Methodology Control Function Realization Within The Electronic Government Concept Framework

T. N. Saurenko, V. G. Anisimov, E. G. Anisimov, M.A. Sonkin

Abstract: Governance/control is one of the most important functions of government. Therefore, automation of control processes based on information computer technology's introduction is an urgent problem of creating an electronic government. The article proposes a methodological approach to the control functions of public authorities' implementation in e-government concept framework. The approach is based on the principle of selective control. The expediency is conditioned upon the impossibility of total control due to limited resources. Optimization of control processes is based on using appropriate models of mathematical programming. The combined application of the selectivity principle and optimization model reduces the state's expenditures for implementation of control functions while ensuring the required quality control. In whole, the methodological approach considered in this paper forms a basis for specific models and methods, formation ensuring the introduction of computer technologies into the control processes of e-government.

Index Terms: e-government, control functions, resource costs, the selectivity principle, and optimization.

1.INTRODUCTION

Performance of control functions by the state bodies is aimed at identifying violations of legislation in the controlled process that leads to negative consequences for the state and society [1-4]. It is associated with certain input requirements of both government and participants of controlled processes. Limitation of resources does not permit total control. Thus, selectivity is a fundamental principle of control activity of state bodies. The essence of this technique lies in the fact that at each moment of time, not all the objects controlled by one or another government body are subject to control, but just a limited sample of them. In this regard, generally, control procedure includes two successive stages; the first stage is about choosing a subset of objects to be controlled and the second stage is on carrying out necessary control activities for each of the selected objects [5-8]. The implementation of the first stage is associated with a risk of selecting a subset of the full set of objects incorrectly. Possibility of incorrectness is explained by including objects that do not contain violations – this identification is the goal of the control activity of a government body and abandoning objects containing violations outside the controlled part of the set [9-10]. This leads to unjustified expenses of state resources and excessive costs for participants of a controlled process, as well as losses of the state and society as a result of undetected violations [11]. The implementation of the second stage is associated with a risk of non-revealing existing violations in controlled objects while monitoring. Also, non-detection of the same leads to unjustified expenses and losses caused by violations. Precise consideration of these risks helps in maximizing the possible reduction (with available resources) of damage to both state and society [12]. In case of risk events is an essential problem of the state bodies control activities. Its solution is extremely difficult in both organizational and scientific- technical aspects [13-14]. Formation of a methodological approach to its solution is the goal of this article. At the same time, the main attention is paid to its first stage, since without successful controlled objects sampling further control activities are meaningless.

- *T.N.Saurenko, Moscow, Peoples Friendship University of Russia (RUDN), Russia, E-mail: tanya@saurenko.ru*
- *V. G. Anisimov , Peter the Great St. Petersburg Polytechnic University Russia, E-mail: an-33@yandex.ru*
- *E. G. Anisimov, Customs department, Peoples Friendship University of Russia (RUDN), Russia, E-mail: an-33@rambler.ru*
- *M.A. Sonkin, Information Technology Division, Tomsk polytechnic university, Russian, E-mail: sonkinmichael1@gmail.com*

2. ESSENCE OF THE METHODOLOGICAL APPROACH

The choice of a set object to be controlled by a set of objects of one or another class is based on analysis of information available to the controlling state body on each of the considered set objects and information on the results of previous control acts with objects of this class. The large amount and variety of this information leads to formalize an analysis process. To this end, every object under control at a moment of time t will be represented as the corresponding vector.

$$X^{*k}(i,t) = \{x_1^{*k}(i,t),\ x_2^{*k}(i,t),\ \dots,\ x_{n-1}^{*k}(i,t),\ x_N^{*k}(i,t)\},\quad k = 1,2,\dots K,\quad i \in I^k(t) \qquad \dots(1)$$

where k - object class identifier;

K - Number of object classes controlled by the considered state body;

i - Object identifier;

$I^k(t)$ - set of objects of k-class, controlled at the moment of time t by the considered state authority;

n - Parameter identifier of the controlled object;

N -number of parameters characterizing each controlled object of k-class;

$x_n^{*k}(i,t)$ - Actual value of n-parameter of i-object of k-class at t-time.

The “a priori” information about a control object of the state control body will be represented as a vector

$$X^k(i,t) = \{x_1^k(i,t),\ x_2^k(i,t),\ \dots,\ x_{n-1}^k(i,t),\ x_N^k(i,t)\},\quad k = 1,2,\dots K,\quad i \in I^k(t) \qquad \dots(2)$$

where $x_n^k(i,t)$ is the information about the n-parameter of the control object arriving to the state control body.

With such formalization, violations are manifested in submitting unreliable information about the objects of control in the state control body. This means a mismatch of the components of vectors (1) and (2). This discrepancy will be represented as a vector;

$$\Delta X^{k}(i,t) = \{\Delta x_1^k(i,t),\ \Delta x_2^k(i,t),\ \dots,\ \Delta x_{n-1}^k(i,t),\ \Delta x_N^k(i,t)\},\quad k = 1,2,\dots K,\quad i \in I^k(t) \quad \dots(3)$$

where $\Delta x_n^k(i,t)$ is the deviation of the n-th component of the vector (3) from its real value, determined by the corresponding component of the vector (2). If the components of vectors (2) and (3) are measured on an absolute scale, then we have

$$\Delta x_n^k(i,t) = x_n^{*k}(i,t) - x_n^k(i,t),\qquad n = 1,2,\dots N \quad \dots(4)$$

If the a priori information about the object of control contains only valid information about its parameters, then (3) is a “zero” vector and in relation to this object the control measures are not expedient. If vector (3) contains nonzero components, then the control body should open these deviations to determine the violations corresponding to these deviations and take measures to eliminate them. The opening of deviations is associated with the conduct of one or another set of control measures. Their implementation, in turn, requires the involvement of appropriate human, time, financial, material and other resources.

Within the framework of our formulated problem, the first stage of the control procedure consists in the choice of a set of objects $I^k(t)$ with nonzero vectors from the set of subsets $I^{*k}(t) \subseteq I^k(t)$ (3). This choice is carried out in conditions of a priori uncertainty. In this regard, in the selection process, a subset $\hat{I}^k(t) \subseteq I^k(t)$ is formed, which is not always the same in comparison with the subset $I^{*k}(t)$. The considered choice is ideal if

$$I^{*k}(t) \bigcap \hat{I}^k(t) = I^{*k}(t) = \hat{I}^k(t), \quad \dots(5)$$

and absolutely not perfect if

$$I^{*k}(t) \bigcap \hat{I}^k(t) = \varnothing, \quad \dots(6)$$

The relation (5) means that all objects in which there are violations and not a single object without violations are selected for control. The relation (6) indicates that in the set of objects selected for control, there is not a single object with violations. All the real results of the choice lie in the interval between the ideal and the non-ideal, that is, for them the relation

$$I^{*k}(t) \bigcap \hat{I}^k(t) = I_1^k(t),\quad I_1^k(t) \neq \varnothing,\quad I_1^k(t) \neq I^{*k}(t), \quad \dots(7)$$

The subset $I_1^k(t)$ in (7) contains all the objects in the sample $\hat{I}^k(t)$ for which the vector (3) is nonzero, i.e., objects that have signs of violations.

Denote:

$I_2^k(t)$ -set complement to $I_1^k(t)$ $I^{*k}(t)$;

$U\{I_1^k(t)\}$ - the expected damage from the non-detection of violations caused by the objects of control included in the set;

$U\{I_2^k(t)\}$ - the expected damage from the non-detection of violations caused by the objects of control included in the set $I_2^k(t)$.

Given these designations, the immediate expected relative effect of the first stage of the control procedure is determined by the ratio:

$$W^k(t) = \frac{U\{I_1^k(t)\}}{U\{I_1^k(t)\} + U\{I_2^k(t)\}},\quad k = 1,2,\dots, K, \quad \dots(8)$$

In the simplest case, a relative number of identified objects of control containing violations are taken as an indicator of damage. Then, the quantities $U\{I_1^k(t)\}$ and $U\{I_2^k(t)\}$ are quantitatively equal to the powers of the corresponding sets $I_1^k(t)$ and $I_2^k(t)$.

Relative effect, determined on the basis of relation (8), at ideal choice is equal to unity , and zero otherwise. Naturally, in the process of control, every government agency seeks to select objects as close as possible to the ideal. At the same time, it proceeds from the information that it contains, and this information usually includes:

1) Data on the parameters of a set of controlled objects $I^k(t)$ at a current time;

2) Data on the results of previous control activities over similar objects:

$$\tilde{I}^k(\tau < t) = \tilde{I}_1^k(\tau < t) \cup \tilde{I}_2^k(\tau < t), \quad \dots(9)$$

where $\tilde{I}^k(\tau < t)$ is - set of objects checked in the course of previous control activities (up to time point t);

$\tilde{I}_1^k(\tau < t) \subseteq \tilde{I}^k(\tau < t)$ - subset of objects in which violations were detected during previous control activities;

$\tilde{I}_2^k(\tau < t) \subseteq \tilde{I}^k(\tau < t)$ - subset of objects in which no violations were detected in the course of previously;

3) operational data on the control objects and possible violations, received from additional sources of information both (open and closed).

The application of this information in the interests of forming a subset of objects for carrying out control activities is based on a principle “it was so - it will be so”. It assumes the presence of deterministic or statistically stable links between the vector components’ values (2) and possibility of violations, identification of which is the goal of the control procedure. Specific methods for implementation of this principle can be divided into the following relatively independent groups:

1) methods using risk profiles;
2) techniques based on identification of anomalous parameters’ values of control objects;
3) techniques based on construction of statistical models that establish statistically stable links between the vector components’ values (2) and violations;
4) methods based on operational data on control objects and possible violations, received from additional sources;

5) complex methods for selecting objects for control activities.

Detailed consideration of these techniques within a single article is not possible. Therefore, further, we consider one of the promising approaches to statistical models' construction that establish statistically stable links between the vector components' values (2) and violations, on the methodological level of synthesis. The essence of the approach is as follows:

1. Basing on information on the results of previous control activities over similar objects, single-dimensional empirical functions are built for distribution of the violations' probability for each component of the vector (2) of objects controlled at the current time.

2. By convolving single-dimensional distributions (for example, using the apparatus of generating functions), the multidimensional distribution function is constructed for violations' probability for objects controlled at the current time.

3. Admissible level of violations' probability is set, and objects falling into an unacceptable area are included in the subset $\hat{I}^k(t)$ of objects for which conducting control activities is advisable.

When implementing this approach, the violations probability distribution functions for each component of the vector (2) of currently controlled objects can be built up by both a subset $\tilde{I}_1^k(\tau < t)$ of objects with previously detected violations and a subset $\tilde{I}_2^k(\tau < t)$ where violations were not identified during previous control activities. In this case, one should keep in mind the peculiarity of the state control process, which lies in the fact that undetected violations are henceforth not clearly manifested and introduce false information into the subsets $\tilde{I}_1^k(\tau < t)$ and $\tilde{I}_2^k(\tau < t)$. Consequently, built according to the $\tilde{I}_1^k(\tau < t)$ and $\tilde{I}_2^k(\tau < t)$ subsets, single- dimensional distribution functions of violations' probabilities for each of the vector (2) components will not be identical to each other. This explains the task of finding the ways to account this false information. Its solution can be obtained on the basis of the so-called synthesis of non-alternative hypotheses [1].

In general, the considered approach provides fairly correct using the available “a priori” information to build a subset $\hat{I}^k(t)$ of objects for which conducting control activities is advisable.

The peculiarity of the control activity of state bodies lies in the limited resources for implementation of control activities in respect of objects included in the set $I_1^k(t)$. Their limitations can lead to necessity of reducing the power of this set, that is, to exclude a number of objects from it and thereby reduce the number of control activities. Such actions lead to reduction of control effect. Moreover, due to the difference in resource costs for identifying various deviations of real parameters of objects (values of vector components (1)) and declare ones (vector components (2)), the reduction of the effect depends on what objects are excluded from the set $I_1^k(t)$. This circumstance necessitates the optimization of control processes with restrictions on the control body resources. In the interests of the formalized presentation of the optimization procedure, the control body's resources are divided into non-recoverable and recoverable, divisible (continuous) and indivisible (discrete). The control optimization procedure is based on an inherent mathematical programming model [2 - 7]. We will consider the general nature of these models on the example of the choice of control objects in case of restrictions for non-recoverable continuous resources in the control body. Let's introduce the notation:

$R^k(i,t) = \{R_1^k(i,t),\ R_2^k(i,t),...,\ R_{m-1}^k(i,t),\ R_M^k(i,t)\}$ -vector of resources required for the implementation of control activities in relation to the i-object of the k-class at time t;

$R_m^k(i,t)$ -volume of divisible non-recoverable resources of the m-species, necessary for implementation of control activities in relation to the i-object of the k-class at time t;

M-number of types of divisible non-recoverable resources necessary for implementation of control activities in relation to the i-object of the k-class;

$I_3^k(t) \subseteq \hat{I}^k(t)$ - a subset of objects from $\hat{I}^k(t)$ for which a decision has been made to conduct control activities;

$I_4^k(t) \subseteq \hat{I}^k(t)$ - a subset of objects from $\hat{I}^k(t)$ for which control activities are not carried out.

Taking accepted notations into account, the procedure for choosing from a variety $\hat{I}^k(t)$ of objects for implementation of control activities can be formalized as the following problem of mathematical programming: define subset $I_3^k(t) \subseteq \hat{I}^k(t)$ of objects for implementation of control activities to ensure compliance with the conditions

$$W^k(t) = \frac{U\{I_3^k(t)\}}{U\{I_3^k(t)\} + U\{I_4^k(t)\}} \xrightarrow[I_3^k(t)]{} \max, \quad k = 1,2,...,K, \qquad \text{…(10)}$$

under restrictions

$$\sum_{i \in I_3^k} R_m^k(i,t) \le R_m^{*k}(i,t), \quad m = 1,2,...,M, \qquad \text{…(11)}$$

where $R_m^{*k}(i,t)$ - is the volume of divisible non-recoverable m-type resources available to the control body at the moment of time t.

3.CONCLUSION

In general, the addressed provisions constitute a general methodology for applying a risk-based approach in performing control functions of state bodies. They form a basis for building up specific models and methodologies ensuring introduction of computer technologies into the processes of electronic government control activities.

REFERENCES

[1] Anisimov, V.G., Zegzhda, P.D., Anisimov, E.G., Bazhin, D.A. A risk-oriented approach to the control arrangement of security protection subsystems of information systems. Automatic Control and Computer Sciences, 2016, 50(8), pp. 717-721.

[2] Anisimov, V., Anisimov, E., Sonkin, M. A resource-and-time method to optimize the performance of several interrelated operations. International Journal of Applied Engineering Research, 2015, 10(17), pp. 38127-38132.
[3] Anisimov, V.G., Anisimov, Ye.G. A branch-and-bound algorithm for one class of scheduling problem. Computational Mathematics and Mathematical Physics, 1992. 32(12), pp. 1827-1832.
[4] Alekseyev, A.O., et al Application of Markov chains in estimating the computational complexity of the simplex method. Soviet journal of computer and systems sciences, 1988, 26(5), pp. 130-134.
[5] Alekseyev, A.O., et al The use of duality to increase the effectiveness of the branch and bound method when solving the knapsack problem. USSR Computational Mathematics and Mathematical Physics, 1985, 25(6), pp. 50-54.
[6] Anisimov, V.G., Anisimov, E.G. A method of solving one class of integer programming problems. USSR Computational Mathematics and Mathematical Physics, 1989, 29(5), pp. 238-241.
[7] Anisimov, V.G., Anisimov, E.G., Saurenko, T.N., Sonkin, M.A. The model and the planning method of volume and variety assessment of innovative products in an industrial enterprise. Journal of Physics: Conference Series, 2017 803(1).
[8] Sonkin M.A., Maslova N.R., Baidalee S.A., Semyikin S.V., Pleshkov A.G. Creating and Developing Local Information System of the Tomsk Region. information society, 2016, 1, pp.9-18.
[9] A Framework for Electronic Government : Evolution , Enablers and Resource Drainers, Shirish C. Srivastava, 2004.
[10] Balutis, A.P. "E-government 2001: Understanding the Challenge and Evolving Strategies," Public Manager (30:1), 2001, pp. 33-37.
[11] Li, F. "Implementing E-government Strategy in Scotland: Current Situation and Emerging Issues," Journal of Electronic Commerce in Organizations (1:2), 2003, pp 44-65.
[12] Guidelines on Information security, Electronic Banking, Technology risk management and cyber frauds, Reserve Bank of India Department of Banking Supervision, Central Office, Mumbai, link: https://rbidocs.rbi.org.in/rdocs/content/PDFs/GBS300411F.pdf (accessed on 03.12.2019).
[13] Ethical and Policy Issues in Research Involving Human Participants, Volume I Report and Recommendations of the National Bioethics Advisory Commission Bethesda, Maryland August 2001. Link: https://www.onlineethics.org/cms/8033.aspx.
[14] Louis A. Allen, Management and Organization, McGraw-Hill Kogakusha, Ltd.