

Cost management in track facilities of railway transport infrastructure

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Abstract. The purpose of the study is definition and substantiation of the main development points of assessment and planning functions in the cost management system of railway transport infrastructure. Methods used in the study include general scientific analysis and synthesis, dynamic and structural analysis of economic indicators, as well as textual analysis of regulatory documents. Such approach enables to formulate industry-specific peculiarities of cost assessment based on general theoretical concepts of effective use of factors of production. The result of this study is an author's developed approach to cost management system for railway transport infrastructure.

Introduction

Limited resources is the main problem of all economic activities. On the theoretical level, solution to the problem is based on improvement of cost management methods. The results of studies on cost management published in [1-4] characterize common system factors of this process. Works [5-8] describe the peculiarities of cost management in transport industry. However, the authors do not present a complete solution on cost assessment as a progressive factor of manufacturing and economic sustainability and operating safety of transport.

This study is aimed at defining and substantiating the key development points of assessment and planning functions in the cost management system. Subject of the study is an infrastructure complex of railway transport. The study is particularly focused on increasing investment opportunities for updating and improvement of infrastructure based on cost assessment and planning. Relatively low profitability of transportation activities of railway companies is the main system constraint for applying the existing cost management methods. Novelty of the obtained results is proved by their applicability for the companies operating at the break-even point. Conclusions and results of the study have practical value due to their relevance in the conditions of fast growing prices on the resources consumed by transport industry and decrease of the amount of transportation services caused by the economic crisis.

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Research methods

The research methods used in the study are based on institutional approach to assessment of improvement opportunities for cost management system of transportation services market participants. The study includes scientific achievements in economics, best national and international practices on cost effectiveness improvement in transport industry, such as: control theory, systems theory, and other undertakings of Russian Railways JSC on improving operational efficiency [9-13]. Methods used in the study include general scientific analysis and synthesis, specific methods applied for economic studies, such as dynamic and structural analysis of economic indicators [14], as well as textual analysis of regulatory documents. Regulatory and report materials of Russian Railways JSC served as information basis for implementing the study [15].

Results

The analysis of legal framework and its application allowed assessing a number of peculiarities of cost management system for railway transport infrastructure, as well as types of transport activities and governmental support of infrastructure development. This commitment has been implemented also due to development of corporate regulatory framework for cost management (Table 1).

Such low-profit sphere of business as infrastructure is the primary subject that shall be assessed for cost planning effectiveness [16]. In this study, the subject of research focused on development of cost management system was West-Siberian infrastructure department - the branch of Central Directorate for Infrastructure of Russian Railways JSC located in the territory of West-Siberian Railway.

The analysis of business activities demonstrated that the Directorate for Infrastructure, as a vertically-integrated branch, provides a more effective infrastructure cost management system due to the following factors:

1. organization of a single center responsible for the state of infrastructure objects and their development;
2. item-by-item planning of works and current maintenance costs based on the assessment of actual state of infrastructure objects by means of diagnosis and complex systems with the account of reliability, level of physical deterioration and risk;
3. reduction of unit costs on current maintenance compared to the overhaul and retrofit costs;
4. higher quality of all types of repair of infrastructure objects due to ordering services and their acceptance;
5. organization of resource allocation on priority routes on the basis of the infrastructure reliability and availability with the account of its current state and wear of fixed assets;
6. modification in effectiveness and performance assessment system for infrastructure complex activities.

Table 1. Corporate regulatory framework for cost management of Russian Railways JSC.

No.	Introduced	Canceled
1.	Order of the Ministry of Transport of the RF as of 08/17/2007 No.124 "On approval of introduction procedure for separate accounting of revenues, costs and financial performance for different types of activities, tariff components and aggregate activity types of Russian Railways JSC"; effective of 01/01/2008 (resolution of the Government of the Russian Federation as of 50/21/2007, No. 640-p)	Order of the Ministry of Transport of the RF as of 08/17/2007 No.124 ceased to be in force because of the order of the Ministry of Transport of the Russian Federation as of 12/31/2010 No.31

2.	Order of the Ministry of Transport of the RF as of 12/26/2011 No.330 "On the introduction procedure for separate accounting of costs and revenues by natural monopoly entities in the field of railway transportation"; accepted by the order of the Ministry of Transport of the RF as of 12/31/2010 No.311 "On approval of introduction procedure for separate accounting of revenues, costs and financial performance for different types of activities, tariff components and aggregate activity types of Russian Railways JSC"	Order of the Ministry of Transport of the RF as of 12/31/2010 No.124 ceased to be in force since 10/26/2015 because of the order of the Ministry of Transport of the Russian Federation as of 09/15/2015 No.271
3.	Order of the Ministry of Transport of the RF as of 08/12/2014 No.225 "On the introduction procedure for separate accounting of costs and revenues by natural monopoly entities in the field of railway transportation" (hereinafter referred to as "Procedure") came into force since 01/09/2015	Effective to date

It should be noted that providing evidence for effectiveness and performance assessment is one of the essential points in improvement of effectiveness for current infrastructure maintenance. For more in-depth studies of the cost formation and planning processes in West-Siberian Directorate for Infrastructure a separate directorate department is formed - track maintenance service.

The track maintenance service is a key department of the Directorate of Infrastructure, because with the help of maintenance divisions (MD) is organizes railroad tracks services [17]. In the context of decreasing the planned preventive maintenance (PPM) volume since 2021 and reconstruction of 20 thsd km of rail tracks it is planned to increase the effect of substantial investments in renovation of mechanical equipment of track complex by 110 billion rubles (around 1,8 billion USD). The problems of railway transport infrastructure are emphasized as a result of considerable difference in operational performance of MDs: 50% of costs are spent on 168 MDs which provide 75% of traffic load, and the rest 50% of costs are spent on 211 MDs providing only 25% of the load [15].

It is found that the economic efficiency of operation of Russian Railways transport infrastructure is largely defined by the costs on tracks maintenance and repair. The main internal factors also influence the costs of railway complex, they can become the basis for effective managerial decisions on costs optimization [18]. Table 2 presents the classification of the main factors that influence railway complex costs.

Table 2. Classification of the main factors that influence railway complex costs.

Group attribute	Factor
1. Operational conditions defined by natural and macroeconomic factors	1.1. Climate conditions 1.2. Tax attributed to costs 1.3. Social welfare payments
2. Operational conditions defined by the product and labor market conditions	2.1. Salary level 2.2. Prices for material resources, fuel and energy resources
3. Conditions defined by the transportation market situation	3.1. Structure of transportation by traffic type (passenger, freight) 3.2. Structure of transportation by freight type
4. Operational conditions defined by the level of technical equipment of railway transport	4.1. Traffic flow 4.2. Structure of railroad line by the number of tracks 4.3. Plan and profile of tracks (grades and curves) 4.4. Track structure by railway track

	superstructure (type of rails and ties, type of ballast, share of continuous welded rails, etc.) 4.5. Number and type of artificial structures 4.6. Number of guarded and unguarded level railway crossings 4.7. Number of items of railway equipment, motor transport, structure of industrial buildings 4.8. Operational reliability of technical facilities, incl. track and its facilities 4.9. Level of physical wear and obsolescence of main assets
5. Transportation and facilities maintenance technology, quality of operation	5.1. Trains velocities 5.2. Mechanization of track operations 5.3. Unit labor requirement

The conducted studies demonstrated that it is reasonable to group the cost items for the planning purpose in the following way:

1. maintenance costs;
2. repair and improvement costs;
3. amortization costs;
4. other costs.

These costs are annually planned, which means that the Central Directorate for Infrastructure allocates planned funding for these purposes when forming the budget for each of the existing units. Consequently, cost planning activities in railway transport industry is done in cycles.

The biggest part of costs of track facilities are spent on maintenance, complete rebuild or repair. Such costs are defined according to the following regulatory provisions:

1. Classification of capital assets subject to amortization, Decree of the Government of the RF as of 01/01/2002 No. 1;
2. Resolution of Russian Railways JSC as of 10/30/2003 No.43 "On the procedure for defining useful life of capital assets when accounting in Russian Railways JSC";
3. Catalog of capital assets inventory items of Russian Railways JSC approved by the resolution of Russian Railways JSC as of 03/13/2007 No.395p.

Capital assets and related operational costs take the second position in the cost structure of MD (Table 3), therefore, more attention shall be given to better use of capital assets of track facilities, including tracks, machines and equipment [11, 20]. Along with mechanization, machines are widely introduced in track operations, which enables to perform up to 70% of operations with the help of machines and mechanisms.

Table 3. Item-by-item cost analysis of maintenance division of West-Siberian Directorate for Infrastructure.

No.	Cost items of MD West-Siberian Directorate for Infrastructure, million rubles	2014	2015	2016	2017
1.	Materials	398.02.	438.21.	447.83.	624.21.
2.	Fuel	112.23.	138.22.	139.76.	140.10.
3.	Energy	35.98.	36.45.	37.53.	39.01.
4.	Other costs, services performance	302.45.	310.78.	311.99.	322.10.
5.	Labor costs	2897.21.	3023.47.	3287.19.	3321.55.
6.	Social welfare payments	901.01.	947.12.	956.60.	980.20.
7.	Amortization	2348.87.	2423.11.	2103.12.	2233.98.
8.	Other costs	1232.56.	1423.90.	1542.91.	1324.02.
	Total costs	8228.33.	8741.26.	8826.93.	8985.17.

The key measures to enhance intensity of use of the existing infrastructure include improvement of maintenance stations operation technology, optimization of distances between maintenance points, elimination of temporary repair areas using rail-welding machines. At the stage of technology development for elimination of temporary repair areas and rail defects, many repair facilities of Russian Railways JSC (maintenance sections, track machine stations) faced the problem of high amount of such faults.

The most cases of rail faults and single rail renewal occur because of insufficient rolling contact fatigue of rails metal (defects 21, 26, 30); higher dynamic loading in the rail joints (defects 53, 56, 46, 43); rail head shelling and longitudinal cracking (defects 14, 16, 24) after slipping or sliding, as well as after rolling of wheels with big flat spots or chatter marks. In 2017, costs for single rail renewal and faults repair amounted to 211 million rubles (around 3,4 million UDS) (Table 4).

Table 4. Dynamics of rail faults elimination in the territory of West-Siberian Directorate for Infrastructure.

	2014	2015	2016	2017
Number of eliminated faults, pcs	3,124	3,517	3,657	3,824
Costs for faults elimination, million rubles	149.85	177.48	194.33	211.23

In recent years, global studies have been conducted on reasons for formation of rail faults, measures of faults elimination, extension of service life of rail facilities and equipment (Table 5).

Table 5. Dynamics of increase in number of joints that require welding, exemplified with West-Siberian Directorate for Infrastructure.

No.	Period	Length of continuous welded rails, km	Number of joints that require welding, pcs
1.	as of 01/01/2007	924.	1,602
2.	as of 01/01/2008	1,173.5	3,138
3.	as of 01/01/2009	1,362.6	5,867
4.	as of 1/1/2010	1,573.4	7,863
5.	as of 01/01/2011	1,763.3	9,648
6.	as of 01/01/2012	1,968.2	11,613
7.	as of 01/01/2013	2,163.7	11,308
8.	as of 01/01/2014	2,325	14,792
9.	as of 01/01/2015	2,502	14,500
10.	as of 01/01/2016	2,620	14,603
11.	as of 01/01/2017	2,870	14,102

At the stage of technology development for elimination of temporary repair areas and rail defects, many repair facilities of Russian Railways JSC (maintenance sections, track machine stations) faced the problem of high amount of such faults (Table 6).

Table 6. Comparative analysis of existing temporary repair areas on the level of Directorates for Infrastructure.

No.	Directorate for Infrastructure	Length of continuous welded rails, km of tracks	Number of joints that require welding, pcs
		as of 01/01/2017	
1.	October	10,223	59,058
2.	Kaliningrad	746	3,870
3.	Moscow	10,599	52,928
4.	Gorky	6,454	26,648

5.	Northern	5,604	11,548
6.	North Caucasus	6,443	17,582
7.	South-Eastern	5,733.	21,300
8.	Privolzhsk	5,245	27,066
9.	Kuibyshev	5,688	18,230
10.	Sverdlovsk	5,580	19,566
11.	South Ural	6,016	20,824
12.	West-Siberian	7,068	17,936
13.	Krasnoyarsk	2,441	9,086
14.	East-Siberian	2,870	14,102
15.	Zabaikal	3,075	15,924
16.	Far Eastern	3,245	10,362
	Total:		346,030

Along with conventional approach to elimination of rail faults, there are some advanced solutions, like aluminothermic rail welding and wide gap welding technologies.

To reveal practicability of using new means of railway transport repair comprehensive proof shall be provided. This process starts with the project design stage, when the preliminary feasibility assessment is performed [19].

Introduction of aluminothermic rail welding and wide gap welding technologies in production process of the Russian Railways JSC chain is an important factor that affects the results of business activities, such as quality, completeness and timeliness of all operations and, consequently, the amount of services, their prime cost and financial position of the company.

In order to improve cost management system it is suggested to use the economically feasible costs approach, based on the fact that due to transformation of costs (sphere of purchase of factors of production) into expenses (sphere of end products sales) the cost of production are formed, in other words, promotion expenses shall provide functioning of production costs [1].

On the example of West-Siberian Directorate for Infrastructure, cost management model was suggested based on capital functioning. Practical implementation of this model is based on comparison of the two existing technologies – single rail renewal and rail repair technologies, like build-up weld, welding and grinding.

Conclusion

The main outcome of the conducted study consists in the developed methodical approach to cost assessment and planning for track facilities of railway transport infrastructure. The author's approach to cost efficiency analysis is based on the use of aggregate benefit-cost ratio. It enables to define the cost planning procedure [21].

Practical relevance of the results of benefit-cost ratio for contracts between the railway institutions and third parties consists in the ability to solve two prospective tasks:

1) performance of multiple-criteria analysis of any method of rail repair assignment depending on the return on costs;

2) Assessment of practicability of the used rail repair and definition of limits for assigning such types of repair.

Analysis of the key factors defined as a result of the study showed dependence of these factors on the type and intensity of transportation activities, as well as on lay-out and length of continuous welded rails.

Proof of conclusions and results of the study suggests that further research on adaptation of the author's approach to cost efficiency assessment and planning for other infrastructure components might be perspective.

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