ANALYSIS OF CONTRAVENTIONS TO TRANSPORTATION PROCESSES AND TRANSPORTATION QUALITY MANAGEMENT

Nutovich, Veronica E., *Russian University of Transport, Moscow, Russia.*

ABSTRACT

The article outlines the main provisions of the methodology for analyzing the quality of transport services provided in the process of freight rail transportation. The methodology assumes the analysis in a fully automated way in the EASAPR SFTO system in interaction with adjacent corporate systems for all types of violations of transportation processes, both at the time of their detection, and regardless of the subsequent filing of claims. The result is a clarification of the effect of various factors and operating factors on the overall financial risks of JSC Russian Railways particularly in case of customers' claims. The methodology is aimed at improving the quality of freight transportation, development of client focused operations and improvement of the image of JSC Russian Railways.

Keywords: railway, cargo transportation, quality management, violation analysis, methodology, corporate systems.

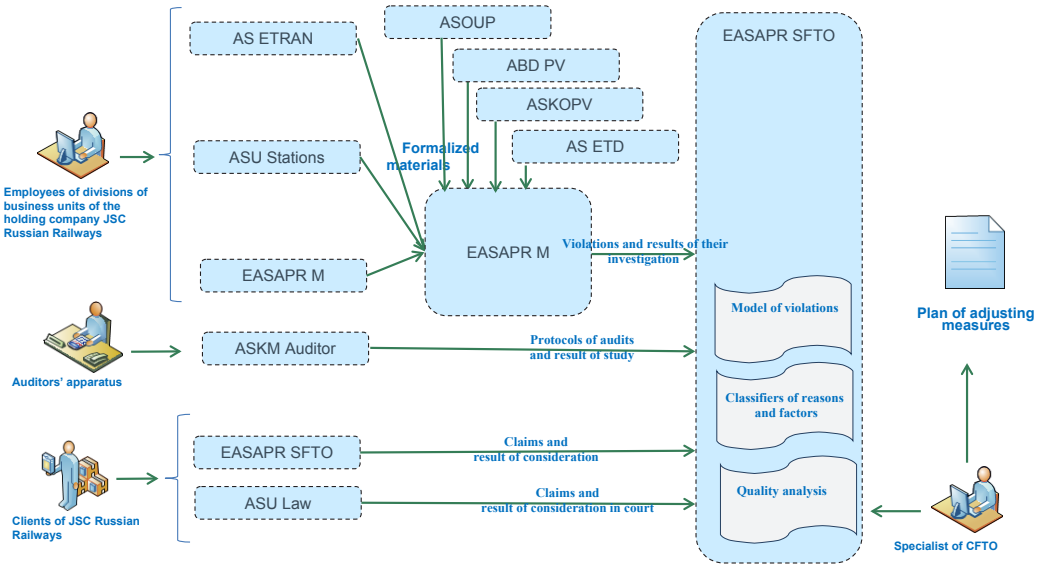
Background. *In accordance with GOST [Russian state standard] R51005–96 «Transport services. Freight transportation. Nomenclature of quality indicators» [1]* **the quality of transport services** *in freight transport means «a set of characteristics ... of freight transportation or a transport forwarding activity determining their suitability to meet the needs of ... consignors and consignees», and* **freight transportation** *is defined as «transportation services for movement of tangible property related with their safety and timeliness of delivery». That is, from the very beginning this standard establishes the main groups of quality indicators, prescribing them in the very concept of freight transportation.*

The quality management system on European and American railways is based on the use of ISO 9000 standards and includes four basic components: standard development, monitoring, audit and quality assurance [2]. Monitoring is carried out with the help of automated systems and is aimed at timely detection of defects, forming an objective view of the quality of service to their customers.

On the railways of Russia, a quality management system is also being implemented in accordance with GOST ISO 9000–2011 «Quality management systems. Basic provisions and vocabulary» [3]. The JSC Russian Railways developed and introduced a policy and a concept of client-focused corporate politics in the field of freight transportation [4, 5], a standard of customer service in the center of corporate transport services [6], a quality standard for JSC Russian Railways [7], a management quality strategy in the holding company Russian Railways [8].

Creating an effective quality monitoring system involves the use of a set of assessment tools and research methods. Among them there is the methodology developed by the author and approved by the order of Russian Railways of November 30, 2017 No. 2597/r for the analysis of the quality of transport services for freight rail transportation [9]. The methodology provides for the analysis in a fully automated way in the ESSAP SFTO system in conjunction with adjacent corporate automated systems. The scheme of combined information flows is shown in Pic. 1.

Objective. *The objective of the author is to analyze violations of transportation processes and transportation quality management.*



Pic. 1. The scheme of information flows.

Methods. *The author uses general scientific methods, mathematical apparatus, evaluation approach, comparative, statistical and economical analysis.*

Results.

1. Conceptual meanings and definitions

The analysis of quality of transport services in freight transportation is a tool to manage the risks of freightage quality violations aimed at identifying hidden relationships between the main characteristics of freight transportation and the resulting violations that lead to subsequent payments in the event of a claim or recovery of funds by court decisions.

As a result of violations, the company not only may incur losses from claims and suits, but also lose the image of a reliable partner, which in turn can lead to an outflow of customers and loss of traffic. Complaints and lawsuits show the degree of customer satisfaction. However, not for each violation and not every client will make a claim and a suit. Therefore, the analysis should be carried out for all types of violations, and immediately at the time of their detection.

Violations can be documented in three ways – when drawing up a corresponding primary document (usually a general form or commercial act) in the EASAPR M system, when registering the results of the audits and inspections performed in the ASKM system, when a claim of a client enters the Russian Railways in the system of ESAPR SFTO. The description of the systems of EASAPR M, ASKM and EASAPR SFTO are present in the textbook «Information technologies of freight and commercial work» [11].

In all cases of appearance of recorded violations, they are automatically saved in the module of records of violations of the EASAPR SFTO system. For each of them, the amount of financial risk is calculated, the causes directly leading to the violation and the factors contributing to the occurrence of violations are established.

Based on the data accumulated by the module, statistical operational and periodic reports on the status of quality assurance throughout the entire network of JSC Russian Railways are automatically generated, and quality analysis is also carried out. The explorer analysis and confirmatory (confirming) analysis are singled out.

The key is the concept of a factor. In the methodology, two groups are considered – the factors of transportation and the factors of violations. Their impact on the onset of a violation in the course of cargo transportation is of a probabilistic nature, it does not mean the inevitability of the violations, but only its probable possibility. Depending on the strength of such impact, the results of the study can identify factors of low, moderate and high degree of influence.

Factors of transportation – conditions or circumstances of its implementation, affecting the violation. For each of them a group of potentially possible factors is established.

Factors of violations – additional circumstances, not provided for in the contract of carriage, which affected the violation. For each violation, there are potentially possible causes.

Cause of a violation – an event or a process that directly caused a deviation from the normal course of the process of providing freight services.

Statistical risk of a violation (R_{Si}) – frequency of occurrence in the analysed period of the i-th type of a violation.

This kind of a risk is determined by the formula:

$$R_{si} = \frac{n_i}{k_i}, \qquad (1)$$

where i – type of a violation; R_{Si} – statistical risk of the i-th type of a violation; n_i – number of the i-th type of violations in the analytical period.

Financial risk of a violation (rf_k) – expected value of the possible loss of JSC Russian Railways from payment in the event of a violation and filing of a claim or legal action for damages. It is determined for each k-th violation.

Aggregate financial risk of a violation (Rf_i) – total financial risk for all violations of the i-th type for the analysed period.

Such a risk is determined by the formula:

$$Rf_i = \sum_{k=1}^{n_i} rf_{ik}, \qquad (2)$$

where Rf_i – cumulative financial risk of the i-th type of violations; n_i – number of the i-th type of violations in the analysed period; rf_{ik} – financial risk of the k-th violation of the i-th kind.

Aggregate financial risk due to the violation (Rfp_{il}) – total financial risk for all violations of the i-th type for the analysed period, due to one reason l.

Such a risk is determined by the formula:

$$Rfp_{il} = \sum_{k=1}^{m_{il}} rf_{ilk}. \qquad (3)$$

where Rfp_{il} – cumulative financial risk due to the reason l for all violations of the i-th kind; m_{il} – number of violations of the i-th kind in the analysed period due to the reason l; rf_{ilk} – financial risk of the k-th violation of the i-th kind due to the reason l.

Aggregate financial risk by groups of causes of violations (Rfg_{iq}) – total risk for all violations of the i-th kind, which occurred for one group of reasons q. A group of reasons is a combination of causes of violations having the same name, but relating to different types of violations.

Such a risk is determined by the formula:

$$Rfg_{iq} = \sum_{k=1}^{m_{iq}} rf_{iqk}, \qquad (4)$$

where Rfg_{iq} – cumulative financial risk for the group of causes q for all violations of the i-th kind; m_{iq} – number of violations of the i-th type in the analytical period that occurred due to the group reason q; rf_{iqk} – financial risk of the k-th violation of the i-th type that occurred due to the group reason q.

The criterion of analysis – an integral indicator reflecting the state of ensuring the quality of freight transportation.

As part of the methodology, the aggregate financial risk of a violation of Rf_i is taken as an analysis criterion. In the same capacity, there may be a statistical risk of a violation Rs_i.

2. Exploratory analysis

Such an analysis is used to interpret statistical data on detected violations in the course of freight transportation and their consequences. It does not imply any a priori judgments about the factors of violations, its purpose reveals the influence of the causes and factors of violations, the nature of the involvement of the responsible divisions of JSC Russian Railways.

The result of the exploratory analysis is drawn up in the form of Ishikawa cause-effect diagrams,

Pareto diagrams, risk maps showing the causes and factors of violations, as well as responsible units with the greatest degree of influence.

Calculations are carried out for all types of violations in the aggregate and then for each type of violation separately.

The exploratory analysis is constructed by the criterion of aggregate financial risk of a violation Rf_i or by the criterion of statistical risk of a violation Rs_i.

The following is a variant of the construction of the exploratory analysis by the criterion of the aggregate financial risk Rf_i.

At the first stage, the first section of the analysis is formed for all types of violations and the reasons of their occurrence.

For each type of violation, the aggregate financial risk of a violation Rf_i is calculated by the formula (2).

The aggregate financial risk for all violations is then determined as the sum of all cumulative financial risks for all types of violations that occurred in the analysed period:

$$Rf = \sum_{i=1}^{n} Rf_i , \qquad (5)$$

where Rf – total financial risk for all violations; n – total number of violations in the analysed period; Rf_i – aggregate financial risk of the i-th type of violations.

For each reason that caused the occurrence of violations of each kind, the aggregate financial risk for reasons Rfp_{il} is calculated using the formula (3).

A grouping of causes relating to different types of violations is made, but having the same content.

Next, the aggregate financial risk for each group of reasons Rfg_{iq} is determined by the formula (4).

Ishikawa cause-effect diagram is plotted, reflecting the effect of the reasons of each group on the overall quality score – the overall financial risk for all violations.

To determine a statistically significant set of group of reasons that have a cumulative effect on the overall quality score of at least 80 %, a Pareto diagram is constructed.

A risk map is formed, which is the matrix of the shares of aggregate financial risks K_{li} for each reason l in the aggregate financial risk of each i-th type of violations; K_{li} is determined by the formula:

$$K_{li} = \frac{Rfp_{il}}{Rf_i} , \qquad (6)$$

where Rfp_{il} – aggregate financial risk due to the reason l for all violations of the i-th kind; Rf_i – aggregate financial risk of the i-th type of violations.

The cells of the risk matrix are colored in color, depending on the degree of the effect of the reason on the aggregate financial risk.

All received values are divided into three intervals:

– from 0 to 0,29 – low degree of influence;

– from 0,3 to 0,49 – moderate degree of influence;

– from 0,5 to 1,0 – high degree of influence.

Similarly formed are:

– the second section of the analysis for all types and factors of violations;

– the third section for all types of violations and responsible units;

– the fourth section for each type of violation separately with the formation of tables for identified reasons, the factors of violations and responsible units, as well as the construction of Pareto diagrams.

In the fifth section, a text interpretation of the results of the exploratory factor analysis, containing the main conclusions, is worded.

Evaluation of the resulting tables and diagrams will allow the development of corrective and preventive management decisions aimed at improving the situation and quality of work. These activities should be included in the sixth section of the analysis.

3. Confirmatory analysis

A fundamental feature of confirmatory analysis is the need for preliminary determination of the hypothesis about the impact of a specific set of factors of violations or transportation factors on the result.

The hypothesis of confirmatory analysis is formed by a specialist of CFTO and is a set of conditions of two different types:

• fixed conditions – are designed to limit the volume of the sample under study and set the a priori characteristic of the technological processes being studied;

• variable conditions – are conditions, the influence of which on the general criterion of the quality of freight transportation is supposed to be established.

Conditions might be described by factors of transportation, factors of violations, causes of violations, types of violations, responsible units.

One of the possible examples of elements of analysis.

Hypothesis: the period of transportation has a significant impact on the violation of the delivery time of coal to the Far Eastern ports.

Fixed conditions: transported cargo – coal; the destination road – the Far East road; station of destination – Vanino, ..., type of violation – delay in the delivery of goods.

Variable condition: period of transportation.

The statistical risk of a variable condition Rsv_i – frequency of the onset of violations in the analytic period that satisfies the fixed hypothesis conditions for the i-th value of the variable condition.

The financial risk of a variable condition (Rfv_i) – total financial risk for all violations for an analytic period that satisfies the fixed hypothesis conditions for the i-th value of the variable condition.

Confirmatory factor analysis takes on the function of checking the validity of the proposed hypothesis.

Confirmatory analysis is constructed by the criterion of financial risk of the variable condition Rfv_i or by the criterion of statistical risk of the variable condition Rsv_i.

The following is a variant of constructing a confirmatory factor analysis by the criterion of financial risk of the variable condition Rfv_i.

A subset of the violation model is formed that satisfies a set of fixed conditions.

In the example above, this subset includes all coal transportation in the direction of the stations servicing the port stations of the Far Eastern road that ended with a violation of the established delivery time.

Then, the total number of technological processes that meet a set of fixed conditions is determined.

In the same example, this is the total volume of coal transported in the direction of the stations servicing the port stations of the Far Eastern road, regardless of the violation of the established delivery time.

The next step is to calculate the financial risk of each violation.

As part of the example, this is the estimated penalty for late delivery of goods for each shipment with a violation of the delivery time.

After that, the financial risk of the variable condition for each value of the variable factor is specified.

In the example given, this is the sum of all financial risks for all transportations that occurred during one period (month) and ended with a violation of the established delivery time.

To determine a statistically significant set of values of the variable factor, having an aggregate effect on the financial risk at a level of not less than 80 %, a Pareto diagram is constructed; in the case of a large number of values of the variable condition, only the first 10 values with the greatest influence are taken into account.

Based on the data obtained, a risk map is formed, which is the matrix of the shares of the influence of individual causes of violations on the financial risk corresponding to each value of the variable condition; in the case of a large number of values of the variable condition, only the first 10 values with the greatest influence are recorded in the risk map.

Finally, a textual interpretation of the results of the confirmatory analysis is formed, containing the main conclusions about the existence of a dependence between the values of the variable factor (analogue in the example – the month of transportation) and the amount of expected losses from payment of late fees for delay in the delivery of goods, that is, the validity of the proposed hypothesis.

The results of the analysis can also be used to draw up a plan of preventive measures aimed at reducing the negative impact of individual causes and factors.

Conclusion. *The result of applying the methodology is to determine the degree of influence of various factors and operating factors on the overall financial risks of JSC Russian Railways, related to the possible filing of claims by customers. The analysis of tabular data, Ishikawa and Pareto diagrams, and risk maps (the matrix of the influence of individual causes on the overall financial risk for each type of violations) is analyzed.*

The methodology will allow developing of a plan of preventive measures aimed at reducing the overall financial risk on the basis of objective information about revealed violations, acting causes and negative factors, and, therefore, improving the quality of freight transportation, developing customer orientation and improving the image of JSC Russian Railways in the transport market.

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Information about the author:
Nutovich, Veronica E. – Ph.D. (Eng), head of the research laboratory «Freight and commercial work», deputy head of the department of logistic transport systems and technologies of Russian University of Transport, Moscow, Russia, NutovichVE@miit.ru.

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