ANALYSIS OF OPERATIONAL FACTORS OF OPERATING DOMAINS

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ABSTRACT

For centralized control of traction resources on railway it is easy to solve tasks of strategic planning and operational management of the operation of rolling stock under treatment at an operating domain. A certain relocation of locomotive fleet gives its advantages for a variety of positions, including intensification and unification, maintenance of machinery. The author analyzes resulting indicators of operating efficiency of traction resources, accompanying calculation means and introduces obtained findings.

ENGLISH SUMMARY

Background. *The introduction of new information technologies in control system of traction resources of railways helps to solve tasks of strategic and technological planning, operational management of operational activities with the use of operating domain technologies [1].*

In order to improve the quality of management decisions using operating domain model of the organization of operational work at the proper time a system of performance indicators of traction control centers was introduced on the basis of management methodology of operation of locomotives in the intensification of locomotives and improvement of efficiency of locomotive crews [2].

Supply of new locomotives, requiring less costs due to improved characteristics, made it possible to undertake gradual redeployment of in-service locomotive fleet, to exclude traction rolling stock from turnover, produced a standard service life, and to concentrate uniserial and locomotives of the same type within the boundaries of operating domains. Reduction of different seriation of locomotive at a depot unified a technology for their operation and maintenance, released technological equipment, strengthened technical and technological literacy of locomotive crews and maintenance personnel, reduced a nomenclature of supplied parts. Such a strategy aimed at solving a basic task – to achieve a transition from treatment of locomotives within the boundaries of railways to their treatment at operating domains [3].

Objective. *The objective of the author is to analyze resulting indicators of operating efficiency of traction resources.*

Methods. *The author uses analysis, mathematical methods and comparison.*

Results. *A resulting indicator of operating efficiency of traction resources set an average daily performance of a locomotive. Pic. 1 shows a scheme of logical relationship of traction resource elements (locomotive fleet, locomotive crews, maintenance facilities) and average daily performance of a locomotive of an operating fleet of freight traffic. In terms of operating domain technologies by means of unification of types and series, extension of locomotive runs, rapid redeployment of locomotives at an operating domain, depending on a train situation, it becomes possible to perform the given traffic volumes with a smaller fleet, which leads to an increase in performance of a locomotive.*

Locomotive performance depends on the rational organization of working and rest time of locomotive crews. By increasing the stay time of locomotives in point of crews' change a value of performance decreases, similar performance is associated with passage of locomotives to a home depot and turnover of maintenance. Productivity growth is possible when the amount of work is a performed by a smaller locomotive fleet and a correspondingly a smaller contingent of locomotive crews. Availability and efficient use of repair capacities ensures a repair of rolling stock in time and reduction of downtime of locomotives awaiting repairs, that is here, there is also a resource to improve performance indicators.

In an analysis of the effectiveness of centralized control of traction resources the impact of consolidated indices is estimated according to the formula

$$\Delta W_{Л} = \frac{W_{л}}{Q_{бр}} \cdot \Delta Q_{бр} + \frac{W_{л}}{S_{л}} \cdot \Delta S_{Л} + \frac{W_{л}}{\psi} \cdot \Delta \psi \quad . \qquad (1)$$

The results of calculations on the example of the original data before and after implementation of an operating domain technologies are shown in Table 1.

From the data of the last column (Table 1) it is clear that due to the introduction of an operating domain

Table 1

Change in average daily performance of locomotives under centralized control of traction resources

Name of an indicator	Value		Change	Ratio, reflecting an impact degree	Assessment of complex indicator impact on performance, th. ton –km gross
	before	after			
Average daily performance of a locomotive, th. ton-km gross	758,7	819,64	+60,95	–	–
Average weight of a train, tones	2415,1	2457,7	+42,6	0,3	+13,39
Average daily run of a locomotive, km	360,8	377,1	+16,3	2,1	+34,26
Performance indicator	0,871	0,884	+0,015	871,359	+13,30

Table 2

Assessing the impact of locomotive performance on a depot at its total value for an operating domain of control

№ depot	Operating locomotive fleet	Locomotive performance, ton-km/day		Deviation from a standard	Proportion of operating locomotive fleet	Assessment of impact on a total value
		plan	fact			
1	2	3	4	5	6	7
1	28	1223	1263	40	0,277	11,09
2	17	977	1056	79	0,168	13,30
3	22	1116	1200	84	0,218	18,30
4	34	744	720	– 24	0,337	– 8,08
Range	101	997,04	1031,64	34,60	1	34,60

model of traction control the value of integrated indicators (average weight of a train, average daily run, performance ratio) increased, which in turn had an impact on increase of a resulting indicator of traction resources control- performance of a locomotive on an amount equal to 60,95 th. ton- km gross. Due to the increase in the average weight of a train performance increased by 13,39 th. ton- km gross, and with an increase in average daily run performance gain amounted to 34,26 th. ton- km gross. Eventually the change in the performance ratio made it possible to increase a resulting indicator by 13,30 th. ton- km gross.

Change in locomotive performance causes increase (+) or decrease (-) in need for operating and operated locomotive fleet (ΔM). The saving of the fleet can be determined by the formula:

$$\Delta M=\left[-\frac{M^{\text{ДО}}\cdot\Delta W_{Q_{\text{бр}}}}{W^{\text{ДО}}+\Delta W}\right]+\left[-\frac{M^{\text{ДО}}\cdot\Delta W_{S_{\text{Л}}}}{W^{\text{ДО}}+\Delta W}\right]+\left[-\frac{M^{\text{ДО}}\cdot\Delta W_{\psi}}{W^{\text{ДО}}+\Delta W}\right], \qquad (2)$$

where $M_{\text{от}}$ is an operating or operated locomotive fleet in reporting period;

$\Delta W_{Q_{\text{бр}}}, \Delta W_{S_{\text{Л}}}, \Delta W_{\psi}$ – change in locomotive performance during the reporting period as compared to the previous period, obtained in assessing the impact of integrated indicators on the value of performance.

The individual parts of the formula (2), in brackets, reflect the impact of consolidated performance indicators of operational work at an operating domain to reduce the need for the locomotive fleet. The first summand shows the locomotive fleet savings by increasing the average weight of a train gross, the second – a result of increase in daily average run of locomotives, and the third – consequences of increase in performance ratio of locomotives.

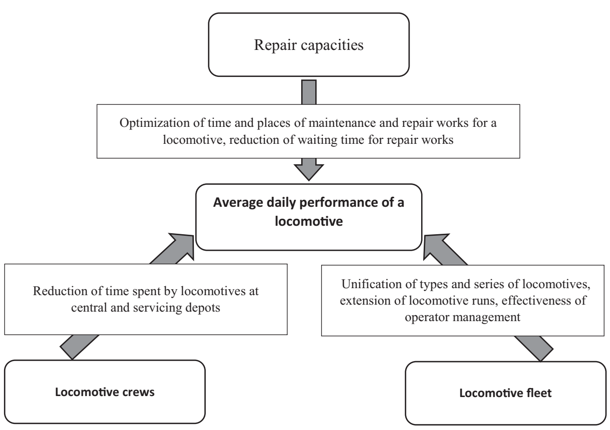
We consider an example of calculation of changes in need for locomotives, depending on the implementation of qualitative indicators of an operating domain work based on the data of Table 1. Following the introduction of operating domain technologies as compared to the same period before the introduction there is an increase in performance of locomotives $\Delta W_{\text{л}}=53,2$ th. ton- km gross, including due to the growth of a train weight $\Delta W_{Q_{\text{бр}}}=13,39$ th. ton- km gross, due to increased average daily run $\Delta W_{S_{\text{Л}}}=26,90$ th. ton- km gross and due to changes in performance ratio of a locomotive by 11,8 th. ton- km gross.

We assume that at an operating domain fleet of $M=130$ locomotives is in operation, the original value of a daily average locomotive performance – $W^{\text{ДО}}=758,6$ th. ton- km gross. In this case according to the formula (2) we have:

$$\Delta M=\left[-\frac{130\cdot13,39}{758,6+53,2}\right]+\left[-\frac{130\cdot26,90}{758,6+53,2}\right]+\left[-\frac{130\cdot11,8}{758,6+53,2}\right]=-2,25-4,45-1,99=-8,7.$$

That is, increase in locomotive performance in the implementation of testing area technologies by 53,2 th. tones- km gross/day caused decrease in a fleet by 8,7 units, including due to increase in a train weight – by 2,25, average daily run – by 4,45 and locomotive performance ratio – by 1,99.

Increase (+) or decrease (–) in the need for locomotive crews is estimated:



Pic. 1. Interrelation of elements of a traction resource and its resulting indicator.

$$\Delta Б = K_Б \Delta M_л = K_Б(\Delta M_{Q_{бр}} + \Delta M_{S_Л} + \Delta M_{\psi}), \quad (3)$$

where $K_Б$ – average number of crews per one locomotive of an operating fleet in the considered period:

$$K_Б = \frac{Б}{M}, \quad (4)$$

At the same time $Б$ is a daily average attendance contingent of locomotive crews for the evaluation period.

It is established that for data given in the previous example, value of $Б_{от} = 450$ crews. According to the formula (4) we calculate the average number of crews per one locomotive of an operating fleet in the reporting period:

$$K_Б = \frac{450}{130} = 3{,}5 \text{ crews/loc.}$$

Then according to the formula (3):

$$\Delta Б = 3{,}5 \cdot (-2{,}25 - 4{,}45 - 1{,}99) =$$
$$+ -7{,}89 - 15{,}58 - 6{,}97 = 30{,}44 \quad .$$

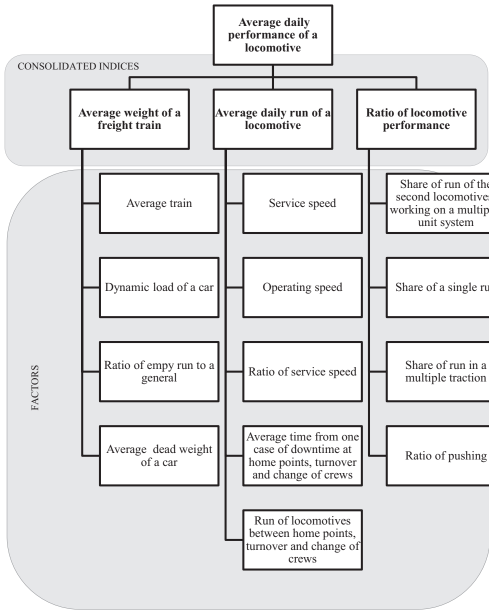
Thus, increase in locomotive performance in the implementation of testing area technologies as compared to the same period before the introduction led to a decrease in the need by 30,44 locomotive crews. Moreover the increase in a train weight contributed to reduction by 7,89 locomotive crews, average daily run – by 15,58, and performance ratio- by 6,97.

Increase or decrease in the need for locomotive crews may occur:

- due to changes in the performance of locomotives, which affects the demand in them, and, consequently, in locomotive crews;

- due to changes in the time spent by locomotive crews at the depot from the time of appearance before the acceptance of the locomotive, as well as movement to take passengers.

Enlargement of operating domains of traction resources control makes it possible to reduce a number of local areas of traffic control, its traction support and to achieve improvements of major performance indicators by focusing on several local operating domains. We call this component «effect of integration of indicators of locomotive use». To assess the effect of integration of indicators of locomotive performance at an operating domain it is proposed to use dependence from influence of proportion of operating locomotive fleet on the depot, which is a part of an operating domain:



Pic. 2. Structuring of performance indicators of traction rolling stock use.

$$W_л = W_1\gamma_1 + W_2\gamma_2 + ... + W_n\gamma_n \quad (5)$$

where W_1, W_2, W_n - average daily performance of a locomotive on a depot 1, 2, ..., п, ton-km gross;

$\gamma_1, \gamma_2, \gamma_n$ – proportion of an operating locomotive fleet on depot 1, 2, ..., п.

Conclusions. *Efficiency of use of traction resources at a range should be considered from the standpoint of the following components of performance:*

1) The impact of qualitative performance indicators of an operating domain on a need for locomotives and locomotive crews and, as a consequence, the operating costs of their maintenance;

2) the effect of integration of indicators of locomotive fleet use.

The proposed approaches to the analysis of indicators of operating domains in a centralized control of traction resources are suitable for the analysis of impact of operational parameters of operating domains areas on a network-wide level.

Keywords: railway, control, locomotive, operating domain, performance indicators, traction resource, productivity, organization costs, centralization.

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