



A Cure for Railway Employees' Headaches (Review of the Monograph «Economic Assessment of Seasonal Unevenness of Transportation»)



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ABSTRACT

Macheret, D. A., Razuvaev, A. D., Ledney, A. Yu. Economic Assessment of Seasonal Unevenness of Transportation: Monograph [Ekonomicheskaya otsenka sezonnoi neravnomernosti perevozok: Moonografiya]. Moscow, Prometei publ., 2022, 142 p. ISBN 978-5-00172-334-9.

The monograph presents the results of a study of seasonal unevenness of transportation – one of the fundamental economic

problems of the transport industry. Using improved methodological tools for assessing seasonal unevenness, transportation by mode of transport was analysed. A scientifically based approach to determining the influence of seasonal unevenness of transportation on the economic efficiency of the use and development of transport infrastructure is disclosed. Attention is focused on assessing the value of transport infrastructure and the economic efficiency of its development, taking into account the unevenness of transportation.

Keywords: railway transport, transport infrastructure, seasonal unevenness of transportation, cargo transportation, passenger transportation.

The unevenness of transportation, either cargo or passenger, has always been a «headache» for transport workers, long called a necessary evil and causing a helpless shrug.

Indeed, what else «stresses» a business executive more than the need to maintain reserve resources for potential growth in production volumes? There are costs associated with both excess inventory and understocking. Railway businesses are no exception, especially considering the cost of the infrastructure they use.

There were, of course, attempts to combat unevenness – administrative, organisational, technological, and economic ones, but it was not possible to soften Her Majesty Unevenness.

The presented monograph makes a brilliant attempt to first understand this phenomenon, study it

from all sides, and only then use the research results in practical activities.

Let's say right away that there are many types of unevenness, it manifests itself in cargo traffic, and in passenger traffic, and in time, and in directions, but the subject of the study was a singular, the most significant type of unevenness in transportation – which is seasonal. In it, like a drop from the ocean, the authors tried to determine the main characteristics and scale of the problem.

The research begins «from the stove» – the unevenness coefficients used for decades (if not centuries!) are carefully examined. It would seem that there is something unclear here. Taking a closer look at these very coefficients, you can find that until now they have been calculated approximately, which in today's era of universal digitalisation is not even

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The full text of the review article in Russian is published in the first part of the issue.

Полный текст статьи-рецензии на русском языке публикуется в первой части данного выпуска.

possible to imagine. The most interesting thing is that the use of refined methods for calculating unevenness led to completely different conclusions about maximum transportation volumes.

Fans of macroeconomics will also be interested in assessment of the dependence of operating costs on the level of load of the railway infrastructure by season, which confirms the operation of the fundamental economic law of diminishing returns.

In the same series, there is convincing evidence of the accelerating growth of operating costs (and, accordingly, the cost of transportation) with an increase in the level of infrastructure load during the season of maximum traffic volumes and, consequently, a deterioration in the quality of use of rolling stock over time, primarily a decrease in train speeds. It's nice when everything that was previously considered obvious and explained in simple terms acquires the foundation of a mathematically proven theorem.

As a result of the research, the authors were able to construct a universal model of the influence of seasonal uneven loading of the railway infrastructure on the efficiency of its use and development. The use of this model makes it possible to assess both the effectiveness of using infrastructure in real conditions and, more importantly, to ensure informed planning of investments in its development for the future.

An indicative calculation of the impact of seasonal unevenness of transportation on the economic indicators of implementation of the Long-term Development Program of JSC Russian Railways until 2025 indicates the high elasticity of the effectiveness of investments in development of railway transport according to the unevenness of infrastructure load. (When the level of unevenness changes by 1 percentage point, the overall effect of investment changes by 5,5 to 7,2 %, and the return on capital investment changes from 1,95 to 2,2 percentage points, depending on the change in scenario uneven infrastructure load). This is an important and very concrete result.

What's especially gratifying is that the model is universal. Nothing prevents you from using it on all other types of transport. Due to the presented dependences of efficiency assessment indicators on seasonal unevenness of infrastructure load, it becomes possible to develop options for reducing the costs of transport activities and optimising infrastructure capacities.

As a touchstone of the theory – an analysis of unevenness of transportation during the coronavirus pandemic. This can be called the highlight of the study, confirming its universality.

Here is a pill for the long-standing «headache» of transport employees that was an uneven transportation. The recipe for use is simple:

1. More accurately analysis of the seasonal unevenness of transport infrastructure load, identifying the main factors influencing the unevenness indicators,



and determining the minimum achievable (or maximum permissible) level of seasonal unevenness.

2. On this basis, to predict seasonal unevenness for the future and develop measures to reduce it (prevent exceeding the maximum level).

3. Using the developed model, to assess the impact of seasonal unevenness of transportation on the economic results of both current and investment activities of railway transport.

The authors could well have stopped there and expected well-deserved applause, but...

Scientific work differs from practical recommendations in that it always contains groundwork for future research. In the best traditions of academic science, the monograph develops philosophical issues of determining the «value» of transport infrastructure and brilliantly proves that it in no way can be reduced to assessing its cost. Here we also propose (maybe not indisputably) methodological tools for assessing the value of railway infrastructure and its use to determine the effectiveness of infrastructural development.

The presented method for assessing the value of transport infrastructure based on the effects generated by implementation of cargo transportation for both the carrier – the owner of the infrastructure and for the owners of goods – allows us to significantly clarify the economic assessment of infrastructure in comparison with assessment of value according to financial statements. At the same time, it was revealed that the value of the railway infrastructure is sensitive to the unevenness of transportation and can be increased by reducing it.

There is something to think about both for the authors in their further research and for scientists interested in this issue.

In conclusion, I would like to note: will it be possible to get rid of unevenness as such (especially since there are both statistical and technological prerequisites for this), or will we find ways to level it out, including with the help of scientific approaches similar to those described in the monograph after a certain number of years? But it is simply necessary to note that in solving this problem many people have already stopped having headaches and undecieved themselves.

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**SELECTED ABSTRACTS
OF D.SC. & PH.D. THESES SUBMITTED
AT RUSSIAN TRANSPORT UNIVERSITIES**

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Akashev, M. G. Refinement of the methodology for assessing the processes of interaction between cargo car wheels and rails using a strain gauge wheel set. Abstract of Ph.D. (Eng) thesis [*Utochnenie metodiki otsenki protsessov vzaimodeystviya koles gruzovogo vagona i relsov primeneniem tenzometricheskoi kolesnoi pary. Avtoref. dis... kand. tekhn. nauk*]. Moscow, RUT (MIIT) publ., 2023, 21 p.

Ensuring safety of railway traffic is an important problem, and the task of improving the methodology for assessing the processes of interaction between wheels and rails during features of a cargo car, considered in this thesis, is relevant.

The objective of the work is to improve the technology for assessing the condition of the track, as well as methods for assessing the impact of rolling stock on the track and the dynamic features of the rolling stock.

It has been established that the use of a strain-gauge wheel set provides sufficient accuracy and ample opportunities to perform long-term recordings of the forces of interaction between wheels and rails on a section of track of any length, necessary for the probabilistic analysis of these processes.

A finite element model of a strain-gauge wheel set of a cargo car was developed using the «Universal Mechanism» software package, which made it possible to perform calculations of its stress-strain state and determine the installation locations of strain gauges that make it possible to measure with the smallest errors the lateral and vertical forces at the points of contact of the wheels with the rails.

An object car was created, consisting of an empty tank car with an oncoming strain gauge wheel set, to identify dangerous sections of the track where there is a decrease in the safety factor of the wheel against derailment below the normalised value.

To test the identification of track sections that are dangerous due to wheel derailment conditions, field and operational tests of a specially formed experimental train were carried out, the latter consisted of a cargo car with a strain gauge wheel set, a track measuring car and a laboratory car with simultaneous recording of signals from all measuring devices.

A geometric-force method for assessing the condition of the track is proposed, which significantly complements the existing one, based on identifying deviations in the geometry of the rail track, since it allows one to determine sections of the track that are dangerous due to the conditions of derailment of the wheels of empty cars, which, according to existing standards, would be considered harmless for their movement.

Based on the results of experimental tests carried out on the railway network, a technology of a geometric-force method for assessing the state of the track has been developed and approved by JSC Russian Railways, which makes it possible to identify track sections in which the safety factor of the wheel against derailment decreases below the standard value of 1.3, set for cargo cars.

It is proposed that to determine the probabilistic characteristics of lateral forces, it is advisable to use a technique for isolating a random signal against a background of noise and represent their

recording as a product of two random processes: telegraphic and modified.

The results obtained showed that the use of a strain-gauge wheel set and the wheel-rail interaction processes determined with its help makes it possible to refine the assessment of the state of the track and indicators of impact on the track.

The prospect for further development of the topic is improvement of the strain gauge wheel set, the development of new schemes and methods that allow taking into account the influence of additional factors on the accuracy of determining the forces of interaction between the wheel and the rail.

2.9.3. – *Railway rolling, train traction and electrification.*

The work was performed and defended at Russian University of Transport.

Grebennikov, N. V. Scientific basis for increasing the energy efficiency of autonomous locomotives with electric power transmission. Abstract of D.Sc. (Eng) thesis [*Nauchnie osnovy povysheniya energeticheskoi effektivnosti avtonomnykh lokomotivov s elektricheskoi peredachei moshchnosti. Avtoref. dis... dok. tekhn. nauk*]. Rostov-on-Don, RGUPS publ., 2023, 40 p.

Objective of the work is development of new scientifically based technical solutions, concepts of structure and operating modes of traction equipment of locomotives with electric power transmission, ensuring increased energy efficiency of operation, based on methods for processing recorded information by on-board systems of locomotives.

Based on the analysis of the current state of the problem of operating efficiency of autonomous locomotives, it has been established that the energy efficiency of locomotives is standardised only for the full power of the diesel generator set, and the operating efficiency is assessed by specific fuel consumption per unit of transportation work, and the lower is the load on the axle of the car, the greater is the specific diesel fuel consumption, and therefore increased energy efficiency, cannot be achieved solely through creation of new powerful locomotives, and special attention should be paid to the operating modes of locomotive traction equipment, which will allow the power characteristics to be adjusted to operating conditions.

Analytically, patterns have been established that make it possible to determine the efficiency of traction electrical equipment of locomotives, depending on the current and output/input power. It has been proven that voltage regulation leads to a significant reduction in the energy efficiency of traction electrical and electromechanical energy converters on autonomous locomotives with electric power transmission.

By applying the energy approach, a methodology has been developed and theoretically substantiated for assessing the energy efficiency of operating autonomous locomotives with electric power transmission based on the passport data of traction equipment and parameters obtained from locomotive recorders.

Based on the analysis of operational data, it was established that the diesel generator set of cargo, passenger and shunting locomotives operates for a long time with loads of less than 50 %, this necessitates the use of multi-diesel power plants for locomotives of all types of traffic. The operating conditions of electric power transmission elements are determined and the underutilisation of energy efficiency of energy conversion is revealed, especially in direct and alternating-direct current transmissions, due to the low power utilisation factor of the diesel generator set and electric power transmission in general.

By applying the developed methodology for assessing the energy efficiency of operating autonomous locomotives and analysing the results obtained, a concept for increasing energy efficiency has been developed, substantiated and formulated, which is based on the principle of scalability of the traction equipment used in an autonomous locomotive depending on operating conditions.

The use of the finite element method for carrying out traction calculations is theoretically justified, allowing for the expansion of existing methods for carrying out traction calculations in order