

# Intelligent management methodology based on the performance results of customs authorities

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**Abstract.** Current trends in the development of the Russian customs service are focused on world experience in building effective systems of foreign trade regulation based on advanced management decision-making methods. Traditional methods and models are transformed into a new management methodology that allows implementing an intelligent decision-making process. The most important task of the customs authorities is to increase the efficiency of customs administration. This problem can be solved by creating and implementing an intelligent management methodology based on the results of their activities. The methodology proposed in the work transforms the mission and the general strategy of the customs authorities into a system of specifically formulated goals, as well as indicators that determine the degree to which each of the set goals is achieved in the context of basic prospects adapted to the activities of the customs authorities. The possibility of intelligent modeling of quantitative assessment of the degree of achievement of each goal increases the efficiency of the described technology. The methodology of intelligent management based on the performance results of customs authorities was proposed, taking into account risk factors and uncertainties that reflect the characteristics of this activity. The methodology is based on the provisions of the strategic management theory, a balanced scorecard, the methodology of intelligent modeling based on fuzzy logic. The obtained results reflect the procedure for implementing the intelligent management methodology, which is based on the balanced scorecard methodology with the possibility of intelligent mathematical modeling of a quantitative assessment of the degree of achievement of each goal, in the work of customs authorities.

## 1. Introduction

The customs authorities, acting as an institutional participant in the international supply chain of goods, have a direct impact on the volume and structure of foreign trade, time and financial costs of participants in foreign economic activity (hereinafter - FEA) and the state, ensuring national security and stability of the country's economy. The development of the activities of customs authorities in accordance with the Public Declaration of the Goals and Tasks of the Federal Customs Service for 2018 is connected, first of all, with the creation of the necessary conditions to increase the usefulness of the sphere of foreign economic activity for all participants in the process of moving goods by simplifying procedures and increasing the efficiency of administration.

An effective solution to the problem of managing customs authorities is hindered by a number of problems existing in this area. These include the problem of an adequate assessment of the results of



their work in the most important strategic areas of activity. To date, in assessing the activities of the customs service, there are various approaches regulated by both international ratings and national regulatory legal acts. These approaches involve the assessment of different areas of activity at different levels of the customs system using a different assessment methodology. This creates the complexity of an unambiguous assessment of activities and the formation of a comprehensive vision of the results and the selection of appropriate management measures to achieve the goals. One way to solve this problem is to use the technology of a balanced scorecard, taking into account the adaptation of its methodology to the characteristics of customs activities.

## 2. Materials and methods

Based on the results-based management methodology, the technology of a balanced scorecard, first introduced by R.S. Kaplan and D.P. Norton in a Harvard Business Review magazine article in 1992 [1], allows structuring the mission and overall strategy of the customs authorities into a system of specifically formulated goals, as well as indicators that determine the degree to which each of the goals is achieved in the context of basic prospects adapted to the activities of the customs authorities.

When choosing mathematical modeling tools, researchers can be guided by various considerations [2]. When choosing a mathematical apparatus for modeling the assessment of the degree of achievement of the goal, it is worth considering the non-zero width of the information granule, due to the high degree of uncertainty of the environment in which customs officials operate. You should also take into account the fact that the model should be, as far as possible, intuitive to the specialist making the decision. The latter will be largely possible if the mathematical apparatus allows simulating human way of thinking. Therefore, it is advisable to apply intelligent mathematical modeling based on fuzzy logic with its subsequent computer implementation. Fuzzy modeling, in contrast to analytical modeling, allows taking into account the degree of reliability of the data, as well as assess different options for the output values [3]. The feasibility of applying this approach, taking into account the formulated requirements for the model, is justified by the founder of the fuzzy set theory L.A. Zadeh. Examples of using this approach simultaneously with bibliometric analysis can be found in the study [4].

## 3. Results

An analysis of the regulatory documents governing the activities of the customs authorities, especially the Strategy for the Development of the Customs Service of the Russian Federation until 2020, allowed identifying three key areas for the development of the customs service of the Russian Federation at the present stage: customs regulation, customs administration and the provision of customs services. At the same time, the following strategic goals correspond to these areas: increasing the level of economic security of the Russian Federation, the full receipt of revenues in the federal budget, creating favorable conditions for conducting foreign economic activity, and developing customs authorities.

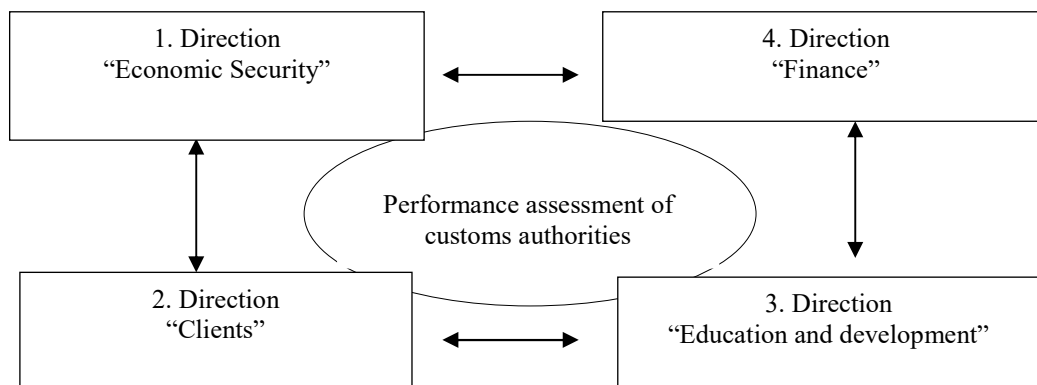
A necessary step in improving the identified areas of activity of the customs authorities is the assessment of their results, which allows, firstly, obtaining feedback from consumers of these results, and, secondly, creates the necessary basis for substantiating subsequent decisions on the intelligent management of this activity.

The intelligent management system based on the results of the activities of the customs authorities requires a reasonable choice of indicators for the assessment, formation and modeling of such an assessment system. In the activities of the customs authorities, various approaches to assessing the results of activities are found, which allow this assessment to varying degrees [5; 6; 7].

The analysis of these works, as well as the results of foreign studies [8] allows concluding that the balanced scorecard is a comprehensive approach that makes it possible to form a system for assessing key goals and directions of development of the customs service. Traditionally, in a system of balanced indicators (hereinafter referred to as BSC), the results of an organization's activity are analyzed according to four aspects (prospects): the prospect of business processes; customer perspective; the

prospect of learning and development; financial perspective. Obviously, the application of these prospects to the results of the activities of the customs authorities requires adaptation taking into account the specifics of this activity, namely: the law enforcement focus of the customs authorities puts the prospect of ensuring economic security to the fore; features of the activities of customs authorities, taking into account the existing level hierarchy, leaves its mark on the prospects of finance (fiscal function), customers (creating conditions for foreign trade activities), and training and development (development of the system of customs authorities), in fact, including the prospect of business processes.

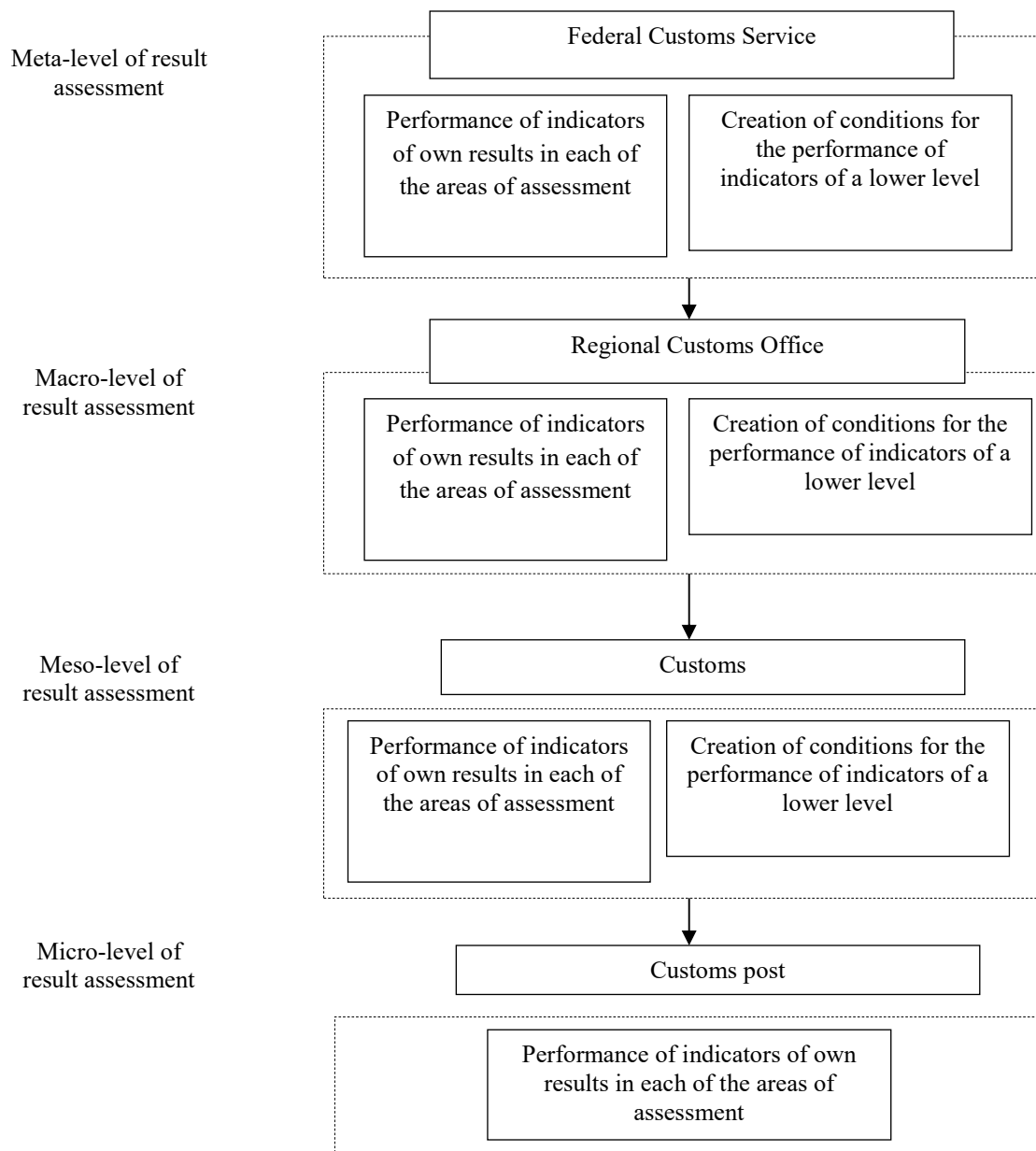
Based on the selected, a system for assessing the performance of customs authorities on the basis of the BSC can be conceptually presented in the form of Figure 1.



**Figure 1.** System for assessing the performance of customs authorities based on the BSC.

The proposed areas of performance assessment require the development of a system of performance indicators (key performance indicators) for each identified area. It should be borne in mind that system for measuring the performance of customs authorities is regulated now by applicable law and essentially covers two levels of assessment: assessment of the performance of the FCS of Russia (Federal Law of 03.08.2018 No. 289-FZ “On Customs Regulation in the Russian Federation”) and an intra-departmental assessment of the activities of customs authorities subordinate to the FCS of Russia (order of the FCS of Russia dated December 28, 2017 No. 2121 “On approval of methods for calculating performance indicators, indicators of the effectiveness of activities and indicative indicators of regional customs offices and customs directly subordinate to the Federal Customs Service of Russia”), - regional customs offices (hereinafter referred to as RCO) and direct subordinate customs (hereinafter - DSC). Moreover, indicators approved by regulatory documents at each level are only partially related.

At the same time, the four-level hierarchical system of customs authorities (FCS of Russia - RCO - customs - customs posts) necessitates the necessity of highlighting exactly four levels of assessment and the formation of a system of indicators for each of these levels in the system of assessing performance. Taking into account the fact of strict hierarchical subordination of a lower level to a higher one (customs posts are subordinate to customs, customs to RCO, etc.), at each level of assessment, indicators should be formed of both the actual performance of the level functioning and the assessment of the conditions (opportunities) created by the higher level for achieving performance indicators, which is reflected in Figure 2.



**Figure 2.** Proposed levels of assessment of the activities of customs authorities based on the BSC.

Taking into account the directions of the formation of performance indicators for customs authorities within the framework of a level management system, strategic goals can be represented in the form of a “goal tree”, at each level of which a specific goal is formed. Assessment of the degree of achievement of the strategic goal in the direction of “Economic Security” reflects the role of customs authorities in ensuring it in the country. An assessment in the direction of “Clients” indicates the created conditions for doing business in the field of foreign trade. An assessment within the framework of the “Training and Development” perspective allows measuring the degree of innovation in the activities of customs authorities. The “Finance” prospect provides an assessment of the volume and completeness of revenues to the federal budget.

Measuring the assessment of the degree of achievement of the strategic goal in each of the directions, we obtain a sequence of assessments  $E_0, E_1, E_2, E_3$ , where  $E_0$  is the assessment of the degree of achievement of the strategic goal at the meta-level, i.e. at the level of the Federal Customs Service;  $E_1$  - assessment of the degree of achievement of the strategic goal at the macro-level, i.e. at

the level of the regional customs administration;  $E_2$  - assessment of the degree of achievement of the strategic goal at the meso-level, i.e. at the customs level;  $E_3$  - assessment of the degree of achievement of the strategic goal at the micro-level, i.e. at the level of the customs post.

We consider the mathematical model of assessment with  $E_i$  ( $i = 0; 1; 2; 3$ ) of the degree of achievement of the strategic goal as described by means of logical inference by the rules using the fuzzy implication operator of the following form:

$$E_i : \left\{ \left( E_{i11}, \dots, E_{i1k_1}, \dots, E_{i41}, \dots, E_{i4k_4} \right) \right\} \rightarrow [0;1], \tag{1}$$

where  $E_{ijs}$  –  $s$ -th key performance indicator of the  $i$ -th level of the  $j$ -th direction of assessment;  $j=1;2;3;4$ ,  $s=1;\dots;k_j$ ;  $k_j$  – number of indicators of the  $j$ -th direction;  $(E_{i11}, \dots, E_{i1k_1}, \dots, E_{i41}, \dots, E_{i4k_4})$  – vector of key performance indicators.

The model proposes to apply a logical inference scheme based on the Mamdani implication by expert fuzzy rules (knowledge) bases:

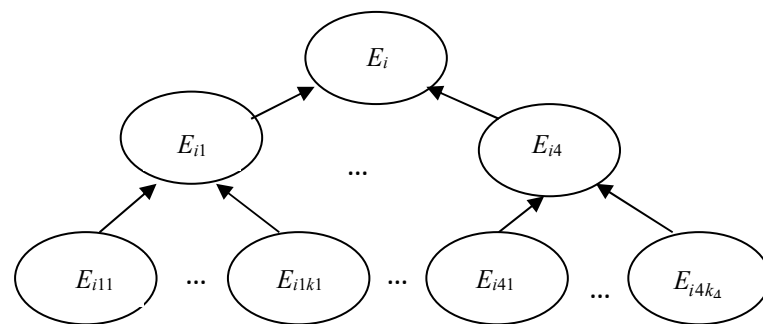
$$\bigcup_{l=1}^{r_j} \left( \bigcap_{\alpha=1}^n x_\alpha = t_\alpha^{\beta l} \text{ with weight } \omega_{\beta l} \right) \Rightarrow (y = d_\beta), \beta = \overline{1; m}, \tag{2}$$

where  $(x_1, x_2, \dots, x_n)$  – vector of input variables;  $t_\alpha^{\beta l}$  – fuzzy term of variable  $x_\alpha$  in line with number  $\beta l$  ( $l = \overline{1; r_j}$ );  $r_j$  – number of rules in the knowledge base;  $m$  – number of terms of the output parameter  $y$ ;  $\omega_{\beta l}$  – rule weight with number  $\beta l$  ( $\omega_{\beta l} \in [0;1]$ );  $\bigcup$  – fuzzy disjunction;  $\bigcap$  – fuzzy conjunction.

The choice of the Mamdani algorithm is determined by the fact that the fuzzy production model obtained as a result of the simulation is transparent (intuitively clear): the information is presented in the form of rules that are available for interpretation by experts. As fuzzy production rules, conditional statements are applied that recreate the human way of thinking, and, in contrast to the scalar multi-criteria assessment model, reflect the real paradigm of conclusions used by experts.

**4. Discussion**

Key performance indicators in accordance with the identified strategic prospects are developed by experts based on the functionality of the customs authorities. To ensure the compactness of the knowledge base and to obtain private assessments in the directions presented in Figure 1, it is advisable to cascade the specified indicators and obtain a hierarchical structure in which the output variable of one knowledge base is the input variable of the knowledge base of the next level [9]. Any scheme in which priorities are established between elements can be considered as some sort of ordered tree. Figure 3 shows an ordered tree of logical inference corresponding to a fuzzy mathematical model of assessment  $E_i$ , where  $i=0;1;2;3$ .



**Figure 3.** Scheme of hierarchical fuzzy knowledge base for modeling the assessment of the degree of achievement of a strategic goal at the  $i$ -th level.

Carrying out intelligent decryption of the graph, it is advisable to separately distinguish the syntactic and semantic aspects. The syntax of tree elements is interpreted as follows. Peaks  $E_{i11}, \dots, E_{i1k_1}, \dots, E_{i41}, \dots, E_{i4k_4}$  are private indicators; peaks  $E_{i1}, \dots, E_{i4}$  - aggregated indicators, which are convolutions  $f_{E_{i1}}, \dots, f_{E_{i4}}$  of private indicators,  $E_{i1} = f_{E_{i1}}(E_{i11}, \dots, E_{i1k_1})$ ,  $\dots$ ,  $E_{i4} = f_{E_{i4}}(E_{i41}, \dots, E_{i4k_4})$ ; the peak  $E_i$  is a convolution  $f_{E_i}$  of aggregated indicators:  $E_i = f_{E_i}(E_{i1}, \dots, E_{i4})$ . Semantic interpretation of the graph elements: peaks  $E_{i1}, E_{i2}, E_{i3}$  and  $E_{i4}$  - assessments of the degree of achievement of the goal, respectively, in the areas of "Economic Security", "Clients", "Training and Development", and "Finance" at the  $i$ -th level;  $E_i$  - (integrated) assessment of the degree of achievement of the goal at the  $i$ -th level. Each indicator is treated as a linguistic variable. Convolutions  $f_{E_{i1}}, \dots, f_{E_{i4}}$  and  $f_{E_i}$  are made using the logical inference on expert fuzzy knowledge bases (2).

The degree of achievement of the goal is assessed not only at the levels of the customs post, customs and regional customs offices, but also at the level of the Federal Customs Service. At the same time, the proposed models make it possible to predict the assessment at each level and identify problem areas subject to managerial impact.

The computer implementation of the models is proposed to be carried out in the mathematical computing environment MatLab using the Fuzzy Logic Toolbox package. An example of modeling assessments of the degree of achievement of a goal at the meso and micro levels with its subsequent computer implementation can be found in the works of the following authors [10, 11].

Taking into account defuzzification based on the resulting membership function, a component-wise definition of the expression (1) has the following form

$$E_i : (E_{i11}, \dots, E_{i1k_1}, \dots, E_{i41}, \dots, E_{i4k_4}) \mapsto \|E_i\|, \quad (3)$$

where  $\|E_i\|$  - value of defuzzified function  $E_i$  on the input set  $(E_{i11}, \dots, E_{i1k_1}, \dots, E_{i41}, \dots, E_{i4k_4})$ , or a quantitative assessment of the degree of achievement of the strategic goal at the  $i$ -th level. Since  $\|E_i\| \in [0; 1]$ , then on the set  $\{\|E_0\|, \|E_1\|, \|E_2\|, \|E_3\|\}$  we can enter the usual linear relation " $\leq$ " and form an ordered information-measuring space  $\|E\| = \langle \{\|E_0\|, \|E_1\|, \|E_2\|, \|E_3\|\}; \leq \rangle$  based on the knowledge, where  $\|E_0\|, \|E_1\|, \|E_2\|, \|E_3\|$  - the results of the models (3), provided that  $i$  takes the values 0;1;2;3, respectively. All obtained assessments can be arranged in one block chain  $\|E_0\| \rightarrow \|E_1\| \rightarrow \|E_2\| \rightarrow \|E_3\|$  reflecting the degree of achievement of the strategic goal in each direction. The first block in the chain should be considered as a separate case, since it does not have a parent block. In a set-theoretic sense, this means that you can compare assessments of the degree of achievement of each goal at each level. The strategic goal is considered achieved if the following chain of inequalities is fulfilled:  $\|E_0\| \leq \|E_1\| \leq \|E_2\| \leq \|E_3\|$ . Each inequality is a guarantee of ensuring the creation of conditions for the fulfillment of indicators of a lower level (Fig. 2), which creates the necessary methodological basis for the effective functioning of the intelligent management system based on the results of the activities of customs authorities. Moreover, the assessment  $E_0$  cannot be less than the allowable assessment developed on the basis of reference values on a scale from 0 to 1. If the condition that the management system in the customs authorities must meet is that the allowable assessment at the meta-level should be equal to one, then quantitative values of assessments of the degree of achievement of the goal at all lower levels should also be equal to one. If, for  $i < j$ , the condition  $E_i \leq E_j$  is not fulfilled, then measures should be developed and implemented to improve the performance of customs officers. If, for objective reasons, this coordination of actions at all levels cannot be achieved, then a system of

acceptable assessments of each level is developed, which are the lower bounds for the values of the estimates  $\|E_0\|, \|E_1\|, \|E_2\|, \|E_3\|$ . These minorants are the main target indicators and are used to make management decisions.

## 5. Conclusion

The approach proposed in the work on the formation of an intelligent management methodology based on the results of activities of customs authorities allows creating a comprehensive system for assessing the results of activities of customs authorities on key prospects for their development from the point of view of the interests of participants in this activity. The proposed methodology is based on the level structure of indicators, the assessment of both the results achieved in the selected levels and directions, and the possibility of meeting indicators. At the same time, the obtained assessments reflect knowledge of the management system, can be compared and therefore taken as the basis for achieving a coordinated understanding of the problem situation due to the communicative actions of actors at each level of the managerial structure, which increases the effectiveness of management according to the results of activities and solves the problem of a reasonable choice of appropriate management measures to achieve set goals.

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