Ergatic System of Complex Safety of Subjects of Education[1]

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Abstract – **Possible approaches to building the system of complex safety of education subjects are discussed in this paper. Characteristic of the proactive approach, based not on waiting for an extraordinary event and the elimination of its consequences, but on the identification and monitoring of risk factors as an alternative to the traditional retroactive approach is given. The structure of the ergatic model of complex safety and its elements are described. Proposes the original variant of the classification of threats to the subject of education. Discusses the principles of producing the information system of complex safety of education subjects.**

Keywords – proactive approach to safety provision; ergatic system of complex safety; subjects of education; safety threats; conceptual and informational models of system of complex safety

I. INTRODUCTION

The actualization of the safety problems of the subjects of education due to the transition from industrial to post-industrial civilization, that is accompanied by an increase in the level of uncertainty and unpredictability of the future, the global "human dependence" of the world. In this regard, some scientists (W. Beck, E. Giddens, N. Luman et al.) qualify modern society as a" risk society" which shifts in the zone of "megarisks".

The analysis of researches shows that the most authors define the concept of "safety of education" as the state of protection of subjects of educational activities from real and projected threats of social, technological and natural character, ensuring their normal functioning and sustainable development. Notes, that often these problems are considered in the context of psychological and protection of student's health, but the complex safety of education as a system of interconnected dynamic processes and objects is still out of the field of scientific research. In addition, the issues of safety of education are traditionally studied in the paradigm of a retroactive approach, that aimed primarily at strict compliance with regulatory requirements, analysis of the causes of deviations and the development of preventive recommendations. This approach is based on the expectation of negative events, it is characterized by a certain cyclicity: an emergency – increased activity after an extreme event – its decline after some time. An alternative to that is a proactive approach, which is not focused on waiting for an extraordinary event and the elimination of its consequences, but on the identification and monitoring of risk factors, the probabilistic assessment of the scenarios of the situation and the risks associated with it, when the situation has not yet become critical, but it can cause an unacceptable reduction in the level of safety and lead to incidents, accidents, catastrophes.

II. ERGATIC SYSTEM OF COMPLEX SAFETY

A. Conceptual model

The safety of the subjects of education can be considered in the narrow and broad sense. In the first case we are talking about the safety of the individual in the education system, and we understand the safety as a state of protection of the interests of the individual from various dangers (threats) in obtaining education. In the second case, we assume that the safety of the education system is a state of protection of the interests of the public institution (the educational system and its elements) from internal and external dangerous factor (threats).

[1] ***As the subjects of education, we will understand participants of educational activities - managers, teachers, students, parents, and educational organizations***

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The ergatic system is a human-machine system of interaction of object (subject of education) with external and internal environment.

The structure of the model of the ergatic system of complex safety includes answers to questions (Fig.1):

- protect what?
- protect from what?
- protect who?
- protect how?

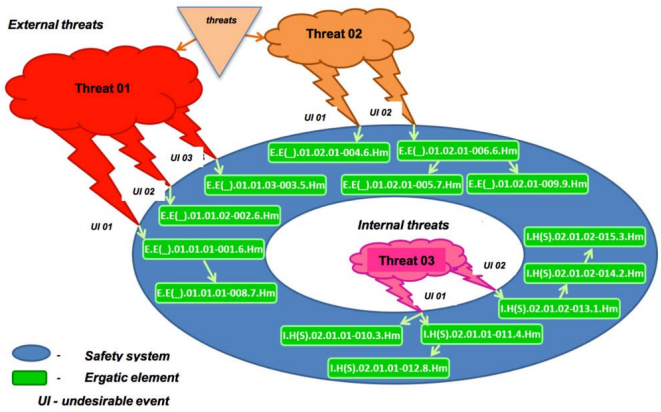


Fig. 1. Conceptual model of the system

Solution of the problems of the safety of education subjects are traditionally focused on the levels of threats and risks emanating from a certain object, which can be classified as relevant in the current conditions and potentially possible.

Safety threat to the subject of education is a possible impact on the subject, which may directly or indirectly damage its safety.

The object (subject) of danger is the carrier or source of danger (threats), which may be the social environment, technical sphere, natural factors or individuals.

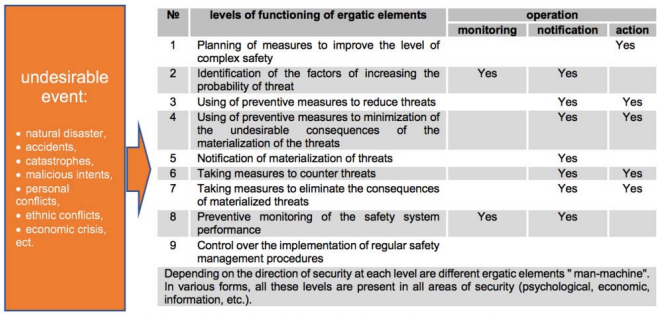
Classification of threat sources and their manifestations can be carried out on the basis of a logical chain: the source of danger – factor (vulnerability) – threat (danger) – consequences (attack).

- source of danger - potential anthropogenic, technogenic or spontaneous safety threats, which are fraught with danger and under certain conditions by themselves, or in different totality, exhibit or detect hostile intentions, harmful properties, destructive nature;
- danger - a threat (potential or actual) of the commission of any act (action or inaction) directed against the subject of education;
- factor - the internal causes of the object, leading to a violation of safety;
- consequences (attack) - the results of the threat when the source of the threat affects through factors (vulnerabilities).

The effectiveness of ensuring the complex safety of the subjects of education will depend on the quantity and quality of identified and neutralized risks (threats) that characterize the functioning of the education system.

One of the obvious problems here is too many various threats in the real educational space, to which the system of complex safety should respond. Certainly, the solution of safety management problems connected with such a number of controlled parameters and reactions (inputs and outputs), as well as uncontrolled disturbing effects can't be found without the involvement of strict mathematical and optimization models. For the construction of such models it is appropriate and convenient to use randomized algorithms (Granichin O.N., 2015), which will be shown in our next articles. Here we focus on the fact that the complexity of the system causes its ergaticity, i.e. the need for it not only human, but also technical elements. A lot of threats can't be provided with quality control by a person, because a person is a threat to the safety himself when he makes a mistake. Therefore, it is necessary to maximize the automation of the safety system, the creation of formal algorithms for solving safety tasks with elements of "error protection".

When we build a system of complex safety of education subjects, it is important to determine the full range of threats and forms of counteraction (from preventive measures to elimination of indirect consequences), not limited to a direct "collision" with a materialized threat. Based on this, it is necessary to connect the levels of functioning of ergatic elements with a set of typical operations inherent in each level (Fig. 2).



№	levels of functioning of ergatic elements	operation		
		monitoring	notification	action
1	Planning of measures to improve the level of complex safety			Yes
2	Identification of the factors of increasing the probability of threat	Yes	Yes	
3	Using of preventive measures to reduce threats		Yes	Yes
4	Using of preventive measures to minimization of the undesirable consequences of the materialization of the threats		Yes	Yes
5	Notification of materialization of threats		Yes	
6	Taking measures to counter threats		Yes	Yes
7	Taking measures to eliminate the consequences of materialized threats		Yes	Yes
8	Preventive monitoring of the safety system performance	Yes	Yes	
9	Control over the implementation of regular safety management procedures			

Depending on the direction of security at each level are different ergatic elements " man-machine". In various forms, all these levels are present in all areas of security (psychological, economic, information, etc.).

Fig.2. Decomposition of levels of functioning of ergatic elements

Each element of the system must have set of typical characteristics:

- type of interaction – it reflects the degree of influence of factors in the choice of reaction to the threat (the degree of automation of decision-making);
- tuning – it contains a set of activities aimed at ensuring the functioning of the system;
- reflected threats - a check-list of threats that the system must confront;

- response - a set of operations performed by the system when it receives a signal about the materialization of a relevant threat;
- communication - rules for notification of identified threats and actions performed by the system.

B. Information model

An important issue in building an information model is data structuring (Fig.3).

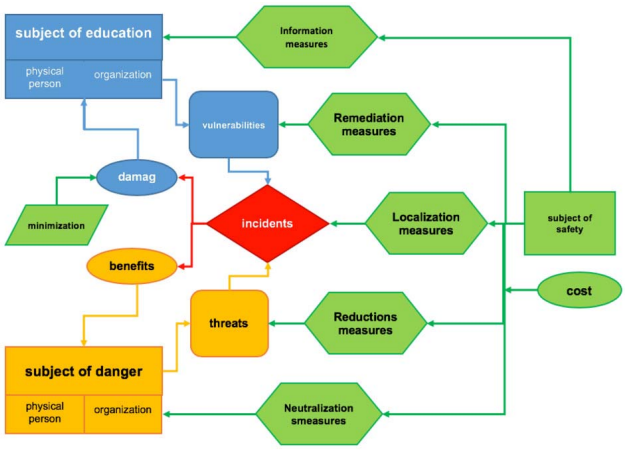


Fig. 3. Information model of the system

There are various classifiers of threats to which the system of complex safety should respond. Any of these classifications can be taken as a basis for the development of an information system, in particular, the classifier for the educational organization can reflect the following characteristics of threats:

- the threat comes from the external environment or occurs directly within the educational organization - the element of the classification "environment of threat": "I" - Internal or " E " - External;
- the threat proceeds from the properties or events of the non-living environment or it is a direct and immediate consequence of the actions of certain people - an element of the classification "source of threat": "H" - Human or "E" – Environment;
- If the threat is internal and its source is a person, it may be necessary to introduce an additional classifier "subject of threat": "S" - student, "T" - Teacher, "P" - parent, "F" – firm.
- types of safety - economic, environmental, psychological, information, etc. and the corresponding types of threats that are convenient to present in the classifier with digital codes - 01, 02, ... ,19, 20;

At the same time, each type of threat can be determined through their manifestations. Therefore, in each type of threat, it is appropriate to enter the digital encoding of the species, for example:

- 01. Environmental threat:
- 01.01 - water pollution
- 01.02 - atmospheric pollution
- 01.03 - soil pollution

…

- 02. Information threat:
- 02.01 - theft of valuable information
- 02.02 - malicious provision of incorrect information (misinformation)

…

- detailing threats – codification of specific adverse events (investigation of materialization of threats) that have their own methods of location, or a particular method (action) of the attacker if the threat is credible. Here the most convenient is also a digital encoding, for example:
- 02. Information threat:
- 02.01 - theft of valuable information
- 02.01.01 - penetration into the educational organization's electronic information network through Internet access and theft of electronic information
- 02.01.02 - theft of electronic information by obtaining physical access to computers located on the territory of the educational organization

…

The information map of the model captures the attention to the need to find solutions to the following tasks:

- creating a threat classifier
- When we construct the information model, it is necessary to create an exhaustive list of threats and undesirable phenomena arising from these threats, as well as to consider all possible fluctuations that decrease or increase the threats and the consequences of their materialization.
- development of the typed levels of functioning of elements
- When we construct the information model, it is crucial to analyze options for replacing human actions with machine ones, or to provide a reasoned justification for the impossibility of using automation tools.
- creating the structure of ergatic elements
- When we construct the information model it must be defined "inputs" and "outputs" of the system, possible reactions, possible directions of communication, etc. It must be specified the detail set of possible options of involving people in the decision-making process.
- identification of "nodes of centralization"
- The system is hierarchical, so it is necessary to reasonably determine the "centralization nodes" - within the framework of the model, both the logical and administrative hierarchy of safety subjects should be identified and presented.

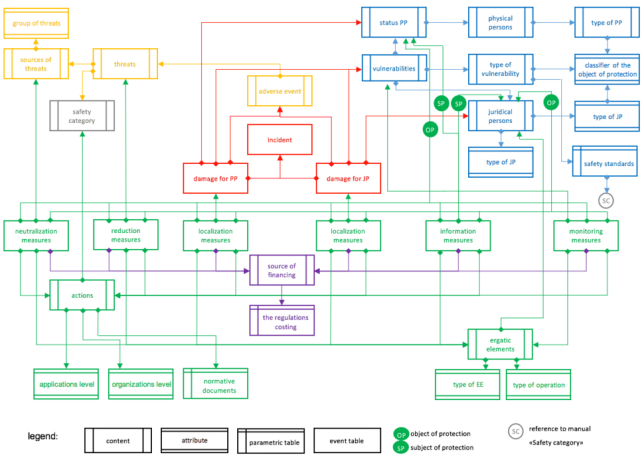


Fig.4. Model of the "Safety Action" segment

III. CONCLUSION

Thus, on the basis of identification, parametric synthesis and codification of structure and information elements (types, structure, content of information, sources and users of information, methods of processing and transmission of information, communication channels, etc.), we present the conceptual and information model of the system of complex safety of subjects of education. These models allow qualitative and quantitative assessment of the level of protection of the subjects of education, as well as it enable to estimate the degree of readiness of the management to prevent, neutralize, reduce and eliminate threats and to adjust the safety activities according expert opinion.

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