International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-11, September 2019

Informational Support of Cash Flow Management Processes in Public Administration

Viktoriya Onegina, Mykola Husiatynskyi, Valerii Nemchenko, Tetiana Mayorova, Lyudmila Bohrinovtseva, Denys Sedikov

Abstract*: Management functions of the state in the field of regulation of financial flows is the basis of a modern market economy. The intricate and complex nature of the control object itself also forces us to continually look for ways to increase the effectiveness of both analysis and planning techniques. High-quality informational support predetermines the effectiveness of managerial decisions in the sphere of regulation of financial flows. The wide variability of information support is the key to the ability to apply effectively administrative impact. At the same time, accounting, control and analysis are interconnected management functions that provide information support for making management decisions at any level. The information analysis technique based on fuzzy decision trees is an innovative and well-proven way to provide government institutions with a reliable analytical tool.

***Keywords* : Cash Flow, Informational Support, Management, Public Administration.**

I. INTRODUCTION

The main goal of managing the state's cash flows is to ensure financially balanced development by balancing the volumes of receipts and expenditures of budgetary and extra-budgetary funds and synchronizing them over time. It is natural that, like any control system, it should be provided with the necessary information base for making informed and informed decisions [1-3].

From the state, financial flows should be understood as the monetary value movement of any elements of state property or objects of state property and, accordingly, any sources of their formation [4-6]. In this case, action is understood as a change in value, quantity, proportion or redistribution between any units of the economy [7].

The general functions of managing financial flows reflect the technological stages of management, which boil down to information and analytical support for the decision-making process. Decision making itself is carried out in the form of management functions that reflect the temporary stages of management: planning, organization of command and control.

The methodology of managing financial flows of the state should take into account their distinctive properties [8-10]:
1) their movement occurs in monetary (value) form;
2) purposefulness (money funds are created and spent strictly in accordance with the intended purpose);
3) a high degree of organization, due to the need to coordinate the interests of the subjects of the financial system;
4) regulation (the movement of financial resources is carried out in accordance with laws, plans, programs and other regulations);
5) the need for monitoring the implementation of rules for the movement of financial resources.

In general terms, the scheme of state financial flows is presented in Fig.1.

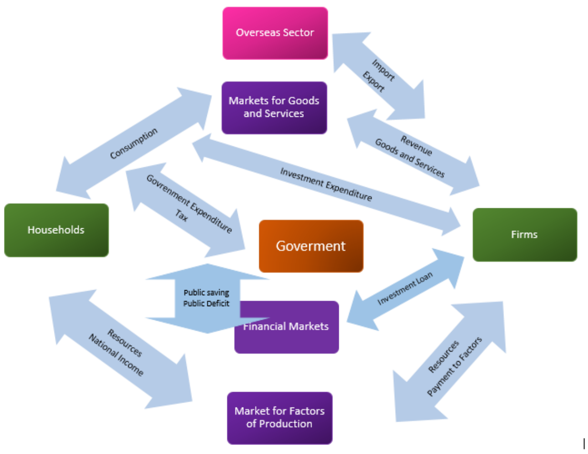

Fig. 1. The scheme of financial flows of the state.

It should also be borne in mind that the effective management of financial flows at the state level must meet specific requirements, namely:
1) to ensure the balance of income and expenditure of funds in any time interval to prevent a large deficit or surplus;
2) provide the necessary opportunities for free manoeuvring with financial resources;
3) ensure the timely identification of deviations of the actual parameters of cash flow from its planned value and determine their causes to take the necessary measures aimed at preventing them in the future

Manuscript published on 30 September 2019.
***Correspondence Author(s)**
Viktoriya Onegina*, Department of Economics and Marketing, Kharkiv Petro Vasylenko National Technical University of Agriculture, Kharkiv, Ukraine
Mykola Husiatynskyi, Department of Management, University of the State Fiscal Service of Ukraine, Irpin, Ukraine
Valerii Nemchenko, Department of Accounting and Audit, Odessa National Academy of Food Technologies, Odessa, Ukraine
Tetiana Mayorova, Department of Corporate Finance and Controlling SHEE "Kyiv national economic university named after V. Hetmana", Kyiv, Ukraine
Lyudmila Bohrinovtseva, Finansial Markets Department, University of State Fiscal Service of Ukraine, Irpin, Ukraine
Denys Sedikov, Department of Management and Logistics, Odessa National Academy of Food Technologies, str. Kanatnaya 112, Odessa, Ukraine

It is possible to evaluate the effectiveness of managing financial flows both from the standpoint of achieving a particular economic effect and achieving a specific goal. It is also necessary to understand that without the presence of evaluation criteria, management effectiveness can be estimated very approximately, therefore the necessary criteria can be called:

- liquidity ratio of financial flow;
- profitability ratio of financial flow;
- coefficient of sufficiency of financial flows from current activities;
- coefficient of accumulation of financial resources;
- coefficient of consumption of financial resources;

This set of indicators allows you to evaluate the structure, dynamics and effectiveness of business flow, and to identify ways of optimal management.

II. METHODOLOGY

One of the ways to make the right managerial decision based on the available information is to provide its analysis using the methodology of fuzzy decision trees. This technique is especially useful if the analyzed data is characterized by insufficient accuracy and completeness [11-13].

A feature of the decision tree methodology is that each of the options belongs to a specific node. If we are talking about a fuzzy decision tree, that is, the tree is constructed using fuzzy logic, then in this case we can only talk about the degree to which a particular variant belongs to a particular node.

To bring the initial data to a homogeneous form, we use the normalization formula:

$$X_{index} = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}} \quad (1)$$

where X_{index} is an index whose values are in the range [0,1], x_i is the numerical indicator that must be represented as an index,

$x_{\min}$ and $x_{\max}$ are the minima and maxima values that x_i can take.

We define the coefficient as the ratio of the options $D_j \in S^N$ of the node N of the target value i, calculated by the formula:

$$P_i^N = \sum_{S^N} \min\left(\mu_N(D_j)\,,\mu_i(D_j)\right) \quad (2)$$

where $\mu_N(D_j)$ is the degree of belonging of the variant D_j to the node N,

$\mu_i(D_j)$is the degree of belonging of the example relative to the target value i,

$S^N$is the set of all variants of the node N. Calculate the coefficient:

$$P^N = \sum_i P_i^N \quad (3)$$

which denotes the general characteristics of the variants of the node N, since fuzzy logic is involved, we use the ratio $\frac{P_i^N}{P^N}$, which takes into account the degree to which the variants belong to a certain attribute.

Now we define an average estimate of the amount of information to determine the class of an object from the set P^N:

$$E(S^N) = -\sum_i \frac{P_i^N}{P^N} \times \log_2 \frac{P_i^N}{P^N} \quad (4)$$

At the next stage of creating a fuzzy decision tree, the algorithm calculates the entropy for partitioning by attributing A with values a_j:

$$E(S^N, A) = \sum_j \frac{P_i^{N|j}}{P^N} \times E(S^{N|j}) \quad (5)$$

where is the node N | j is a child of node N.

The algorithm selects the attribute A^x with the maximum increase in information:

$$G(S^N, A) = E(S^N) - E(S^N, A) \quad (6)$$

$$A^x = argmax_A G(S, A) \quad (7)$$

The node N is divided into several child nodes N | j. The degree to which variant D_k belongs to the attribute a_j. Child Node N | j is deleted if all variants in it have a membership degree of zero. The algorithm is repeated until all variants of the node are classified or until all attributes are used for splitting.

Belonging to the target class for the new record is found by the formula:

$$\delta_j = \frac{\sum_l \sum_k P_k^l \times \mu_l(D_J) \times x_k}{\sum_l (\mu_l(D_j) \times \sum_k P_k^l)} \quad (8)$$

where P_k^l is the coefficient of the ratio of tree leaf options l for the value of the target class k, $\mu_l(D_j)$ is the degree to which the variant belongs to the tree node l, x_k is the membership of the value of the target class k to the positive value of the classification outcome.

III. EXPERIMENT

As an experimental base for verification, the situation was selected regarding the management of the financial flow of the territorial-administrative unit, associated with the redistribution of excess budgetary funds to implement new investment projects.

The list of projects and initial data are presented in Table 1, while:

x^1 - the scale of the project (an indicator of the complexity and complexity of the implementation and further maintenance of the project);

x^2 - the estimated amount of financing (a quantitative indicator of the degree of funding from the budget of the administrative unit);

x^3 – the rating of the social significance of the project (expert assessment by questioning about the interest of public organizations, trust funds and the population in the implementation of the project);

x^4 - the level of risk justification (summary expert assessment of the possible consequences of both delays in implementation and potentially negative effects in the future);

x^5 - an indicator of the political feasibility of implementation (a parameter derived on the basis of comprehensive information and analytical examination of the impact of the project on the political situation both in the region and in the country as a whole).

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Table- I: Initial data and coefficients for constructing a fuzzy decision tree

#	Investment projects	x^1	x^2	x^3	x^4	x^5
1	Investment projects	0,71	12,47	1	1	0,01
2	Reorganization of transport infrastructure (district №5)	3,06	12,47	0	4	0,02
3	Primary education subsidies	0,32	16,63	0	2	0,09
4	Modernization of pumping stations	0,85	16,63	8	8	0,02
5	Agricultural land disinfection	4,11	16,63	0	3	0,02
6	Project "Safe Streets"	3,26	20,78	9	6	0,07
7	Project "Stop traffic jams"	5,73	20,78	9	6	0,1
8	Reconstruction of the city historical museum	1,28	24,94	4	6	0,02
9	The construction of a new storage terminal for heavy vehicles	0,44	29,1	3	5	0,01
10	Repair and modernization of the fire station (district No. 2)	2,1	29,1	5	5	0,15
11	Recycling Labeling Project	5,21	29,1	5	5	0,09
12	Creation of additional capacities in the wastewater treatment system	1,88	33,25	0	7	0,08
13	Purchase of additional equipment for the school of civil aviation pilots	2,88	33,25	0	7	0,07
14	Modernization of equipment and facilities of the incinerator	3,67	37,41	0	10	0,02
15	Modernization of analysis systems and disaster warning	0,21	37,41	0	8	0,02
16	Financing innovative investment reimbursement project	1,08	37,41	2	7	0,01
17	Project for Environmental Control of Water Consumption	1,44	37,41	10	0	0,06
18	Construction of additional housing by a young specialist	2,58	37,41	6	8	0,06
19	Financing of test and repair work on the replacement of water locks in the sewer system	2,08	41,57	0	10	0,01
20	Funding for additional courses in primary and secondary schools	0,32	41,57	0	10	0,02
21	Modernization of police vehicles (a comprehensive three-year project)	4,84	41,57	7	9	0,06
22	Construction of additional electrical substations (areas No. 3 and No. 4)	6,15	41,57	8	10	0,06
23	Project "Good Heat" (heating systems)	4,25	41,57	10	8	0,02
24	Reconstruction of the building of the trading exchange	6,34	41,57	10	8	0,15
25	Project for the comprehensive replacement of automatic fire extinguishing systems	6,03	41,57	6	10	0,11

To begin with, we calculate the degree to which each variant belongs to the attribute values. A general view of the function for attributes is shown in Fig. 2. Three-level scale - “low”, “medium”, “high” significantly simplifies the process of constructing a decision tree.

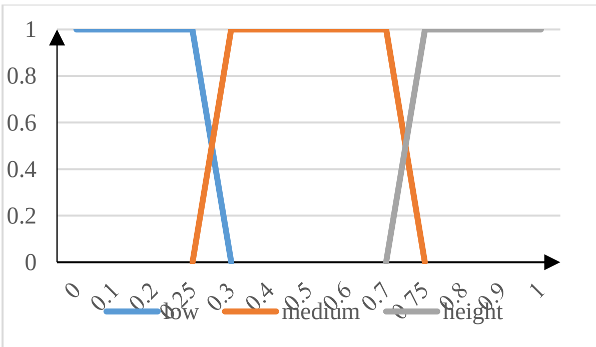

Fig. 2. Membership function graphs.

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In the beginning, it is necessary to find the value of total entropy:

$$E(S^N) = -\sum_i \frac{P_i^N}{P^N} \times \log_2 \frac{P_i^N}{P^N} = 0{,}99$$

We find the coefficient of characteristic examples of the node N by the formula:

$$P^N = \sum_i P_i^N \quad (9)$$

$$P_{yes} = \sum_i x_i^1 = 10{,}71 \;,\; P_{no} = \sum_i (1 - P_{yes}) = 14{,}29,\; P = P_{yes} + P_{no} = 25$$

Similar calculations are performed for the criteria 2 x, 3 x, 4 x. The calculation results are shown in Table 2:

Table- II: Values of total entropy for each criterion

	x2			x3			x4			x5		
	low	medium	height	low	medium	height	low	medium	height	low	medium	height
Pyes	7,31	2,29	2,77	3,11	4,06	4,5	1,14	5,47	6,37	4,63	6,26	2,11
Pno	7,98	3,37	4,6	8,72	3,4	3,13	3,78	7	5,78	10,41	0,74	2,11
E in bits	1	0,97	0,96	0,83	0,99	0,98	0,78	0,99	1	0,89	0,49	1

Next, we calculate the entropy $E(S^N)$ and the increase in information $G(S^N)$ for each attribute. For clarity, the results are shown in Table. 3.

Table- III: Entropy value for each criterion and maximum growth of each attribute

	x1	x2	x3	x4	x5
E(SN)	0,98	0,98	0,92	0,92	0,99
G(SN)	0,01	0,01	0,07	0,03	0,02

At the next step of the algorithm, each record must calculate the degree of membership in each new node. Nodes to which more than one record belongs are deleted from the tree.

The resulting decision tree consists of three branches grouped by factor x^1 - the scale of the projects

In the first branch, the most ambitious plans fall, the branch is presented in Fig. 3. This branch includes 8 of the largest and most complex projects, while their implementation will cause the most extensive public resonance (possibly both positive and negative). At the same time, the share of budget funds in 4 projects is relatively small, and in 2 other two significant.

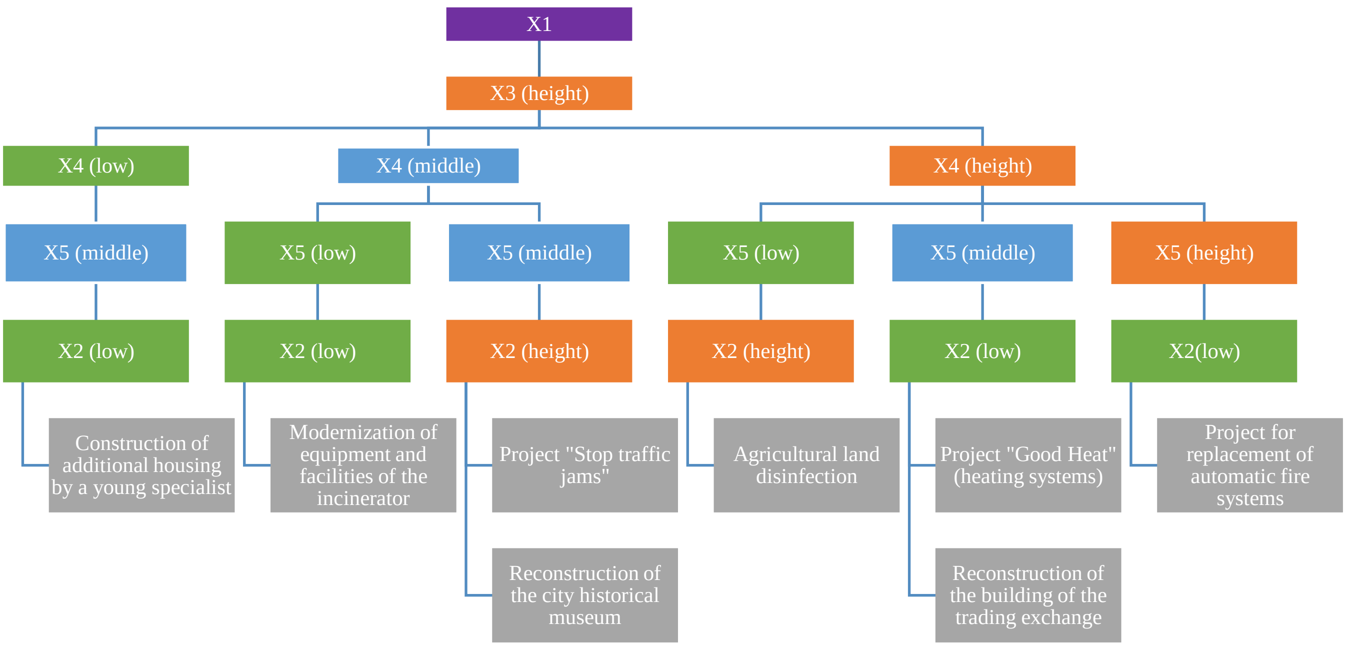

Fig. 3. The first branch of the decision tree (large-scale projects).

The second branch (Fig. 4) unites six projects, characterized by medium social significance, as well as medium and low participation of budget funds in their implementation (3 projects each), despite this two projects have far-reaching political prospects.

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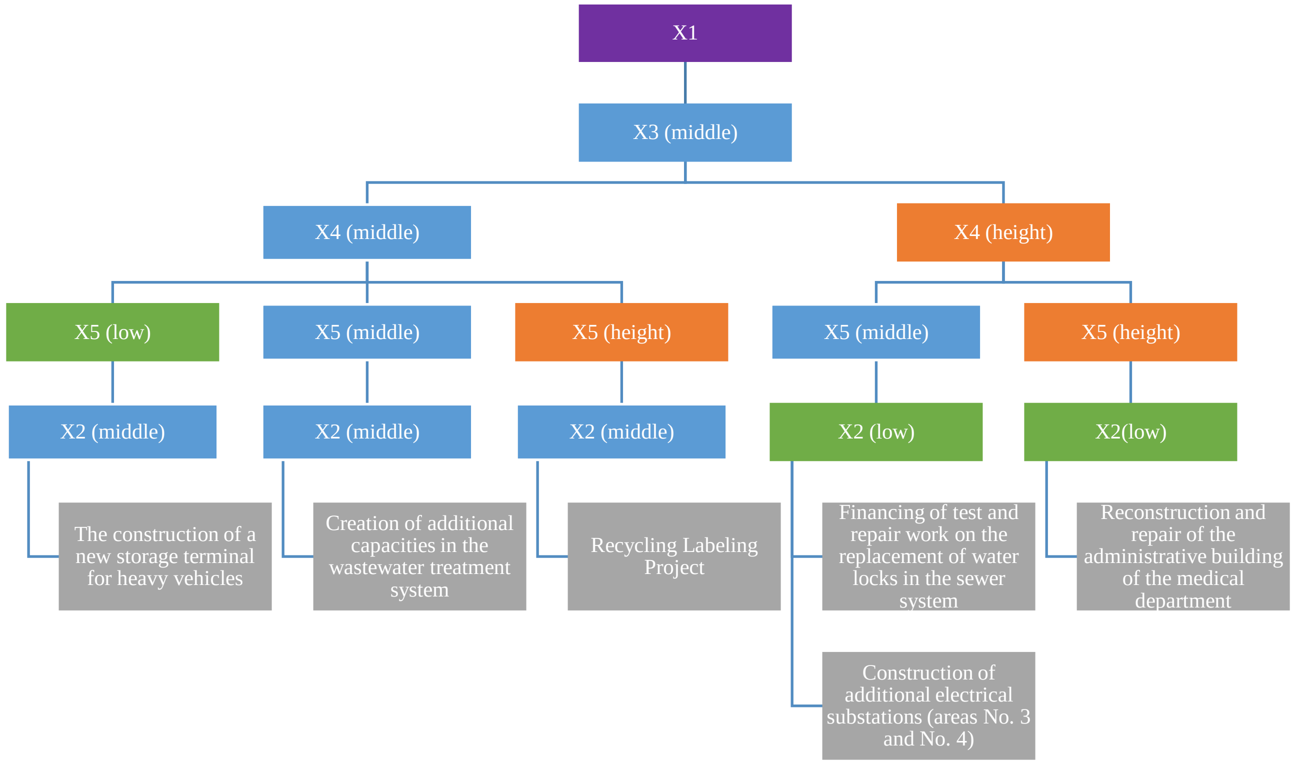

Fig. 4. The second branch of the decision tree (middle-scale projects).

The third branch of the decision tree (Fig. 5) includes 11 projects, the main characteristic of which is a small scale, while social significance is rated as insignificant, although for all these parameters four projects require significant budgetary participation. Also, these projects are characterized by a low political reaction.

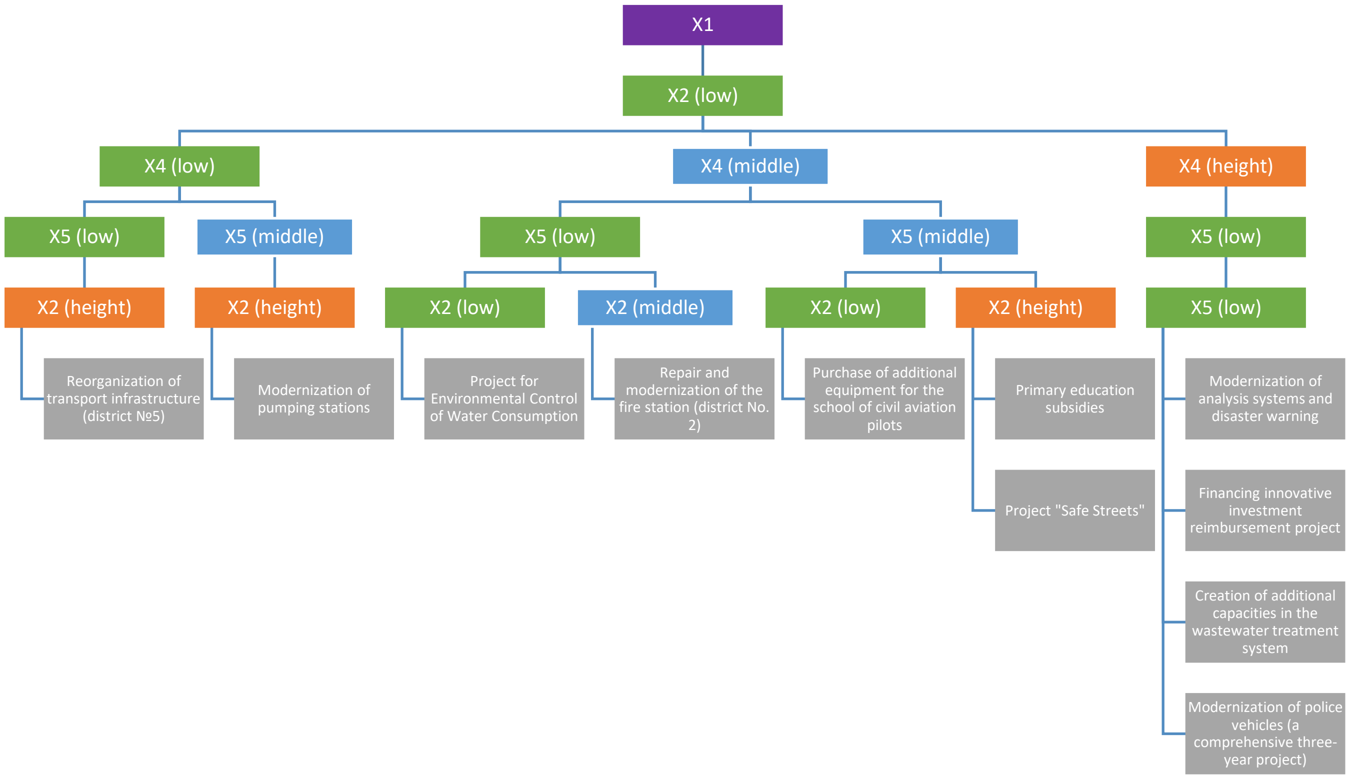

Fig. 5. The third branch of the decision tree (small projects).

IV. RESULT AND DISCUSSION

As can be seen from the visual representation of all branches of the constructed fuzzy decision tree, it is possible to evaluate and make a balanced management decision based on the specific parameters of each object.

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In particular, it is possible to choose for implementation projects that will give the maximum social effect with a minimum of financial costs, or vice versa, focus on the implementation of projects that combine high levels of both of these indicators, while minimizing political risks.

This technique is applicable not only to investment projects but to any issues related to information support when data volumes are difficult to analyze in other ways because of their ambiguous or incomplete nature. In the system of managing financial flows of the state, with its complex and complex parameters and characteristics, this methodology can be successfully applied.

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