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MODEL OF INFORMATION AND ANALYTICAL SUPPORT SYSTEM FOR FIRE SAFETY MANAGEMENT OF EDUCATIONAL COMPLEXES MAJOR CITIES AND AGGLOMERATES

Abstract: *The design of a fire safety system for educational complexes with centralized management differs significantly from that for an educational institution. The article proposes a model of fire safety management support system for educational complexes that combine geographically distributed objects of different levels of complexity.*

Key words: *modeling, management, educational complexes, fire safety.*

Language: *English*

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Introduction

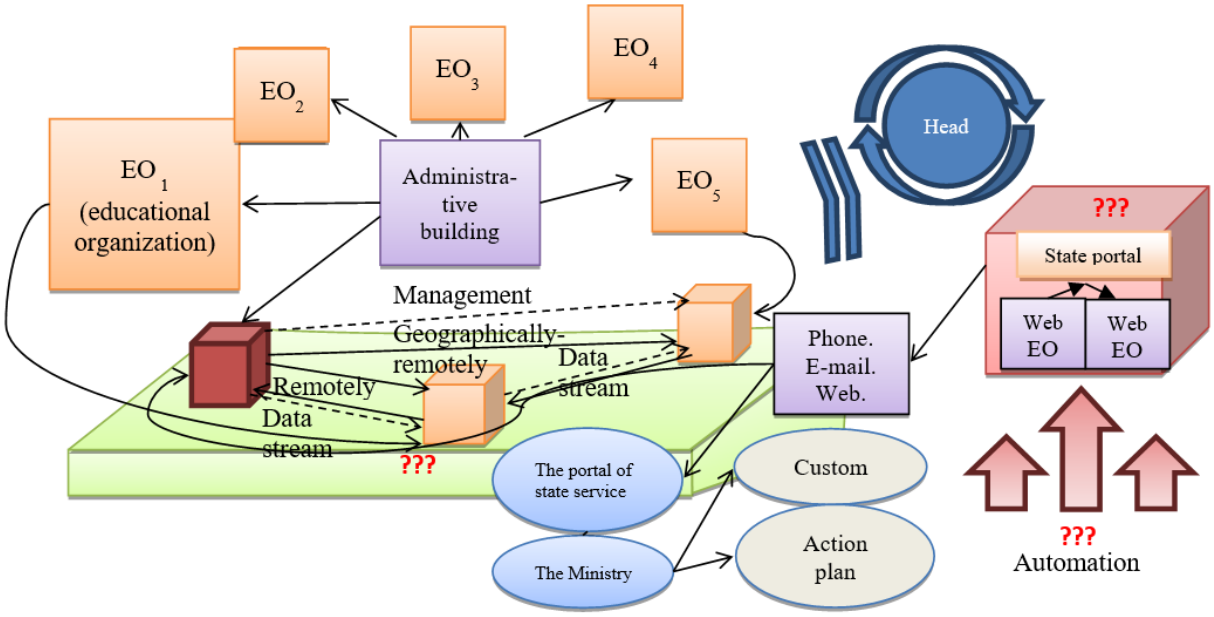
In the last decade, the total consolidation of existing organizational management schemes for organizations of different levels and profiles has achieved both positive and negative results. Many key classical control schemes, such as direct and reverse target trees, *CRM* or *BPMS*-systems can no longer always cover the necessary internal and external processes as a single management environment [8, p. 131]. A way out of this situation is often offered in practice combined options. At the same time, it is always specified that the resulting scenario will have a strictly limited functionality, simulate a strictly defined profile or selected environment.

For example, the educational environment of the Russian Federation (as a management system of a state Corporation) has been constantly modified and changed not only organizationally, but also structurally since 2002. The key point of departure in a new form-stage management system of the training was to transition from fragmented forms of governance each level independently, to the system of management of educational systems, including the educational structure of Junior, middle and secondary levels as a single management body [9, p. 3]. Further, only this control object will be considered from the point of view of a relatively new task – fire safety management of geographically distributed control objects (partially Autonomous) with a single remote control center.

The problematic component is that persons responsible for fire safety at management facilities, according to new Federal regulations, are forced to necessarily coordinate their own decisions (as local coordinating units) with the actions of external specialists of this profile (for example, with the territorial heads of the guard duty shifts of the Ministry for Emergency Situations), using available tools and methods. This scenario is not always possible due to a number of circumstances, which is due to many factors that are not predetermined in advance. For example, an administrative unit (local Director) of an educational structure should use preventive measures to localize an emergency on its own (if possible). However, only the main subject of management (the Director of the entire educational complex) know the resources available and the possible interaction between them, not only the educational structure, but also neighboring objects of the educational complex that even in the early stages of the elimination raises a number of delays related to the organization of interaction online.

It is proposed to comprehensively consider the model of system support in the management of fire

safety of geographically distributed objects, allowing to consider the factors: model scenarios of fires managed objects, standalone technical component, beginning with procurement and ending with processes of reconciliation of key components, centralized support system of resource management in coordination with external regulatory bodies (e.g. the Ministry for Emergency Situations (the Ministry)), (pic. 1).



Picture - 1. Structural diagram of the model of fire safety management support system in buildings of the educational complex

At the first stage of research, typical scenarios for the protection of existing educational complexes were analyzed. It was revealed that at the management stages in case of an emergency, the actions of the responsible personnel differed significantly from similar actions of the personnel at neighboring facilities, which caused many problems. As a result, fire safety systems also performed their functions differently. As a result, the stages of typical scenarios for the development of fires in educational complexes have been worked out. For example:

– in the case of smoke in the room in the basement of the building, the system will work according to the classic scenario "ATTENTION" and "FIRE" with the launch of the control system for the engineering complex of the object;

– in case of a fire on one of the floors, the facility's engineering complex will be launched, warning and evacuation systems will be launched in case of a fire, and smoke removal transoms will be opened [4, p. 4; 5, p. 3].

The developed scenarios take into account that in case of emergencies and fires at management facilities, different scenarios for the development of dangerous situations are possible. As the primary factors may be the smoke, and open burning, and leakage of flammable liquids, etc. in any development personal staff, administration and engineering complex object should work as a single mechanism, following a clear algorithm of actions [3, p. 5].

Moreover, the developed scenarios allow achieving the following non-core results:

– identify the most dangerous areas (required for the development of special technical conditions, the formation of schemes, plans, etc.);

– preidentify the shortcomings of fire protection systems, fire suppression, evacuation of people;

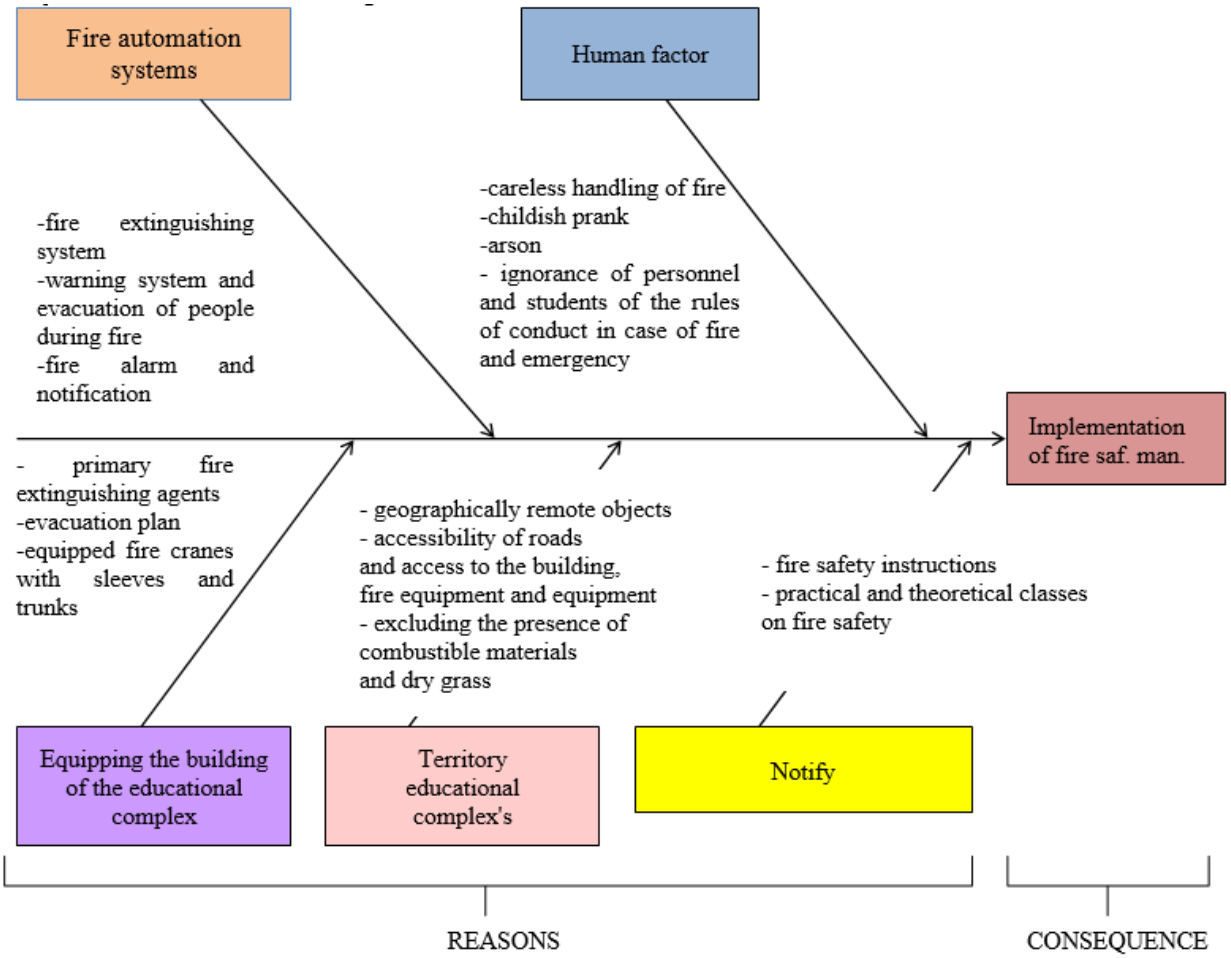
– assess the adequacy of fire safety measures;

– to identify previously undiscovered hazards;

– check the effectiveness of additional security features [2, p. 2].

In addition to the main research of the subject area, the analysis of existing models is carried out. It is revealed that many programs have already been developed that allow creating models of fires mainly in the field mode. More than 150 models of fire development have been registered. However, for this area of research, models should include: features of evacuation of people (taking into account social affiliation); features of using modern means of Autonomous fire protection as a single system.

At the second stage, for a detailed study of the initial data (using the Kaoru Ishikawa diagram [1, p. 4]), the factors, causes and consequences of emergencies and fires were studied using examples of buildings of educational complexes (pic. 2).



Picture - 2. Factors, causes and consequences of emergencies and fires in buildings of educational complexes

The key factors that need to be taken into account when modeling fire safety management processes are highlighted:

– irresponsible attitude to the performance of technical fire safety systems on the part of the service organization and duty personnel, which often leads to the failure of the system of the entire engineering complex of the object;

– the use of resources of buildings and structures of the complex is possible only when using the instructions of the main management;

– only the head of the educational complex makes key decisions in case of emergency situations and fires.

The main factors that may cause emergencies or fires on the territory of the complexes are analyzed.

Let's consider one factor scenario based on the above scheme (the primary cause of the fire is a person). Necessary:

1. *Ensuring compliance with fire safety requirements in the educational complex*: compliance with fire safety requirements in the field, maintenance of primary fire extinguishing equipment in working order, availability of individual protective equipment and first aid kits for medical care.

2. *Message about a fire*. The most typical factors are: the wrong choice of the GSM network operator, through which the signal is transmitted to the crisis management center of the subject of the Russian Federation.

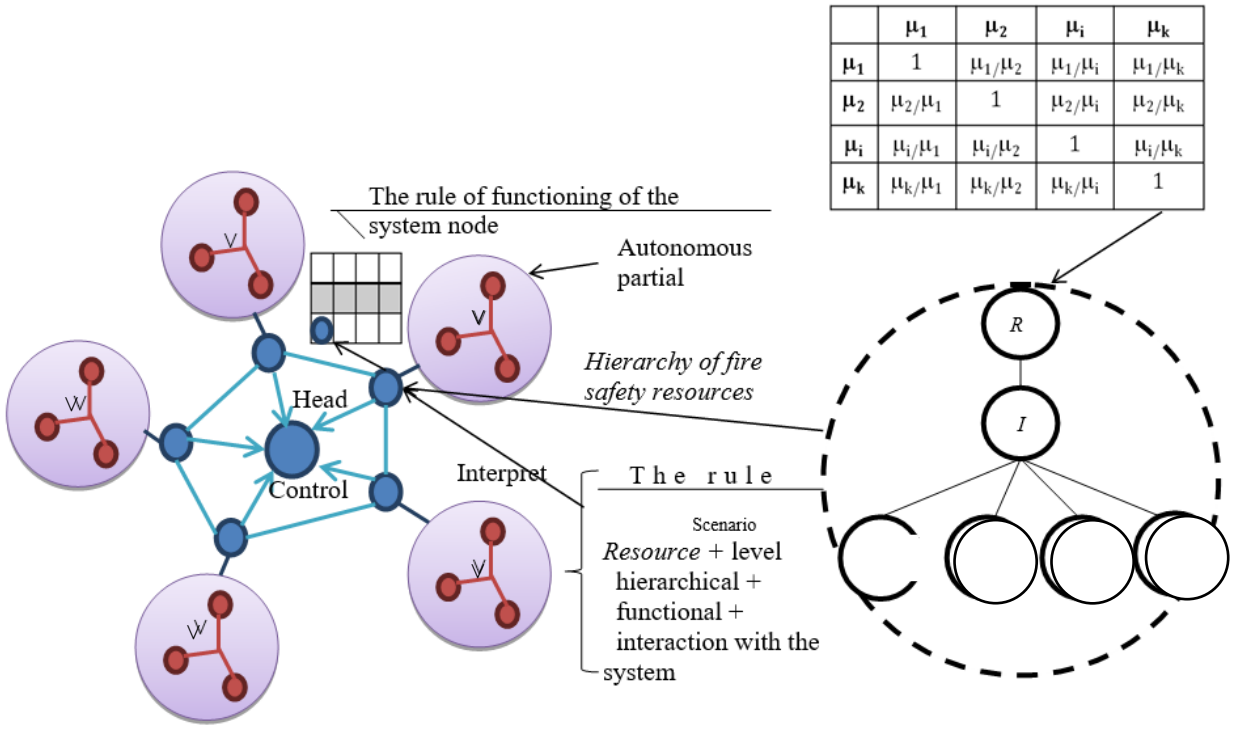
3. *Termination of all work in the building*. Irresponsible attitude to reporting an emergency or fire, as staff are often "used" to believing that such reports may be false or educational. Incorrect configuration of the notification rack that transmits broadcast signals.

4. *The organization of the evacuation*. Irresponsible attitude to the condition of the complex: closing of evacuation exits, cluttering of stairwells, narrowing of evacuation exits and escape routes; smoke may occur due to the fact that there is no or does not perform its function of the smoke removal system, and the presence of strong smoke indicates a fire load.

5. *Organizing a meeting of fire departments*. The presence of foreign cars at the entrances to the territory of the educational complex, the presence of blocked entrance groups on the territory. The fire

safety officer who meets the fire departments is not aware of the presence and number of victims and the location of the fire in the building, as well as not knowing the layout of the building of the educational complex.

At the next stage of research, modeling and systematization of the process of centralized procurement of resources necessary for ensuring fire safety of the entire educational complex as a whole on a competitive basis was performed. A game-theoretic model of the management support system has been constructed that allows to systematize the purchased resources in a single facet of these target projects, the possibility of implementing which is considered by the decision-maker (pic. 3).



	μ_1	μ_2	μ_i	μ_k
μ_1	1	μ_1/μ_2	μ_1/μ_i	μ_1/μ_k
μ_2	μ_2/μ_1	1	μ_2/μ_i	μ_2/μ_k
μ_i	μ_i/μ_1	μ_i/μ_2	1	μ_i/μ_k
μ_k	μ_k/μ_1	μ_k/μ_2	μ_k/μ_i	1

Picture - 3. Model of the process of selecting resources of the management support system by building a payment matrix and a tree of goals

The decision-making process is characterized by a payment matrix, a tuple of the form $\Gamma_R = < I, J, R >$, where [7, p. 123]:

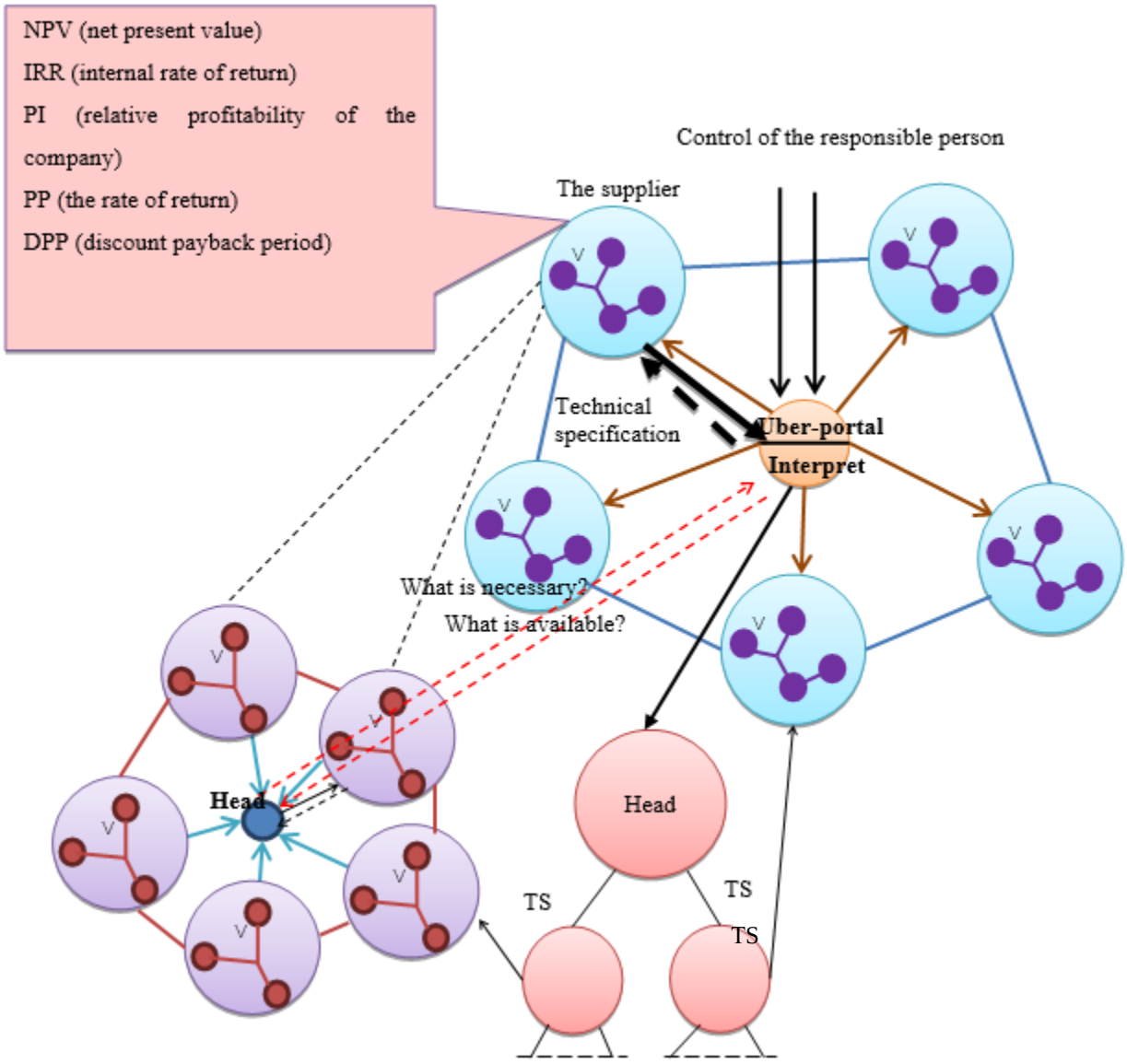
$I = \{1; 2 \dots i; k\}$ – the set of strategies of the first player (the decision-makers (head) on resource selection);

$\tilde{I} = \{(\mu_1/1); (\mu_2/2); \dots (\mu_i/i); (\mu_k/k)\}$ – fuzzy set, μ_i – reliability level of the alternative *i-th* element's;

$J = \{1; 2 \dots j; n\}$ – a set of second-player strategies (those who make decisions about choosing suppliers in the controlling organization. For example, the Russian emergencies Ministry);

R – payoff matrix, $R = R_{k*n} = (r_{ij})$.

To select the most reliable resources, a game-theoretic model of comparative analysis of the reliability level is also built (pic. 4).



Picture - 4. Game-theoretic model of comparative analysis of reliability level

The process of making management decisions for comparative analysis of the level of reliability is characterized by a tuple $\Gamma\mu = < I, J, \mu >$, where:

$I = \{1; 2 \ldots i; k\}$ – many resources;

$\tilde{I} = \{(\mu_1/1); (\mu_2/2); \ldots (\mu_i/i); (\mu_k/k)\}$ – a fuzzy set of resources with a given goal, μ_i – value of the *i-th* resource's ownership function;

$J = \{1; 2 \ldots j; n\}$ – multiple scenarios;

μ – payoff matrix, $\mu = \mu_{k \times n} = (\mu_{ij})$.

The effectiveness of using suppliers ' resources is assessed by a set of assessments. The system for evaluating the economic efficiency of resource use is based on a hierarchical model for calculating efficiency from the point of view of participants in the main process. The system takes into account the dynamics of financial flows arising in the implementation process, as well as incomplete information and uncertainty.

The most commonly used quantitative performance estimates are such indicators as net discounted income *NPV*, internal rate of return *IRR*, return index *PI*, payback period (period) without discounting *PP* and payback period with discounting *DPP* [6, p. 6]. The sequence diagram of the comparative analysis of resource reliability based on the combined application of games has the following form (pic. 5).

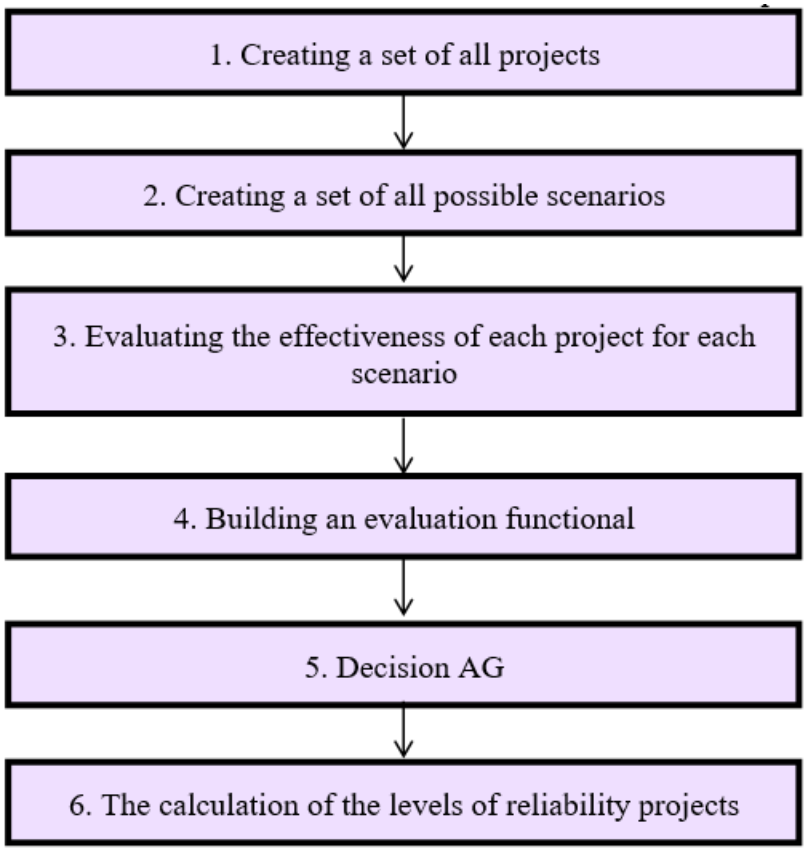
1. Creating a set of *I* all resources by the provider.
2. Generation by the supplier of a set of *J* all possible scenarios for implementing resources on objects.

3. Evaluation of resource efficiency for each new scenario based on calculated values of indicators (primarily *NPV, IRR, PI, PP, DPP*).

4. Evaluation of the values of μ_{ij} function of belonging of the *i-th* resource to the set of $\tilde{I}$ most reliable projects in the conditions of the *j-th* scenario.

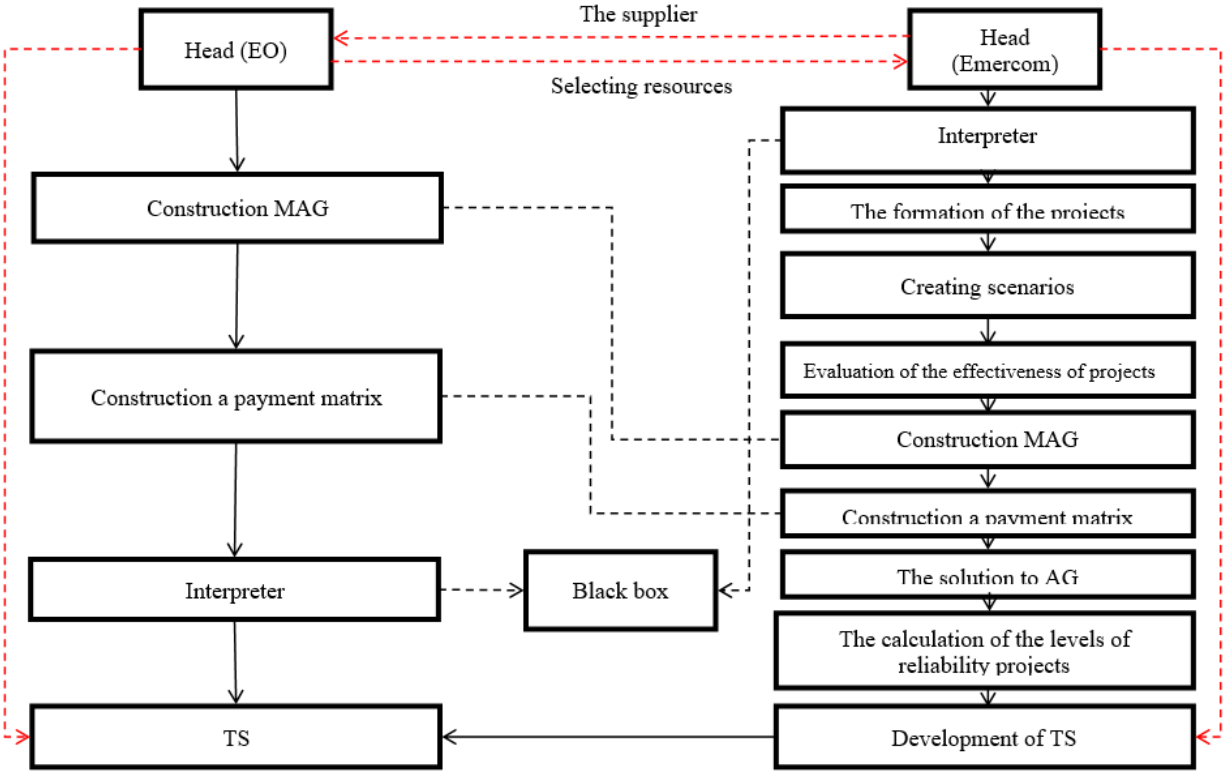
5. The solution to a antagonistic games (AG), $\Gamma\mu = I, J, \mu$.

6. The calculation of the reliability levels of resources, assessments' μ_i^*, $i = \overline{1,k}$, values of the resource set membership function $\tilde{I}$.



Picture - 5. Scheme of comparative analysis of the level of resource reliability

Based on the formalization, the algorithm of interaction between the decision-maker from the educational complexes for selecting resources and the decision-maker from the controlling organization (the Ministry of emergency situations of Russia (Emercom)) when selecting suppliers is constructed (pic. 6).



Picture - 6. Scheme of the algorithm for interaction of decision-makers

To build a conceptual model of transition to a software-algorithmic form of information representation, a model of interaction of data flows in a single information-analytical system using the "black box" method is constructed [9, p. 5].

Modeling the situation on socially important objects in the event of an emergency or fire is important due to a variety of negative factors both at the time of occurrence and when analyzing the consequences. The use of modern information systems and technologies with the use of specialized software systematized in the form of a single information space for educational complexes allows for the most effective fire prevention, localization, elimination, and extinguishing. It is also necessary to take into account that the negativity of these factors can be avoided by a comprehensive analysis, starting from the first stages of resource implementation (for example, the procurement stage) [10, p. 5]. The paper presents the decision-making process using the game-theoretic scheme of comparative analysis of resources based on the combined application of games. The presented model for the selection and distribution of resources is an effective means of solving many problems in ensuring fire safety in the process of functioning of educational complexes.

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