Railway transport management system transformation in passing to polygon technologies

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Abstract. Sustainability of the industrial complexes development, economic growth, the country’s foreign economic activity and thus the efficiency of its economy are largely determined by the country’s transportation system development and the railway transportation system in particular. Today the railroad industry performs a number of complex socio-economic functions aimed at modernizing economic development and increasing the rate of scientific-and-technological advance in all the related industries. Under the circumstances, the issue of complete rethink of financial and economic relations in the industry and, accordingly, the entire management system transformation becomes acute.

1. Introduction

At present, the railway transport system is still being reformed with the current mechanism of its functioning being fundamentally changed and totally new models of the economic mechanism being developed [1].

Managing the Russian Railway network, which is a complex structured system with a long-standing topology, is a challenge. It is necessary to take into account both the current position of Russia in the foreign arena and the processes of reforming the railway transportation system, which fundamentally changes the industry’s operating principles and entails its management system transformation.

Today, the Russian Railways network is actively adopting polygon technologies, the use of which, in the context of the increased integration of the Russian Railways Holding into international transport corridors will achieve a synergetic effect and increase the efficiency of these technologies implementation [2].

2. Main body

In 1997, the Government of the Russian Federation approved the “Transit Traffic Support Program using the Trans-Siberian Railway” [3] in view of the fact that the Trans-Siberian Railway was the world’s powerful transport corridor and, when creating a functioning Eurasian transport platform it would be well positioned to optimize its activities in as sort a time as possible for any transportation volumes, which in its turn, would entail the railway network development with the expected integration of many countries’ steel trunks into a uniform system.

Recently, there has been an increase in cargo traffic to the countries of Asian-Pacific Region, thus breeding a significant competition between all interaction systems of various transportation modes. Increasing competition determines stringent requirements for the development of the process management of the railway transport trunk infrastructure, continuous introduction of advanced
technologies and modern rolling stock. All this requires changes in the management system and cannot be implemented without complete rethink of the industry’s financial and economic mechanism.

Trunk lines have to be prepared for this. Polygon technologies can be able to eliminate the lack of railway infrastructure capacity.

Let’s consider what polygon technologies are about and how they affect the railway transportation management system.

The transportation process control polygon is a complex of network sections that have an integrated technology for the operation of the traction rolling stock, identical infrastructure, the emergence and completion of production cycles when servicing general passenger and cargo traffic with the maximum transport and logistics effect [4].

The main criterion defining the boundaries of polygons is the proportion of rail cars of the total number of those loaded on the polygon, and which are loaded and unloaded within its boundaries, as well as car traffic volume balance. The largest volume of loading and unloading in tons and cars [5] within the polygon boundaries allows the cargo owner to exert a greater influence on the efficient use of rail lines capacity.

The introduction of polygon technologies by the Russian Railways Holding was carried out gradually, starting with the changes in the main facilities management: traffic and locomotive facilities.

Creation of a new locomotive power management structure (Fig. 1) in OAO Russian Railways was launched in 2012-2013 with the emergence of traction resource management centers (TRMC).

In February 2012, the network’s first traction resource management center of the Eastern Polygon was created on the East Siberian Railway. One of the center’s main tasks was the efficient use of the locomotive power and the brigades throughout the polygon [6]. Successful practices in the structure operation contributed significantly to the development of polygon technologies for managing the transportation process.

A year later, in 2013, Operations Control Center appeared.

Figure 1. The standard structure of Traction Resources Management Center.

A pilot project of the transportation process management called “The Eastern Polygon” (EP) has been implemented since 2015.

This project will ensure the connection of transportation flows from the West to the East and make changes in the world trade routes, thus increasing the Russia’s share in the Eurasian transit.

In order to enhance the degree of influence of our country in the markets of the APR countries it is desirable to integrate the Eastern Polygon into several international transport corridors, such as Asian-
North American Trunk Line or ERRAA transcontinental lines project, whereas maximum mutually beneficial cooperation in political, economic and cultural spheres is expected. In future, the Eastern Polygon will serve as a catalyst for the sustained growth of communications and logistic systems and container and terminal business development as well.

The reason for the integration of the 4 railways – the Krasnoyarsk, the East Siberian, the Transbaikal and the Far East railways into a single polygon was the maximum share of car traffic volume in the total cargo carriage volume. In addition, these railways have a single type of traction, an identical car traffic volume transit formation and are included in the export train system loading to the Far Eastern seaports. The working mileage comprises more than 17 thousand kilometers. The polygon has 810 railway stations [7].

The transport needs of 14 constituent entities of the Russian Federation and ensuring transit traffic are implemented through the Eastern Polygon.

From an economic point of view, the development of production facilities in Siberia and the Far East is implied as the basis for the Eastern Polygon.

The Eastern Polygon will serve as a transport platform and provide access to the international market for the largest production and raw materials complexes of the Siberian and Far Eastern Federal Districts: mining and metallurgical, timber, electrical, process industries and innovations.

The first stage of the Eastern Polygon introduction has already been implemented and provides for the modernization of the infrastructure and technical facilities of BAM and Trans-Siberian Railway, which, in its turn, will ensure the passage of the required cargo traffic through the major transportation directions of Siberia and the Far East, in the territories of which more than 80% of the country’s mineral reserves is located.

However, the long-term development of the transport polygon involves an increase in operational performance, and more specifically, in traffic and processing capacity of the infrastructure from 75 to 130 million tons a year, as well as of carrying capacity of additional 20-39.3 million tons a year to already approved amount due to the passage of heavy trains along the coal routes of the Kuzbass raw material base[8].

In 2015, the technological coordination council of the Eastern Polygon was launched, the starting point of which was the creation of the Operational Control Center of the Eastern Polygon (OCC EP) in 2016 intended for the efficient operation of trains on the 4 railways: the Krasnoyarsk, the East Siberian, the Transbaikal and the Far East railways.

The principal activities of the OCC EP are to optimize the operation of the traction and non-traction rolling stock, to plan measures for the repair and modernization of the transport infrastructure in order to improve the volume, qualitative, financial and economic performance of all structural units that make up the polygon [9]. This unit has become a single coordination structure for the organization of train flows to the eastern ports and border crossings in the area between the division points of Mariinsk and Mezhdurechensk, primarily for the efficient passage of coal, oil-loading and timber routes. Such organization of cargo transportation within the framework of the polygon establishes effective conditions for creating logistic schemes for the interaction of transport modes, minimizing transportation costs and reducing delivery time [10].

This in turn contributes to the need to link information systems of the Russian Railways Holding’s central computing facility [11] and main participants in the transportation process, including the ports of the Far East.

Thus, the comprehensive approach to logistic problems will allow coordinating cargo shipment flows with the time schedule. It entails customer focus and consideration of mutual interests of all transportation process participants [12].

Such an approach will also have a positive effect on the efficiency of the train flow pass.

The volume of traffic is increasing and their delivery time is gathering pace.

Therefore, in the future, the effectiveness of the center both in technological and economic terms will primarily be achieved through the balanced, mutually agreed management decisions and the use of end-to-end technologies between all transportation process participants [13].
As part of the EP project an Infrastructure Maintenance Operation Center and the Eastern Directorate for the Operation of the Track Machines has been created.

Based on the above analysis, by implementing this project we can see the management system transformation, which allows us to gradually switch from regional management policies to polygon planning and train traffic organization when introducing modern technical solutions and systematically eliminating barriers.

Management system transformation is not possible without the full implementation of the program for the development of the Eastern Polygon railway infrastructure at BAM and Trans-Siberian Railway.

The set of measures for this program includes putting into operation the secondary running lines for a total of more than 500 kilometers, constructing 85 bridges, building additional passing sidings, strengthening the existing energy supply system in order to drive trains of increased weight and length as well as reconstruction of railway stations and junctions [14].

By now, an action to drive double and connected cargo trains with a train weight of up to 12,600 tons has been taken.

The Eastern Polygon has become a laboratory base for testing technical characteristics of the traction rolling stock, for example, it has successfully tested new series of train electric and diesel locomotives. Locomotives of increased power, capable of a train flow weighing more than 7,000 tons have proved their effectiveness in the Taximot-Tynda section.

The performance of the Eastern Polygon has been estimated with the help of volume and quality indicators: with an increase in cargo turnover by 25.5% over the past 5 years, the service speed has increased by 5% with the average gross train weight increasing by 3%.

Due to the changes in the management structure in 2017, an unprecedented cargo turnover has been achieved, comprising almost 790 billion net ton-kilometers. The well-managed work of all divisions makes it possible to transfer up to 100 trains a day at the junction of the East Siberian and Trans-Baikal railroads.

Polygon also has a positive effect on the development of the 4 railways included in it.

There has been a significant increase in the transfer of the loaded cars at the junctions of Krasnoyarsk railroad. It has increased by 2,219 cars by 2012. The “Transsib in 7 days” project is being successfully implemented on the railroad. Accelerated container trains follow at a speed of 1,145.7 km per day, which is 51.2 km per day more than the network value. In 2017, over 1,200 tons of connected trains with an average weight of almost 9,000 tons were carried along the railroad. Since March 2017, regular traffic of trains weighing 6,300 tons has been organized on the Southern course of the railroad. Due to the introduction of the package scheduling of freight trains developed by the specialists of Krasnoyarsk Traffic Management Directorate and Operational Control Center of the Eastern Polygon, the carrying capacity of the Mezdurechensk-Tayshet line is 28 pairs of trains per day.

The East Siberian Railway has become the center of the Eastern Polygon. The main governing bodies are located in Irkutsk. Meanwhile, a large-scale infrastructure modernization is being continued at East Siberian Railway. 7 large facilities even today affecting the carrying capacity of the railroad have been put into operation over the past 2 years. These are secondary tracks, new passing sidings and reconstructed stations. In general, over 1,700 kilometers of railway lines have been modernized over the past 5 years. Only this allowed the railroad to increase the train speed by 12.4%. A record for daily cargo turnover has been set up – in early April 2018, it amounted to 662 million gross ton-kilometers.

The Trans-Baikal Railway has initiated the development of a unified information system for monitoring locomotive crews in organizing the driving of connected trains. It integrates the data necessary for the operation of locomotive crews on the border of the Trans-Baikal and East Siberian trunk lines. An increase in service speed has been observed at Trans-Baikal Railway over the past 5 years. In 2017, this indicator increased by 1.2% compared to 2016. These and other achievements are associated with the growth of locomotive fleet, reconstruction of the stations and infrastructure modernization. So, in 2017, works were carried out at 12 stations, the electrification of the Borzya-
Zabaykalsk section and other works are still in progress. The railroad replenished its fleet with 58 new locomotives last year.

The Far Eastern Railway currently provides a third of the export traffic of the entire network of the Russian Railways. Last year, the volume of foreign trade cargos reached 116 million tons, which is 21 million tons more than 5 years ago. This March, the maximum daily unloading volume for the entire history of the railway was reached comprising 6,703 cars, which is 1,100 more than the average daily rates for the last two years. Two new tunnels have been built, two old ones have been reconstructed and two border crossings have been renovated over the past five years with the large-scale modernization being underway. In 2018, it is planned to invest 80 billion rubles in the development of the railroad.

All these changes are only the beginning. The Eastern Polygon employees are faced with the task of maximum mobilization. The average train weight by 2025 should exceed 4,000 tons with the service speed being at least 45 kilometers per hour along the entire length and the cargo delivery speed increasing to 500 kilometers per day.

The development of the modern Russia’s economy depends on achieving these performance targets. Indeed, the Eastern Polygon gives life to dozens of mining and industrial business projects in Siberia and the Far East.

According to the Transport Strategy of the Russian Federation until 2030[15], the motion vector is set for a long time to the East. Trans-Siberian Railway and BAM are the part of the transport corridor between Europe and Asian-Pacific Region, through the territory of which the Eastern Polygon passes[16]. The prospects of its further development involve not only modernization of the fixed equipment of the railway transport, but also the prosperity of Siberia and the Far East.

3. Conclusions
Under present-day conditions, the new strategy for the railway industry management structure development involves using polygon technologies providing for both centralized transportation management and interaction of traffic, traction, infrastructure and sales directorates, either of which will be responsible for its part of the company’s business. Within this context, thorough restructuring of the railway transport management system economic mechanism will continue and any management system transformation creates the need for thorough estimation and weighing up each of transformations so as not to lose the stability of railway transport functioning.

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