system. As a result, supply chains will appear, as well as customer requirements. The toolkit operates on the basis of a unique mathematical apparatus.

METHODS AND MATERIALS

Currently, coal is transported by various means of transport

- By car (in case of transportation over short distances);
- By rail (within the country, as well as in international traffic);
- By sea (transportation in international traffic).

In this case, the most popular and economically feasible is the use of transport, both in the domestic energy market, and when exporting products to the international market. This is due to the high operational

characteristics of railway transport with relative low cost.

The purpose of this study is the application of applied information and communication technologies to ensure the improvement of logistics operations during cargo transportation. To achieve the goal, the authors solved the following main tasks:

- Description of the Russian coal mining market as one of the main in the world;
- Determination of modern ways of transporting coal by rail;
- Description of bottlenecks and a description of problematic issues in coal transportation;
- Definition of end-to-end information technologies to improve logistics operations
- Development of the structure of “digital” transport and logistics
- Building models of the “causing threat” in the formation of digital transport and logistics.

The object of study is coal transportation in the railway system.

Subject of research: development of information and communication technologies in order to increase the efficiency of coal transportation by rail.

The research was based on publications in industry-specific scientific journals, information and analytical materials from the Ministry of Transport of the Russian Federation, the Federal State Statistics Service, materials from monographic studies of domestic and foreign scientists, periodicals, Internet data, and the author’s observations and conclusions from the study.

Methodological was based on methods of system and comparative analysis, expert estimates, statistical comparisons. The authors analyzed the problems associated with the transportation of coal. As part of the research,

the Russian regulatory framework was actively used.

Research and original research have improved the efficiency of logistics operations in the transport of coal, based on the use of modern digital technologies.

The practical significance of the study lies in the possibility of using the main results in the process of assessing the condition of vehicles in railway transport. The main conclusions of the article can be used in the work of carrier companies engaged in the freight transportation of energy resources both on the national market and in international traffic.

RESULTS

Achieving the effectiveness of managing coal transportation across the territory of the Russian Federation is possible only if there is complete information about the objects of management, as well as interaction with other transport, freight, information and financial flows on the basis of regulatory frameworks. In a modern economy, there should be not quantitative, but qualitative methods of work. Today it is a solution that allows you to increase efficiency, reduce costs, speed up the process of making managerial decisions. As a result of the study of the transport complex of the Russian Federation. The authors are convinced that the results will be useful for quality practical purposes and for other countries. Low decision-making speed, lack of reliable and timely information, problems in operating a fleet of cars, etc. Increasingly, they prefer road transport, despite the increasingly expensive and limited traffic volumes. Researchers have nothing to do with the problems associated with the carrier (usually studies are related to the energy potential of coal, as well as a description of a particular market). In addition, the study

emphasizes the client aspect, as well as the overall effect for the state as a whole.

Researchers examine in more detail the transportation process associated with the formation and optimization of the movement of logistic coal flows. It should be noted (table 1):

- the formation of coal transportation flows had an impact on the formation of the road network

- coal is a system-forming cargo for the development of the railway network, since it is not subject to competing factors, since it cannot be transferred for transportation to other modes of transport

- transport flows of coal mining products are characterized by large distances

- the infrastructure of the railway network for the main traffic does not provide the required traffic volume and the provision of coal consumption in different territories of the country.

Table1. Shortage of transport opportunities (Churashev, 2014)

Direction of transportation	Cargo deficit, million tons.	
Between the Far East and Eastern Siberia	37-40	
Between Eastern and Western Siberia	48-52	
Between Western Siberia and Ural	45-5	45-50

Another bottleneck is the topology of the railway network, which does not meet modern consumer requirements. In the existing transport paradigm, mobility is a service focused on the individual needs of the client (cargo owner, freight forwarder or passenger).

In addition, the industrial map of Russia has changed in recent years. New points of growth have arisen, some industrial centers have lost their former positions, markets have changed. This entailed a change in cooperative ties, a change in the supply chain.

Existing bandwidth and organizational capabilities are exhausted. The current situation requires a qualitatively different approach to the organization of the transportation process control system.

Thus, the solution of logistical problems in the transportation of coal requires an integrated approach, which consists in solving problems of an informational, technical, and logistical nature.

On December 1, 2016, Russia launched a large program of modernization of the country's economy aimed at digitalization. By decree of the President of the Russian Federation (Decree No. 642 of December 1, 2016), strategies for the country's scientific and technological development were approved. Among the main priorities, two mains are:

- intelligent manufacturing technologies, robotic systems;
- Intelligent transport systems to ensure the coherence of the territory of the Russian Federation;

The strategies described above will make it possible to talk about a national economic approach to economic management, the basis of which is balance, coordinated work of industries and regions. The task of which is to ensure the rational organization of transport and logistics centers, transport infrastructure in accordance with the requirements of the sectors of the real sector of the economy, primarily the mining industry.

An important milestone on this path is the order of the Government of the Russian Federation dated March 19, 2019 No. 466-r, which approved the six-year development program of JSC Russian Railways until 2025 (The Order of the Government of the Russian Federation, 2019). The document highlighted a number of key areas of digital transformation, among which, as applied to

the optimization of rail freight transport, the following can be distinguished:

- creation of a unified information space for freight transportation and logistics to increase the profitability of freight transportation and the logistics business;
- Formation of end-to-end digital technologies for organizing the transportation process (“Digital Railway”) to improve the efficiency of rail transportation and infrastructure

These areas of digital transformation will improve customer service by increasing the efficiency of planning and organizing logistics supply chains, eliminating empty runs, recording and monitoring cargo safety on the way, etc. The general structure of the digital railway is shown in Figure 1.

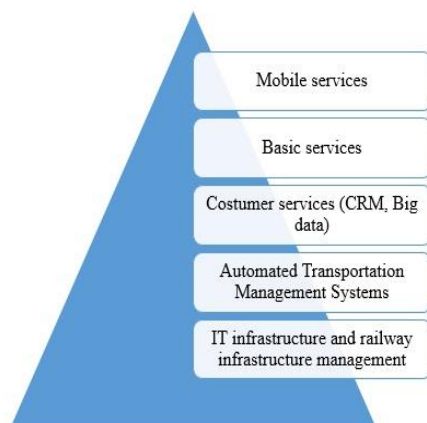


Figure 1. Digital Railroad Structure (A plan for the digital transition of Russian Railways was approved, 2019)

The digital railway will become part of a unified national system of digital transport and logistics, which will operate on the basis of the principles of international and synchronomodality, transparency, and transparency. The foundation of such a platform is service providers (aggregators), transport system operators.

In addition, each system will have a topology adapted to the conditions of the real environment. The configuration is determined not only by the type and nature of the

connection, but also by the transport and territorial framework of the territory (Figure 2). This is important for the Russian Federation, where it is possible to connect to the technological potential dispersed in the digital space.

The digital railway should only be part of the national digital transport and logistics system. Currently, about 8 functional platforms are being developed in Russia (freight and passenger transportation, transfer hubs, operational management of transportation processes, etc.). Time is in the phase of active development of about 53 industry transport projects. In total, today in Russia there are more than 8 billion records than 8,000 carriers from 139 countries of the world. In particular, decision support. To do this, it is advisable to begin processing the rear KPI transportation process. According to Russian Railways, the overall effect of implementing the strategy for using information and communication technologies will achieve an effect of 153 billion rubles (the result of the company), as well as about 400 billion rubles - an indirect effect for the state as a whole. The company uses technologies of robots and ERP-systems, which allows to increase the carrying capacity of railways by 15%.

Naturally, building a network topology for the effective functioning of the “digital” transport and logistics system has a comprehensive project (Governmental Decree of the Russian Federation, 2017), which requires consideration of factors and accumulations of a critical mass of interdisciplinary research. One of the important elements is standardization. The system allows you to improve the quality of the entire system as a whole. This practice will look like this: Best Practice - Protocol (Standard) - Improving Quality.

In general, the process of freight transportation in digital form will be carried out in two planes: topographic and virtual-technological, which definitely provides the construction of technological services. Moreover, the data exist flat, organically complementing each other (Webber, 2018; Zhang et al., 2019). At the same time, the principle of trust of digital information in transport is the basis of data exchange.

The network is part of a self-reproducing system, which at a certain stage will be independent and uncontrolled (industry integration and service bus of trusted interaction).

Digital processing of rail freight can be carried out both in quantitative and qualitative methods in planning and organization (Uddin and Huynh, 2019).

A) Quantitative. Include the application of mathematical models of cost-benefit analysis

B) Qualitative - interviews, seminars, methods of barrier analysis, brainstorming, crowdsourcing, benchmarking (assessment of factors contributing to and hindering the implementation of the project).

- Services
- Apps
- Soft
- Technologies
- Territory

It should also be noted that the process of organizing modern (digital) supply chains is associated with the emergence of a number of risk scenarios, among which the following stand out:

1. Foreign policy risks

A) Sanctions on the part of Western countries, reduction of cargo flows in this direction;

B) Redistribution of the supply chain from European countries in favor of the countries of the Asia-Pacific region (ATR) (Bagimov, 2013);

C) Exclusion of the East Donbass when organizing coal transportation for the Russian Federation;

2. Technical risks

A) Inadequate development of transport infrastructure

B) Difficulties in the digitalization process

C) Risks associated with the lack of technology for the extraction, processing and use of coal (Wang et al., 2018)

3. Logistic risks

A) The significant remoteness of coal deposits from the consumption market, the complexity in terms of the organization of the supply chain - geographical and climatic factors

B) Orientation to deliveries to the Asia-Pacific region (APR)

4. Environmental management

A) Legislation of the Russian Federation related to the environmental consequences of the use of coal as an energy source

B) State policy in the field of energy, regarding the use of coal.

As any project, the process of building and developing a system of “digital” transport and logistics must be considered from two perspectives: outputs from implementation; threats and difficulties, the occurrence of which is likely at the implementation stage (table 2).

Table 2. Benefits-threats from the implementation of a digital approach to the optimization of logistics solutions for coal transportation (developed by the authors as a result of the study)

Benefits	Threats	
	Type of Threat	Grade

Increased speed of transportation		(weight coefficient)
Ensuring the reliability and frequency of traffic	Information Security	1 (0,45)
Reduce losses and travel costs	Terrorist attacks on transport infrastructure	2 (0,25)
Creating innovative jobs	Limited funding	3 (0,2)
Development of the industry and skilled personnel	Bureaucracy Social restrictions	4 (0.1)

result of the implementation of the technical directions described above, it is possible to achieve a number of long-standing transport problems that create barriers to the development of the coal industry, as well as international energy logistics both in the Russian Federation and in various countries of the world.

An important aspect of increasing efficiency in the freight rail segment is technological improvement based on the use of digital technologies that create conditions for inter-rangeality, powerlessness, and a barrier-free transport environment, which is especially important for international transportation. This is achievable thanks to the successful implementation of the following technical areas (Figure 3)

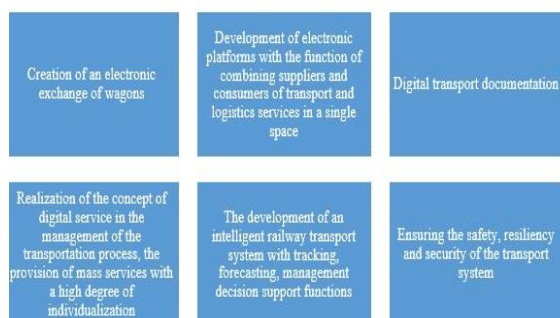


Figure 3. Directions of technical improvement of coal transportation by rail (developed by the authors as a result of the study)

Thus, the approach described in the study and the results obtained will allow us to apply fundamentally new logistic solutions. In particular, to provide customers with access to a single information and communication platform, to achieve greater transparency when carrying out rail freight transportation, to eliminate railroad downtime (Abadi et al., 2016; Cao and Cao, 2017), to increase the environmental component of transport by increasing the efficiency of the transportation process, reducing downtime and increasing the throughput of the iron network dear. As a

CONCLUSION

As analysis has shown, the modern process of transporting coal in various countries of the world is carried out by various modes of transport, the main of which is railway. At the same time, despite the national characteristics common in various countries of the world is the low efficiency of freight rail transport. Among the main problems it is worth noting: the lack and inaccuracy of information, the difficulties associated with the operation of the fleet of wagons, the low throughput of the railway network, organizational difficulties. International logistics also requires the provision of seamless, barrier-free transportation based on the principles of intramodality.

An effective tool for solving the problems described above may be the digital transformation of rail transportation. Moreover, this process is oriented both at the level of transport systems and at the level of a particular carrier company. In the case of the railway operator, the drivers are primarily ERP systems that enable the process of supporting management decision-making. In general, the quality of management today is the quality of information. In this regard, the most informed decision can be made only on the basis of reliable facts, promptly obtained directly from the transport system. Therefore, the digitalization of the transport system is equally important.

The national system of digital transport and logistics is a combination of regional, municipal, functional types of platforms that takes into account both transport systems by mode of transport and basic infrastructure (linear communications). The structure is a multilayer system that combines the issues of the territory (topographic factor), equipment, technologies, software, mobile applications and services.

The main technological areas in this case should be:

- Creation of an electronic exchange of wagons;
- Development of sites with the function of combining suppliers and consumers of transport and logistics services in one space;
- Electronic document management;
- Digital service;
- Intellectualization of transport systems;
- Ensuring security, reliability and trust.

An integral part of the national intellectual transport system is railway transport. The digital railway structure is a collection of platforms covering the following main modules (IT services, transportation services, customer services, management (infrastructure, data, transportation process).

Despite the obvious effect, the digital transformation of freight transportation will have the following risks: foreign policy, technical, logistics, environmental and management. An important aspect here is also information management. It is necessary to achieve a situation of mutual trust, transparent and effective exchange of data in real time, which will make the transportation process productive sectoral instruments of the national economy.

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