RELATIONSHIP BETWEEN BUSINESS BUDGETING AND TECHNICAL REGULATIONS

Levin, Dmitry Yu., *Russian University of Transport, Moscow, Russia.*
Shulgenko, Zinaida S., *Central Directorate of Traffic Management – branch of JSC Russian Railways, Moscow, Russia.*

ABSTRACT

The process of reforming railway transport requires the use of modern methods and tools of economic work. One of the key management tools that ensures the interrelation of the company's strategy with the tasks of numerous divisions is budgeting technology. Technical regulation of operational work determines resources which are necessary for implementation of the transportation plan. A closer interaction of budget of production and technical regulation, in the authors' opinion, will make the transportation process more rational and will result in least material, technical, financial and economic costs.

Keywords: *railways, production budget, technical regulation of operational work, market conditions, physical indicators, financial indicators.*

Background. *The transition of the Russian rail cargo transportation market to its current configuration began in 2003. Then, in accordance with the government program of structural reform, the entire economic complex of the mainline railway transport was transferred from the Ministry of Railways to the authority of a single economic entity – JSC Russian Railways. Simultaneously with the reform, the process of creating companies that are operators of cargo wagons that later formed the competitive field of the market, independent of the owner of the railway infrastructure, began.*

The transition to market relations in Russia requires an adequate change in the style and methods of planning and managing the operational work of railways. The state is the only shareholder of JSC Russian Railways, and, of course, solving state tasks is the main priority of corporate structures. At the same time, the company as a commercial organization must work profitably. It should have resources for development, the ability to offer customers new attractive transport products [1, p. 2].

Objective. *The objective of the authors is to consider relationship between business budgeting and technical regulations.*

Methods. *The authors use general economic and management methods, comparative analysis, evaluation approach, scientific description, mathematical methods.*

Results.

*«**Everything new is well overlooked old**»*

To improve the production budget, a decision was made to improve the quality of planning of the use of locomotives (as one of the most costly resources) and responsibility for the use of resources of JSC Russian Railways. At the first stage, an economic assessment tool was introduced («Guidelines for development of an economic assessment of the service order for maintenance of locomotives in the fleet operated in a cargo type of traffic», order of JSC Russian Railways No. 2830 dated December 30, 2017). By the end of 2018, in the course of work in the new conditions, it was planned to create a system of responsibility of the holding company's structural units for proper development and execution of the production program and cost budget, and at the final stage – to automate the process of forming the demand for locomotive traction resources (2019–2020). As a result, the systems of service ordering will be linked between the functional branches and the budgeting process, making it possible to organize interaction in a new way, to assess the level of responsibility of executants and effectiveness of the efforts made.

Improving the system of budget management and planning of volume and quality indicators involves the use of a predictive business model of cargo traffic, which combines planning for the coming month and specification up to the level of loading and unloading stations, developing a pivot table of planning of car flows between stations and technical regulation of operational work (appropriate methodology was approved by Order of JSC Russian Railways No. 290r dated February 14, 2018).

The technical regulation of operational work, which determines the resources for implementation of the cargo transportation plan, and is intended to rationally organize the transportation process with the lowest material and technical costs, as before, is only formally related to budget planning and financial indicators. In market conditions, the main indicators are profit, income and expense, and only physical indicators are still involved in planning and management of operational work. This is not as harmless as it may seem.

Modern market relations are not something new, it is just a well forgotten old. The future Minister of Transport, Minister of Finance, Chairman of the Committee of Ministers Sergei Witte, in 1880, was appointed as the head of the operations department in the administration of the Society of South-Western Railways, which were unprofitable. He considered his main task to be the maximum increase in operating income, without which the deficit, which had already become chronic, could not be eliminated. He had solved this problem for the period from 1881 to 1885. Net income from operation of his roads increased from 4 million 300 thousand rubles up to 13 million 600 thousand rubles, or more than three times [2, p. 132]. No one of the subsequent leaders of the railways can boast this result. To do this, Witte, however, had to develop, neither more nor less, the basic principles of the theory of tariffs and put them into practice (on his own railway).

And here is the opposite example from our time. In the Big Transport Encyclopedia it is written: «Increasing the weight of a train makes it possible to reduce operating costs for maintenance of locomotive crews, acquisition and maintenance of locomotives, for fuel and electricity, and shunting work. 15–20 % of the current cost of railways is associated with the train weight. In the period 1990–1999 the average train weight on the railways of Russia increased by 252 tons (from 3093 tons to 3345 tons), which saved more than 1,2 billion rubles» [3, p. 917].

However, the above savings relate only to the mentioned operating costs, but apart from them, a large list of other operating costs is associated with the train weight. And if we take them into account, the increase in the average train weight at that time led to losses. Why? Because in the 1990s, the volume of transportation on railways decreased by more than 2,5 times. And with a decrease in cargo turnover, the average train weight should have been reduced by about $\sqrt{2,5}$ times. Besides, on each railway, the efficiency of increasing the average train weight additionally depends on the technical equipment and load capacity.

Obviously, it is important to maintain quantitative and qualitative indicators in operational work, but in market conditions they should be linked to financial indicators, that is, the technical regulation of operational work implies both financial indicators and economic instruments.

Accordingly, the production budget, in order to determine the production program, should not just have a shortened list of quantitative and qualitative indicators of operational work, inventory and working fleet of rolling stock, infrastructure data, human resources, but coordinate production and financial plans, volume and cost indicators, contain mechanisms for the economic regulation of operational work.

Simple balance

A fairly quick transition to market relations in Russia was not accompanied by an adequate change in the style and methods of planning and managing operational and economic work.

The objects of budgeting should not be only incomes and expenses of railways and their subdivisions, i.e. cash flows associated with the transportation process, but also operational performance indicators that determine them. And this should not be formal as now.

While the balance of indicators is a significant concept for financial activities, the balance of transportation needs and transportation capacity should be not less important for operational work [4, p. 240]. Its absence leads to unjustified corporate losses. These losses are caused by both external and internal costs.

The imbalance in the needs and capabilities of rail transport causes external costs:

• failure to comply with regulatory deadlines for cargo delivery;

• material and moral costs due to non-fulfillment of contractual obligations;

• increase in transportation costs;

• reduction in the quality of transport services for cargo owners;

• reduction in competitiveness of JSC Russian Railways on the domestic and foreign cargo transportation markets.

Internal difficulties in operational work are non-fulfillment of specified quantitative and qualitative indicators, train schedules, technological standards for processing cars and trains; irreplaceable losses in throughput, processing and unloading capabilities; inefficient use of rolling stock and infrastructure, causing lower financial and economic results of railways.

In the on-line mode, the adjustment of the size of movement of trains and carrying capacity of sections is achieved by solving the problem of adjustment of saturation of sections by trains.

According to the Charter of rail transport, the carriage of goods by rail is carried out following the applications of shippers (form GU-12). Applications are transmitted electronically through ETRAN system (an automated system for centralized preparation and editing of transportation documents), which has been operating in Russia since 2000.

The system ETRAN does not provide for verification of compliance of applications for transportation of goods with the transportation capabilities of railway transport. Almost automatically received, applications are included in the transportation plan. As a result, a part of shipments is delivered to consignees within an overdue period.

The creation of ETRAN automated accounting and now there is a single database of applications for shippers in an automated integrated system of branded transport services (AKS FTO).

At the next stage of development of ETRAN system, when planning cargo transportation, it is advisable to organize the accounting of the throughput and processing capacity of the infrastructure. The quality of the coordination of applications for transportation largely determines the creation of optimal conditions for train operation and the final economic indicators of rail transport.

It is proposed to use the theory of graphs and flows in networks to choose the route of wagons taking into account:

• the cost of carriage of goods, the volume of processed car flows, fuel consumption, non-productive mileage of rolling stock;

• the cargo transit time and other technical and economic indicators.

This allows to correctly assess the possibilities of existing configuration of the network of railways, technical means (rolling stock), facilities and devices (tracks, power supply, signaling and communications) and select their most efficient use that meets the requirements of carriers.

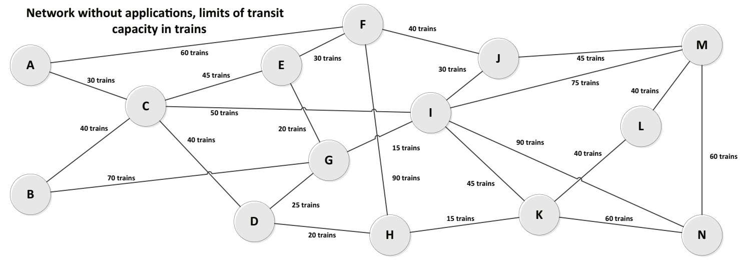
The balance of transportation needs and of transportation capabilities of railways, as previously indicated [5, pp. 21–23], is provided by the criterion for obtaining the highest fare (profit).

Railway network graph model

The solution to the problem of planning the transportation of goods provides that applications are superimposed on the model of the graph of the railway network. At each section applications (cars) «passing» on it are summarized. The amount of cars is divided by the average number of wagons in trains. The resulting number of trains is compared with the available capacity of the section. If the application does not exceed the capacity of the sections, it is included in the cargo transportation plan.

If the carrying capacity of one of the sections is exceeded, transportation in a roundabout (bypassing the section that has exhausted the available carrying capacity) with a charge for the actual distance of transportation is offered to the shipper. If the consignor refuses transportation in a roundabout, the application is rejected. As a result, a combination of applications arises, in which the number of cars (profit, cargo turnover, or weight of the cargo transported) in the sections will be maximum and the carrying capacity will not be exceeded.

For example, this is how the development of a transportation plan looks like if it is considered by the criterion for obtaining the highest fare. The description of the statistical infrastructure model of the railway network is shown in detail in [5,



Pic. 1. A network of railways with carrying capacity of sections [5, p. 21].

p. 21–23]. We will expand the model, returning to and refining previously presented results, if necessary, taking into account data sources.

The statistical infrastructure model of the railway network is described by the graph:

$G_k = \{V_k; R_k\}$,

where V_k – all v_k vertices of the graph – stations; R_k – all r_k edges of the graph – sections; k – sequence number, or designation of the vertex, or the edge on the graph [5, p. 21].

All data, defined as the parameters of the infrastructure model, are updated when a change is made.

The main sources of model parameters:

• for stations– an automated databank of technical and administrative acts of stations and technological processes;

• for sections – Network-3, ASOUP-2 software systems, normative and variant schedules and train formation plans drawn up at the Main Computer Center of JSC Russian Railways.

Further, as indicated, we determine that each edge of the calculated graph corresponds to a set of parameters (from the Network-3 system):

$$R_k = \left\{L_R, v_R^\mu, D_R^\mu\right\},$$

where L_R – length of the section bounded by stations (vertices) V_k, km; v_R^μ – section speed of cargo trains of various categories μ along the section, km/h; D_R^μ – technological time of travel on the section R_k of trains of the category μ, h $\left(D_R^\mu = L_R / v_R^\mu\right)$.

V_i station receives regularized set of orders. The algorithm scans the tables of orders and forms the set S in the form of a table of orders, ordered by time. In accordance with the album of the shortest distances the applications are «superimposed» on the graph of the network of railways. At each section applications (cars), «passing» on it, are summarized. The amount of cars is divided by the average composition (number of wagons) of trains. The resulting number of trains is compared with the available capacity of the section n_i (Pic. 1) [5, pp. 21–22].

The task is to optimize profit r, received from applications s.

The representation of the objective function of the problem for its first variant, its solution through a recurrent two-step procedure are given in [5, p. 22–23].

At each stage, the set of applications is sequentially considered and the maximum profit from transported wagons (accepted applications) is calculated according to the following algorithm:

1. The ordered set S cyclically considers presence of unprocessed applications (block 1).

2. From the ordered set S, the next application s is taken (block 2).

3. For the application s, the route of transportation L and the sections l_i included in it are determined according to the album of the shortest distances (block 3).

4. The l_j sections of applications s_i are cyclically viewed (block 4).

5. Sections l_j along the route (block 5) are consistently viewed.

6. In accordance with the distance along the shortest route, the freight charge r is determined (block 6).

7. The current number of cars t_j is determined for each section l_j along the route (block 7).

8. During the consideration of each application s_i by the accrued method, the current number of wagons in the sections is summarized, i.e. the number of wagons p from the application s_i is added to the current number of cars t_i in each segment l_i making part of the transportation route L (block 8).

9. The resulting increasing current number of cars t is divided by the normal number of cars in composition m and converted into a train flow N for each section (block 9).

10. The resulting train flow N is compared with the available transit capacity of section n:

$\frac{t_j}{m_j} < n_j$ (block 10).

11. With N > n, the bypass of the section is found with a corresponding increase in the fare (block 11).

12. If there is a detour around this section, the shipper is offered to send the cars via an alternative route (block 12).

13. At the completion of the cycle of viewing the options for transporting the dispatch, it is checked whether the option had been successfully found (block 13).

14. If the traffic capacity of a section is not exceeded or there is the consignor's consent to use an alternative route, the application is included in the transportation plan P with a corresponding increase in total profit (block 14).

15. If the consignor disagrees to use the alternative route, or in its absence, the application is not included in the transportation plan P (block 15) and is transferred to the ordered set S_1 of the next month (block 16).

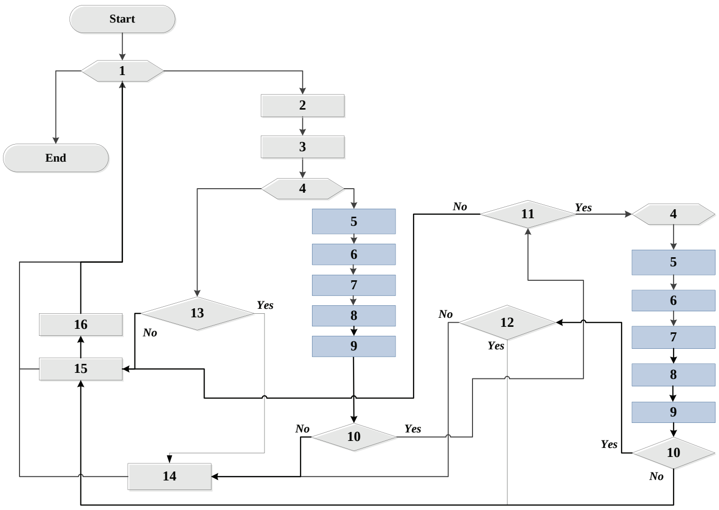
The implementation of the algorithm in the form of a flowchart is presented in Pic. 2

Rules are not for form's sake

On the basis of the cargo transportation plan, technical standards for operational work are being prepared. The purpose of technical regulation is to ensure the implementation of the monthly transportation plan. To achieve this goal, the following tasks are solved:

• determining the volume of traffic for the upcoming month (on average per day) and its distribution along the roads and large stations;

• calculation of indicators to ensure the implementation of this amount of work;



Pic. 2. The flowchart of development of a transportation plan by the criterion for the maximum cost of shipments [5, p. 23].

• distribution of technical equipment and resources by railway units in accordance with the volume of their work.

The result of solving these problems is a system of indicators to be performed during the whole month, which are called technical norms.

At the stage of technical regulation, the volume of traffic, the direction of car flows, the transfer of cars to the junction points between roads, the tasks for transportation, the necessary resources, quantitative and qualitative indicators, indicators of rolling stock use, adjustment measures, etc. are set. Unfortunately, all this is done based only on the needs for transportation of goods – without taking into account the transportation capacity of the railways. The resulting unjustified losses due to the lack of a link between physical and financial indicators remain without a proper economic assessment.

Elimination of other shortcomings is required in technical regulation. The norms of operational work are determined before the beginning of the planned month, but at this time the plan usually contains only about 30 % of the upcoming traffic. That is, the modern transportation plan has ceased to be a complete and reliable information source, a basis for technical regulation. So expert methods have become an alternative option. Moreover, upcoming traffic volumes, as well as the technical capabilities of transport, carrying capacity and transit capacity of sections, processing capacity of stations are assessed expertly, while transportation resources of railways, loading and unloading capabilities of cargo facilities and stations, availability of cars and locomotives are almost never evaluated.

On the basis of detailed plans for transportation of goods, tables of loading in cars on the destination railways are compiled. Cargo loading volumes along destination railways and types of rolling stock are used to develop a consolidated network transportation plan, which is called «checkerwork». These «checkerworks» are compiled for each kind of rolling stock, with their help on each railway loading and unloading is planned. At the Main Computing Center of JSC Russian Railways, the size of loaded car flows for each inter-road joint point is determined.

However, it is impossible to determine the size of movement of laden traffic on specific sections, directions and inter-road joint points according to the «checkerwork», as it shows only inter-road loading correspondence. Therefore, it is necessary to go from the inter-road correspondence to the correspondence between the joint stations of railways.

There are two ways to determine the planned laden car flows by given directions:

• approximate, when the volumes of laden car flows are obtained using the «checkerwork» with the help of special calculation tables, the so-called standards;

• «accurate» when according to the data of detailed transportation plans with indication of destination stations or contracts for the supply of products using a computer, the volumes of car flows for each section are found.

In the plans for transportation of goods, destination stations are indicated only in local traffic. Therefore, to determine the planned laden car flows the approximate method is used. For each inter-road joint point of the railway, two calculation tables (standards) are developed: one for the odd and the other for even directions. In the left part of these tables, all loading railways, the wagons from which should pass through this joint point, are recorded verically, and the railways to which those cars arrive for unloading are recorded horizontally at the top of the table.

Calculation tables (standards) serve not only to identify cargo flows for monthly technical regulation of operational work, but also to develop a plan for formation and schedule of trains.

The distribution of loading at the exit points is determined by experts, based on the existing connections between the railways. This relationship is subject to daily changes in space and time. Therefore, the size and direction of car flows vary significantly.

Another discrepancy is associated with the choice of the direction of car flows. The shortest travel route is applied for which a freight charge is collected. For example, for a delivery from Omsk node to Sverdlovsk node the shortest route is through Tyumen, but through Kurgan node the running time is five hours less, and fuel consumption is 15 % less. Thus, in addition to the shortest route, an economically viable route may also be considered. Therefore, when choosing the route of cars, it is necessary to take into account:

• cost of transportation of goods, volume of processed car flows, fuel consumption, unproductive mileage of rolling stock;

• time spent on cargo transit and other technical and economic indicators.

To minimize time and resources

When planning the size of movement of trains within the areas with numerous branched sections, as we see, not only temporary factors are important, but also factors related to availability of resources for transportation. Optimization of planning of train work in time and resources allows for transit of the necessary train flow in the planned period with minimum resources or as soon as possible with the specified resources. Such an approach to the problem is especially significant in the technical regulation of the operational work of railways and shift-daily planning. It allows to properly assess the capabilities of the network configuration, technical means and devices, to choose the most effective use of them [6, p. 276].

The task of minimizing the cost of processing train flows in a mathematical form can be formulated as follows: each edge of the network corresponds to the throughput n_{ij}, indicating the maximum train flow that can be processed through this edge. In addition, each edge b_{ij} is associated with the cost C_{ij} of processing of one train from the top a_i to the top a_j along the edge b_{ij}. It is necessary to find the train flow from the source to destination, which has a given value and has a minimum cost. Joint points of an area are mainly considered as source and destination points. And since the local train flow has its destinations within the area, in this case the flow with the minimum cost for transit trains is determined.

Formally, the task is to minimize $Z = \Sigma_{ij} C_{ij} b_{ij} z$ when:

$$\sum_i b_{ij} - \sum_k b_{jk} = \begin{cases} -N, if\ j = S; \\ 0, if\ j \neq S, t; \\ N, if\ j = t; \end{cases}$$

$0 \leq b_{ij} \leq n_{ij}$ (for all i, j).

This implies that N does not exceed the maximum flow from a_s to a_t, otherwise the problem has no solution. If there were no restrictions on the carrying capacity of the edges, then it would be enough to find the most economical way from a_s to a_t and to process the entire train flow through it.

In linear programming, there are computationally efficient algorithms (for example, see [7, p. 132]) that allow to get train flows of minimal cost.

Due to the seasonal and daily uneven loading of the lines during the «peak» periods, part of train flows cannot be processed along the shortest routes. At the same time, even if the maximum train flow is processed at some sections, the carrying capacity of an area with many branches of sections is not achieved. Movement of flows along alternate routes increases the network load and may worsen the conditions for processing of trains for which these routes are shortest. In some cases, there is a chain reaction caused by directing of train flows through alternative routes. In turn, an increase in the load of sections slows down the flow and impairs the use of the capacity. The costs associated with this determine the effectiveness of the use of alternative routes.

For each area with many branches of sections, it is desirable to determine such a load, the excess of which makes it inefficient to use bypass routes. In particular, it is possible to prohibit the use of sections for processing roundabout train flows when the intensity of traffic in these sections exceeds the capacity. Such an approach is quite likely when using the dynamic management of train flows on the railway network.

For efficient use of sections, it is advisable for each destination of car flows in terms of train formation plan to determine the direct route (it may not be the shortest) to process the main load and detours for processing the excess load. In general, the entire flow of trains at each destination is the simplest (Poisson). However, the trains that make up the excess will no longer be such a simple flow. It becomes simple only at the moments when the intensity of movement along the shortest routes exceeds their carrying capacity, i.e. the occurrence of an excess flow is concentrated only during a part of the considered time interval. This means that the excess flow of trains is more concentrated, more irregular. With the same average traffic intensity, it requires larger capacity than the simplest flow.

The correctness of the calculation of loaded car flows on the railway network as a whole is checked for acceptance and delivery. These values should be equal to each other [8, p. 253].

Budget integration

The technical regulation of operational work of railways, which defines the guidelines for operational management of the transportation process, should clearly formulate the goal: what we want to achieve by making this or that decision. Longer time, on the one hand, requires an increase in the average train weight. On the other hand, it is necessary to increase the local speed. Both indicators are among the budget tasks of production. But the goals behind them are contradictory. There is an inversely proportional dependence between these indicators [9, p. 18]. While using one and the same technical equipment, increasing the train weight causes the need to reduce section speed and vice versa. At the same time, an increase in the average train weight and an increase in section speed can be achieved only if the power of locomotives increases, the condition of the track improves, etc., that is, if the technical equipment changes.

This situation reflects the contradictions of the modern rationing of operational performance indicators, when there are several goals. The problem of multiplicity of goals is still being solved by «administrative-command methods». Whereas goals must be prioritized. In our case, the train weight should take precedence when the capacity of sections is exhausted or is at a high level. As it was in the 1980s. In the absence of construction of new unloading lines and high throughput, the increase in the average train weight allowed at that time to increase the volume of annually transported cargo. In modern conditions, when after decrease in the transportation volume in 1991, we witnessed excessive capacity but a shortage of certain types of cars, priority should be given to the section speed, which allows to speed up the car turnover, reduce the effects of deficiency in rolling stock and use the existing fleet of cars to transport more cargo. Although in some directions with powerful car flows the dominant idea of increase in train weight can remain.

In order to achieve improvement in one of the indicators, one of the goals, it will be required to sacrifice other indicators. It is advisable to choose a «victim» by ranking the targets. For technical regulation and operational management of transportation the choice should be carried out following financial and economic indicators.

It is most efficient to carry out regulation of train work on cargo-intensive areas developing optimal operating conditions. For this, the vertical section in the standard schedule of traffic on cargo-intensive sections determines the maximum number of trains that can simultaneously be there. And the latter should *determine the number of trains that can be brought to the section and the necessary resources for this and, as a result, the calculated achievement of final results, operational and financial indicators.*

The plan must contain not only indicators, but also ways to achieve them. Using the operating modes of shunting stations allows to create and maintain optimal conditions of their work. Similarly, the choice of optimal modes for the use of sections allows to create the optimal conditions for train work.

It is also timely to comment on the shortcomings of the modern budget, which are eliminated by its combination with the technical regulation of operational work.

The production budget determines the production program of the enterprise for the upcoming period. The railway industry is characterized by provision of volume and quality indicators in the budget [10, p. 85].

Information base of budgeting today is the management accounting system of the enterprise, and more simply – the reporting data for the past period. Thus, on the basis of the work done previously, the distribution of budgetary indicators is forecasted, including the expenses of the subdivisions for maintenance, overhaul, general business expenses, etc. As a result, the plans obtained through significant efforts do not become a sufficiently effective management tool, which is carried out mainly as before by the expert distribution of working capital for various current budget items.

The transition from a static to a flexible budget of expenditures makes it possible to adequately assess the activities of branches, determine the correct amount of their funding and improve the system of cost management.

The most important problem in this area is the realness of developed financial plans. Effective management is possible only if there is a reasonable plan for a relatively long period of time – a year, a quarter. The unreality of plans is caused, as a rule, by unreasonable sales planning data, a planned share of funds in calculations, underestimated repayment terms of receivables, and «bloated» financing needs (subdivisions' costs for maintenance, major repairs).

Combining the production budget and technical regulation of operational work will allow:

- *to combine the system of operational and financial indicators on the basis of planned calculations, providing a market assessment of the transportation process;*
- *to establish goals and strategies to achieve them basing on the top-down principle;*
- *to optimize the use of resources at minimum operating costs;*
- *to budget not according to the reported data on the past work, but to forecast financial flows and increase the efficiency of their distribution;*
- *to balance the needs for transportation and the actual transportation capacity of the railway;*
- *to obtain the greatest economic effect with a shortage of resources;*
- *to adjust the cash flows in accordance with the resources and established norms for their use;*
- *to ensure optimal financial results;*
- *to link planning of financial obligations of enterprises, their implementation and material incentives for employees.*

For implementation of these principles, it is necessary to realize the integration tasks for both spheres of activity – budget and technical regulation, operational work.

Conclusions.

1. As the technical regulation of operational work must contain an economic assessment of organization of the transportation process, the production budget should be based on indicators of technical regulation, but not on the forecast based on the reported data on the past time.

2. Technical regulation of operational work must include financial indicators and economic instruments that allow to implement the company's strategy and ensure a reduction of the costs of the transportation process.

3. The production budget should become a real tool for planning and managing the transportation process; for this, instead of an expert assessment of volume and quality indicators, a reliable cargo transportation plan is to be used.

REFERENCES

1. Krasnoshchek, A. A. Development relay [*Estafeta razvitiya*]. *Gudok*, 2016, 26 June, pp. 2–3.

2. Levin, D. Yu. Witte, S. Yu. Outstanding railway worker [*Witte S. Yu. Vydayushchiisya zheleznodorozhnik*]. Moscow, Infra-M publ., 2018, 418 p.

3. The Big Transport Encyclopedia: In 8 vol., Vol. 4: Railway transport [*Bolshaya entsiklopediya transporta: v 8 t. T. 4: Zheleznodorozhniy transport*]. Moscow, Great Russian Encyclopedia, 2003, 1039 p.

4. Levin, D. Yu. Needs for transportation and possibilities of railways: Monograph [*Potrebnosti v perevozkakh i vozmozhnosti zhelznykh dorog: Monografiya*]. Moscow, Infra-M publ., 2017, 247 p.

5. Levin, D. Yu. Consistency in Transportation Process Control. *World of Transport and Transportation*, Vol. 16, 2018, Iss. 6, pp. 20–32.

6. Levin, D. Yu., Pavlov, V. L. Calculation and use of the throughput capacity of railways [*Raschet i ispolzovanie propusknoi sposobnosti zheleznykh dorog*]. Moscow, TMC for education on railway transport, 2011, 364 p.

7. Hu, T. Integer programming and flows in networks [*Tselochislennoe programmirovanie i potoki v setyakh*]. Moscow, Mir publ., 1974, 519 p.

8. Smetanin, A. I. Technical regulation of operational work of railways [*Tekhnicheskoe normirovanie ekspluatatsionnoi raboty zheleznykh dorog*]. Moscow, Transport publ., 1984, 295 p.

9. Levin, D. Yu. The theory of operational management of the transportation process [*Teoriya operativnogo upravleniya perevozochnym protsessom*]. Moscow, TMC for education on railway transport, 2008, 625 p.

10. Tereshina, N. P., Shkurina, L. V. [*et al*]. Budgeting on railway transport: Textbook [*Byudzhetirovanie na zheleznodorozhnom transporte: Uchebnik*]. Moscow, TMC for education on railway transport, 2010, 344 p. ●

Information about the authors:

Levin, Dmitry Yu. – D.Sc. (Eng), professor of the department of Management of operational work and transport safety of Russian University of Transport, Moscow, Russia, levindu@yandex.ru.

Shulgenko, Zinaida S. – deputy head of Economic service of Central Directorate of Traffic Management – branch of JSC Russian Railways, Moscow, Russia, shulgenkozs@center.rzd.ru.

Article received 30.08.2018, accepted 10.11.2018.