PRACE NAUKOWE Akademii im. Jana Długosza w Częstochowie
Technika, Informatyka, Inżynieria Bezpieczeństwa 2014, t. II, s. 31–48

http://dx.doi.org/10.16926/tiib.2014.02.03

Pjotr Chmiel, Juri Olenjuk, Yaroslav Pidgorodeckyi, Evgen Martyn
Lviv State University of Life Safety
Ukraine, 79000, Lviv, Kleparivska St., 35

METHODS OF SUBMITTING MODELS IN PROJECT-ORIENTED MANAGEMENT OF TRANSBOUNDARY RESCUE SUBDIVISIONS

Abstract.
Objective: Analysis, design, research and practical use of modeling methods of processes of project-oriented management of transboundary systems and operational and rescue subdivisions of emergency response/ situations liquidation.
Methods: Geometric research method of intercommunication of programs and projects in international integration field and management of transboundary systems and operational rescue subdivisions.
Results: Results of scientific research based on the analysis, selection, improving of the element from the set of models of applied geometry permit to offer effective geometric research method of processes of dynamics and optimization of individual elements at the office projects management, programs and portfolios of projects by achieving sufficient mobility of forces and means of operational rescue subdivisions, ensuring at the proper ratio of parameters for the purposes of general system of project-oriented control ensuring high efficiency of interaction of added formations of neighboring countries at extinguishing fires and mitigation of accidents and natural disasters.
Conclusions: The studies allowed to offer effective geometric models that take into account sufficient number of parameters of parametric process in the state space of management system of programs and projects in the field of international integration and implementation of cross-border system and operational rescue subdivisions. The application of proposed models using methods of applied multdimensional geometry in the parameter space formed by a number of different dimensions, allows figuratively and graphically by simple geometric operations to explore general and partial cases of interactions of forces and means in the process of office project organizational management added by rescue groups. Geometric means/tools enable to assess the degree of mobility of forces and means of rescue formations and effectiveness of the action liquidation of emergency situation.
Keywords: transboundary oparational and rescue subdivisions, programs, projects, portfolio of projects, emergencies, project-oriented management, geometric modeling, phase spaces, multidimensional geometry.

METODY REPREZENTACJI MODELI W ZARZĄDZANIU ZORIENTOWANYM PROJEKTOWO TRANSGRANICZNYCH JEDNOSTEK OPERACYJNO-RATOWNICZYCH

Streszczenie: Celem pracy jest analiza, projektowanie, badanie i praktyczne zastosowanie metod modelowania procesów zarządzania zorientowanego projektowo systemów transgranicznych i jednostek operacyjno-ratowniczych dotyczących likwidacji sytuacji nadzwyczajnych. W pracy wykorzystano geometryczną metodę badania relacji programów i projektów w dziedzinie integracji międzynarodowej i zarządzania systemami transgranicznymi i jednostkami operacyjno-ratowniczymi. Przedstawione wyniki badań naukowych pozwalają na podstawie analizy, selekcji i poprawy elementu ze zbioru modeli geometrii stosowanej zaproponować skuteczną metodę geometryczną badania dynamiki procesów geometrycznych i optymalizacji poszczególnych elementów zarządzania projektami, programami i portfelami poprzez osiągnięcie wystarczającej mobilności sił i środków drużyn operacyjno-ratowniczych. Wyniki badań pozwoliły zaproponować skuteczne modele geometryczne, które biorą pod uwagę odpowiednią liczbę badanych parametrów procesu parametrycznego w przestrzeni stanów systemu zarządzania programami i projektami w dziedzinie integracji międzynarodowej i wdrażania systemów transgranicznych i zespołów operacyjno-ratowniczych. Stosowanie proponowanych modeli wykorzystujących metody zastosowanej geometrii wielowymiarowej w przestrzeni pozwala graficznie i wizualnie za pomocą prostych operacji geometrycznych na zbadanie ogólnych i częściowych przypadków interakcji sił i zasobów w procesie zarządzania projektowego i organizacyjnego jednostek ratowniczych. Geometryczne środki dają możliwość oceny stopnia mobilności sił i środków służb ratowniczych i skuteczności działań w sytuacjach nadzwyczajnych.
Słowa kluczowe: transgraniczne jednostki operacyjno-ratownicze, projekty, portfolio projektów, sytuacje kryzysowe, zarządzanie zorientowane projektowo, modelowanie geometryczne, przestrzeń fazowa, geometria wielowymiarowa.

Introduction

Intensification of economic and cultural connections between Ukraine and Poland, and so, therefore, with other European countries and the EU, is accompanied by a significant loads on the borders of both countries. Frequent consequences of such process are violation of technological, environmental and fire safety in the border areas, particularly near the border crossing points. Attempts to maintain proper safety condition require use of various means of prevention of emergency situations and elimination. According to interstate agreements in the field of international integration cross-border systems and operational and rescue subdivisions are created and operate. Such systems and subdivisions are organized hierarchically. Their feature is the simultaneous submission on the upper management level. Important in the functioning of such sub-

divisions in general and individual components strict is subordination of law of the both countries and certain interstate agreements. In particular, their smooth functioning is possible, subject to paragraphs of Code of Civil Protection and legislative acts in the field of fire safety of both countries [1]. Significant impact on a subdivisions' clear response on emergencies is their information provision and regulatory support.

Intensive subjects' interaction of interstate relations requires the development of new methods and effective management of the border security. Due to importance of the considered problem, there are numerous independent from one another parts of management system and the urgent need to improve their interaction in emergency elimination process. New methods should be based on the principles of the use of scientific and practical ideology of project-oriented process management of interaction between cross-border systems and operational and rescue subdivisions. It is the most structured systematic and optimal method in understanding of predicting losses and risks minimization at various stages of the projects of life safety security on cross-border areas. Appropriate level of project-oriented management of transboundary systems and operational and rescue subdivisions can be achieved through comprehensive and thorough study of the interaction of constituents' parts on the models. Question of assessment of the scientific development of systemic problems of project-oriented management of man-made formations, including in the field of human life safety, are solved in scientific researches both foreign and domestic scientists. Scientific exploration in the field of development, research and use of models especially are relevant in the system of civil protection, in particular for solving practical problems of life security on cross-border areas.

Theoretical scientific and methodological development problems of certain applied aspects of project-oriented management in civil protection are highlighted in academic writings of Yu. Rak, T. Rak, R. Ratushnyi, O. Zachko, A. Ivanusa and their students. The development issue and practical use of modeling processes of project-oriented management in solving applied problems in the field of civil protection can be found in the writings of the scientific school of Yu. Rak and his students [2].

Development of methods for modeling the processes of project-oriented management in the part of determination of development tendencies as process in general as well as changes in its defining parameters, we have limited reference [3]. Should be noted powerful capabilities of geometric modeling of technical objects, topographical surfaces [4], processes both in real space [5] and in complex spaces [6]. For the first time geometric modeling tools are used to explore the project-oriented management of cross-border operational and rescue units in [7]. However, issues of methods development of geometric modeling in applied use concerning determination of development trends of the processes of project-oriented management and efficiency of cross-border interaction and

operational-rescue subdivisions require wider coverage and further fundamental research.

Problem setting

Properties of objects, systems and processes are studied involving modeling tools. Modeling methods have applied use and develop in two directions: to solve practical problems with clearly defined parameters and in the case of incomplete information about modeling object, or they take approximate values in some vaguely defined range. Tasks to which we assign the processes of project-oriented management of transboundary systems and operational and rescue units belong to tasks with unclear defined parameters. They are often solved using applied methods of simulation. In the course of research on models, operating a large number of parameters with approximate values of some of them, a numeric value result of simulation is obtained. In this case the is no opportunity to follow the trend of the numeric parameters' change that determine the effectiveness of project-based management, in particular, its position relative to critical values. This certainly limits the ability of research and requires carrying additional research on models, but with different parameter values. The critical point, min or max, often do not appear, especially when given specific parameter values. It should be noted the inability of using in the research process interpolation methods.

Methods of geometric modeling provide significantly wider possibilities. Process of studies occurs with using geometric images in the form of lines and surfaces, and simplicity, imagery and visualization of models make it possible not only to trace the trend of process' changes over time, but also to determine the area of critical values. A promising direction of scientific studies are the analysis, develop and use of methods of geometric modeling in the research processes of project-oriented management of transboundary systems and operational and rescue subdivisions of concerned States.

Purpose of research

The set of modeling methods of objects phenomena and processes is versatile and have practical use for solving specific technical problems. Every problem can be solved by any method, respectively, more or less effectively. Convenience, simplicity, accuracy and versatility of the method determine its widespread use in research practice and computing in the tasks of science and practice, particularly in ensuring the safety of human life. At solving the present problem, especially given the nature of its solution on the cross-border areas of neighboring countries, it is important to explore and choose an effective method of modeling concerning the analysis tasks of project-oriented management pro-

cesses of cross-border operational and rescue subdivisions of emergency response.

The aim of the research is to increase effectiveness of management processes projects' portfolio in field of international integration and implementation of cross-border systems and operational and rescue subdivisions through the development and use of effective tools for modeling management processes by interacting parties in terms of prevention and liquidation of emergency situations in the border areas of neighboring concerned States.

Main part of the research

Particular aspects of solution to the problem of system analysis and study of the interaction of operational and rescue subdivisions using models are developed in [8]. Shown perspectives of using geometric modeling require, however, a detailed and comprehensive review of both modeling object and choice of means of geometric modeling based on application use of known geometries [4].

Structure and functional interconnections of links and elements of the project-oriented management object

Modeling object is the process of project-oriented management of transboundary operational and rescue subdivisions characterized by peculiarities of course on the territory of two neighboring countries. It is one aspect of international cooperation. In this field, the regulations achieved and legally enshrined by the governing bodies of both countries are adhered. The importance of state approach to the creation of operational and rescue subdivisions caused by the tasks that must be performed. They feature is the high mobility of forces and means while ensuring optimal actions during firefighting, search and rescue, mitigation of accidents, emergency and natural disasters, humanitarian operations directly on the border areas of both countries. Regarding the development and modeling processes of international cooperation in the field of civil protection of border areas and objects found there, the elimination and prevention of emergencies, it is important to establish interconnections between different subjects of border cooperation.

Operational and rescue subdivisions are formed and equipped in accordance with the Code of Civil Protection and legislation in the field of fire safety [1] of States personnel, basic, special, auxiliary fire and rescue equipment, especially in those states in which on the border area emergency or fire has happened with attraction of relocation and additional forces and means of the neighboring state. General management of the organization and conduct of necessary measures and rescue operations of the emergency or fire is carried out by central executive body along with economic entity state, in which territory there an emergency or fire has happened. Involvement of material means is

carried in the prescribed manner and is being consistent with the guidance of the State Emergency Services or State Fire Service of one of the countries. An important element in terms of ensuring the high mobility and quality of management concerning conducting rescue operations or liquidation of the disaster is the consistent establishment of campsite with the appropriate governing bodies. Its peculiarity is concentration in one location directly in the area of personnel' operations and material and technical resources. Thus special machinery of operational and rescue subdivision is divided strictly between the individual subdivision belonging to each State that participates in liquidation of consequences of the accidents or fire. Improving the efficiency of interaction between individual units of subdivisions of both countries can be achieved in some cases by the location of special equipment in one subdivision, taking into account the operational situation, rational distribution, the possibility of its rapid use in routine operations.

The set of measures included in the amount of rescue operations in cross-border areas of both countries, has its specifics and is influential element in project-oriented management of cross-border operational and rescue subdivisions. It includes, in particular,

- fire extinguishing and localization on the territory of one or another state;
- carrying water communications;
- emergency shutdown of energy sources on the border areas;
- performing rescue work, providing first aid and the location and evacuation to safe places on both sides of the border (on the basis of concluded international agreements);
- localization and liquidation of certain sources of increased danger in border facilities, networks, communications;
- restoration of functioning on some border areas of energy networks and interstate communicational lines;
- creating temporary schemes of some important boundary objects;
- conducting of works on clearing the border areas;
- protection of the border infrastructure and environment in the area of fire or emergency.

Isolation in a structured list of works to eliminate emergencies on the border areas is an important element in the preparation of normative and legal functioning of cross-border operational and rescue subdivisions and constitutes the basis of formation of the structure of their organization by international agreements of compatible annual trainings and functioning [9].

Classification model of cross-border systems and operational and rescue subdivisions with project-oriented management

The reason for the development of a process model of project-oriented management of operational and rescue subdivisions in cross-border areas is a scheme of interconnections of their structural subdivisions built on the principles of classification model of cross-border operational and rescue subdivisions.

Effective functioning of border zone structures on the territories of both countries possible on condition of clear and harmonious cooperation of individual units of operational and rescue subdivisions, which are complementary and include human and material and technical resources of both countries. Cross-border operational and rescue subdivisions have clearly assigned tasks of people's life in the border areas, form a class of projects of interstate cooperation with similar characteristics and fields of activity. The latter, however, have their own characteristics based on diversity and wide range of emergence, development and methods of disaster management in transboundary areas. Given the reduced range of functions and tasks, as well as the specific of geographical location, topographical features of both section of the border strip, the purpose of individual border establishments and districts, level of financial support for subdivisions, material and technical supply functioning of the interaction of the two components of cross-border operational and rescue subdivisions has its own characteristics. These characteristics, in view of mentioned features, require a special approach to the selection of the type of project-oriented management.

Combination in the general model of the interaction of cross-border operational and rescue subdivisions in project-oriented management with attraction of their two independent components from side of each concerned State requires scientifically based approach as with attraction of methods and means of project-based management and effective research models of relevant processes.

The tasks of forming and managing operative fire and rescue subdivisions are resolved based on the use of practical experience as a governing, commanding and other ranks, hence they have rather low efficiency in its operations and require proper scientific classification approach. Apply theory to processes, which are activated in interstate relations, scientifically based theories of project-oriented management enables to systematize at a glance the various cases of emergence, development and disaster management is the reason to obtain and use versatile scientific tools and development in the field of civil protection in the border areas any neighboring countries. Today, the problems of life security on the cross-border areas of neighboring countries are resolved differently. It should be noted that each state borders with several others, making appropriate individual interstate deals.

The classification model should take into account the peculiarities of project-oriented management of border facilities and communications, location of

checkpoints and transitions through the border, as along the common border of the two countries and adapted to the peculiarities of border communications on other borders of neighboring countries. The main task, ensuring proper life safety, imposes restrictions concerning model's versatility and diversity of network application at project-oriented management of transboundary operational and rescue subdivisions of concerned States.

Models' analysis indicates their priority both at the stage of concluding interstate agreements in the field of cross-border cooperation in general, and the implementation of the provisions of such agreements at liquidation of emergency situations. Developing classification models should be taken into account that modern operative and rescue subdivisions include effective information technology, perfect normative, legal support, and both combine a high level of professional rescuers, and information, in particular the Internet technology. Note that the effective use of human, technical resources and information technology is possible on condition of integration of certain infrastructures as neighboring states and states of the corresponding continent in general. In the last case the effective use of satellite communications. Thus, the classification model has three components (Fig. 1) based on which classification models of security settings of border cooperation in project-oriented management are suggested according to functions (Fig. 2), elements (Fig. 3) and organization of border Operational Rescue subdivision of the concerned State (Fig. 4).

The structure and functionality of the generating methods of models processes of project-oriented management of cross-border operational and rescue subdivision

Tasks of optimization and improving the efficiency of interaction between individual units and subsystems of operatively and rescue subdivisions, as one single state and also interaction peculiarities of two states belongs to the tasks that must be solved systemically both on state level and interaction of region border bodies level. An important part of their solution is to simulate the processes taking into account fluidity in time and interference of many factors.

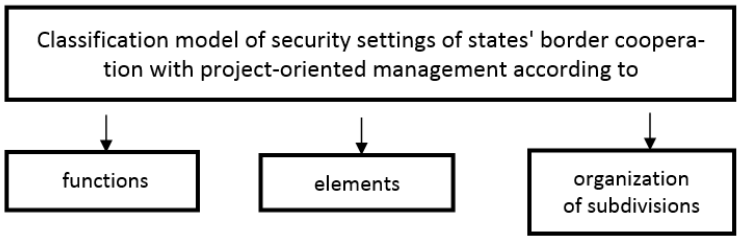

Fig. 1. Hierarchical structure of classifying security settings model criteria of border cooperation of states with project-oriented management

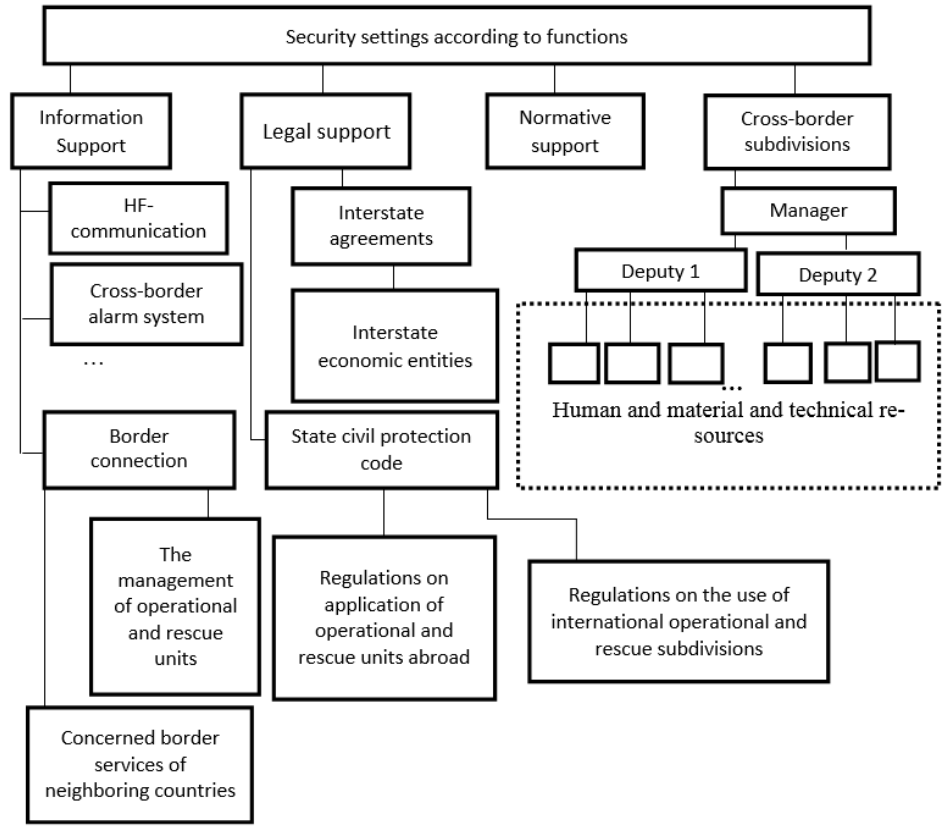

Fig. 2. Classifying security settings model criteria of border cooperation with project-oriented management according to the functions

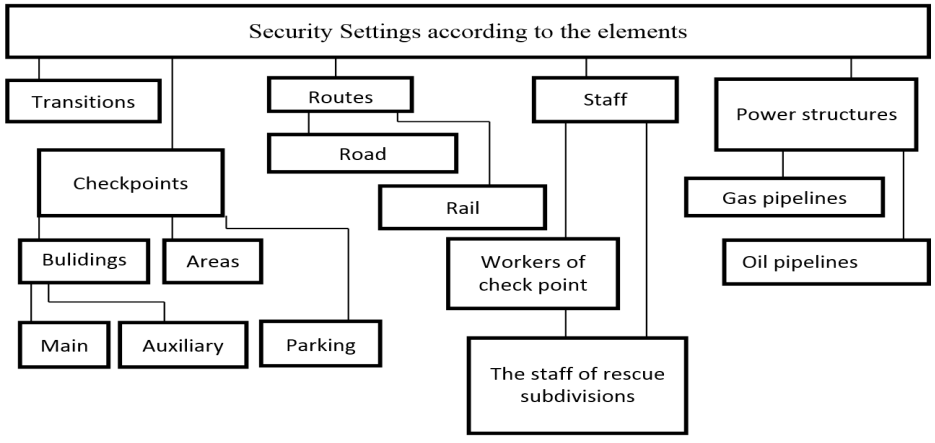

Fig. 3. Classifying model with project-oriented management according to the elements

Modeling of the interaction processes of two operational and rescue units as components of cross-border operational and rescue subdivisions belongs to unsolved practical problems in field of border security cooperation. It is characterized the following features:

- multiparameter character;
- change of many parameters simultaneously, some of which are characterized by different acceleration at the same point in time;
- different physical nature of variable parameters;
- uncertainty of the numerical values of some parameters and respectively the operating range of the their change;
- interconnection complexity of individual units based on the availability in the project portfolio data from mutual influence of human, technical, technological, environmental, informational, regulatory components.

Solution of the problem requires the use of models of specific purpose at presence of the dominant influence of various factors. The choice of model and its settings on the solution of targets of modeling process of project-oriented management of transboundary operational and rescue subdivisions requires an analysis of the basic methods of modeling, development, modernization and adaptation for modeling the specific process of project-oriented management of transboundary operational and rescue subdivisions with variable parameters.

Modeling methods, which can be used in solving tasks, are diverse and relate to different areas of science. Their common feature is versatility. One model is created using restrictions and simplifications, can be involved in the solving processes tasks of different physical nature. With regard to the task, which is considered, multiparameter character and numerical values uncertainty of some parameters is the key condition. Based on the analysis of the interaction peculiarities of individual units of cross-border operational and rescue squads, totality of factors is complemented by the requirement *to follow the tendencies of change* of particular parameters. The scheme of the project implementation of models of project-oriented management of cross-border operational and rescue subdivisions may be submitted in the form (Fig. 5).

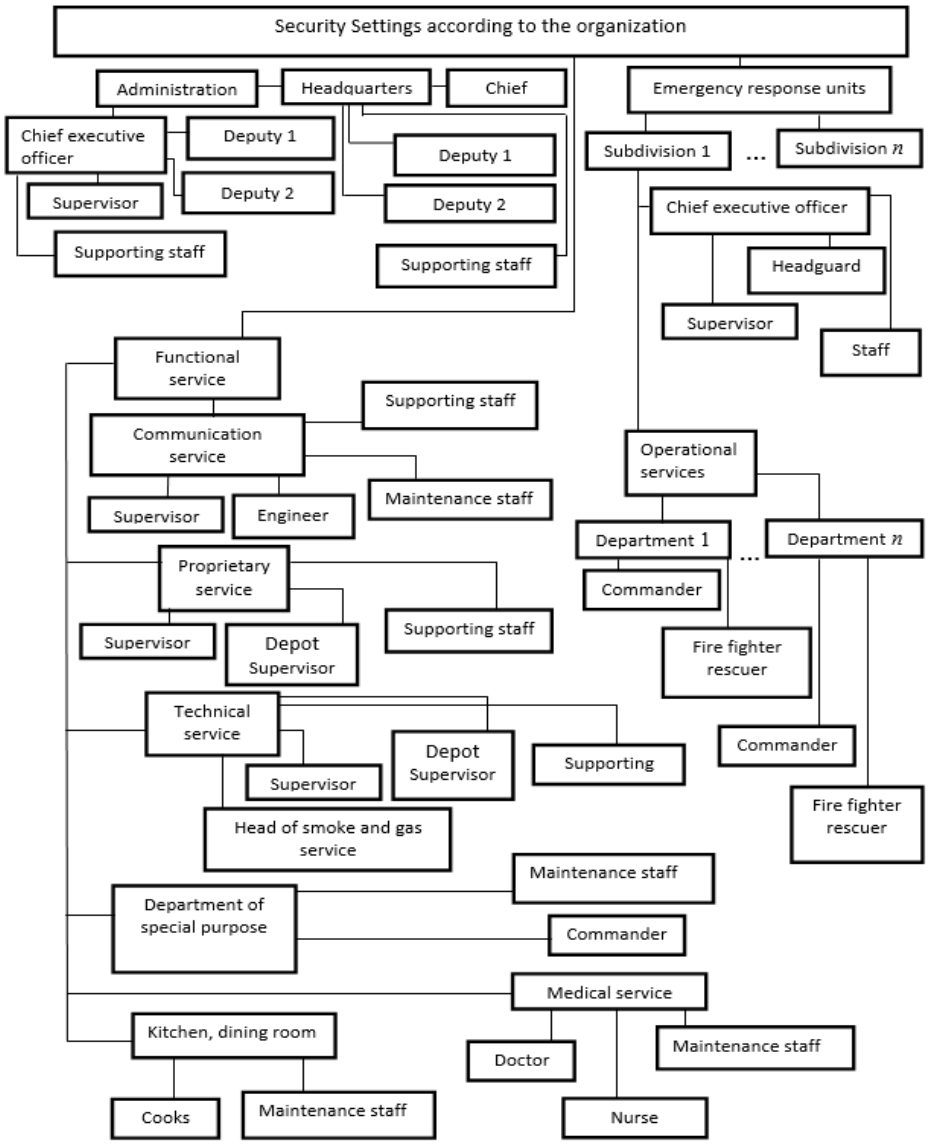

Fig. 4. Classification model of border operational and rescue subdivision of the state at project-oriented management by organization

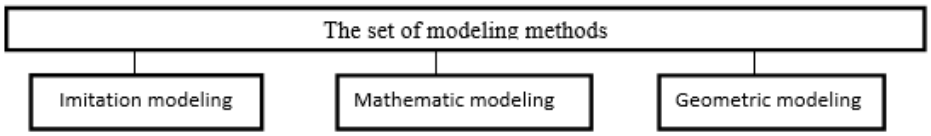

Fig. 5. Scheme of the project implementation of process models of project-oriented management of cross-border operational and rescue subdivisions

A common feature of modeling methods, which are shown in Fig. 5, is their versatility. Categories of individual signs and submission of process results of modeling of presented modeling methods are shown in Fig. 6.

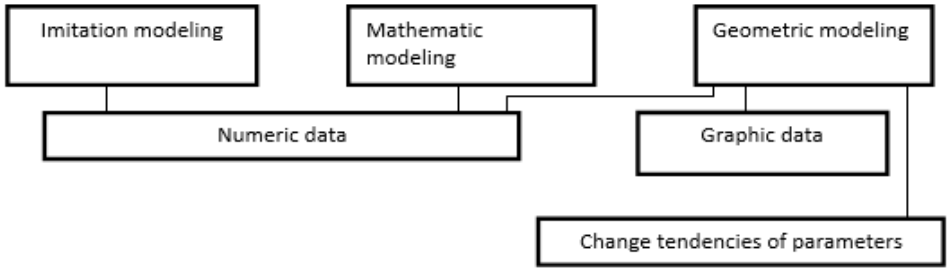

Fig. 6. Categories of modeling methods

Conducted analysis indicates the rationality of choice of geometric modeling of processes of project-oriented management of cross-border operational and rescue subdivisions. However, important factor, which distinguishes the geometric modeling, is the need to consider the simultaneous change of many parameters. Not all methods of geometric modeling take into account the **multiparameter character**, however, responding, the main requirement *to follow tendencies of change a particular parameter.* Specified observation requires conducting the research of methods of geometric modeling. They are shown by matrix organization of methods of geometries components that aggregately define toolkit of geometric modeling (Fig. 7).

Given the specificity of the problem, meaning presence of two components of cross-border operational and rescue subdivision, concept of capacity of methods for geometric modeling are introduced, which means the possibility to operate by means of graphical models using the number of higher measurability. Most of the given geometries operate with a number of parameters, up to three. Applied multidimensional geometry has significantly higher, infinite capacity. The number of parameters that can encompass model of applied multidimensional geometry is unlimited.

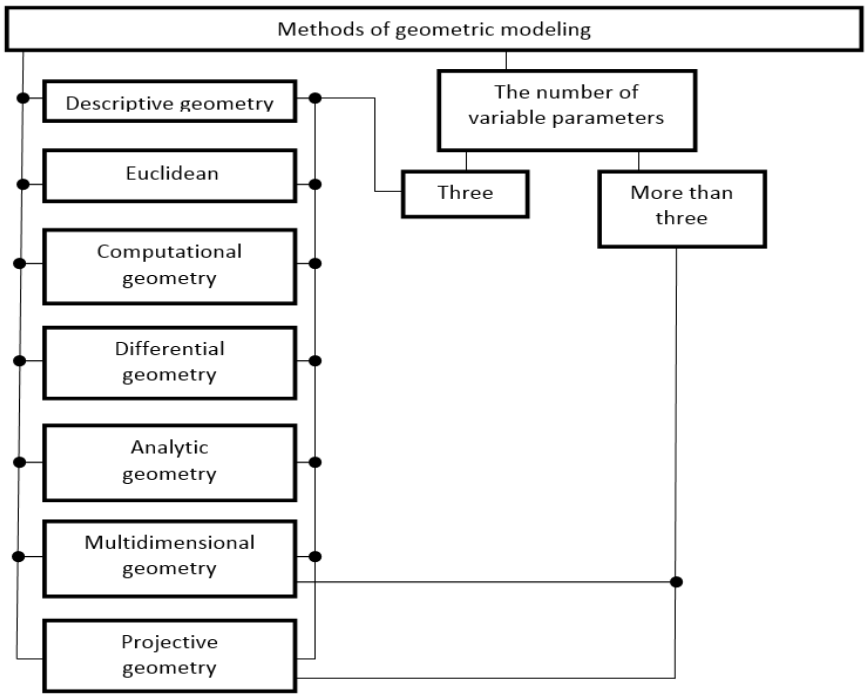

Fig. 7. Matrix organization of methods for geometric modeling

Therefore applied multidimensional geometry has much higher capacity (Fig. 8).

A practical example of implementation methods of geometric modeling using numbers of higher measurability

Analysis of the problems, associated with the investigation of processes of project-oriented management of operational and rescue subdivisions, indicates the possibility of using modeling means of applied multidimensional geometry involving both prime numbers, and numbers of higher measurability. In [10] is shown developed geometric model that applies to the analysis of processes of project-oriented management of cross-border operational and rescue subdivisions, using components built on the principles of Euclidean descriptive geometry [4]. The problem of optimization moving including special transport and rolling stock under conditions of different density of highways is solved in [7]. Tasks of process analysis of the interaction of both operational and rescue subdivisions in the conditions of project-oriented management of transboundary operational and rescue subdivisions in the period of emergency elimination on the border of two states using complex numbers such as $z = x + iy$ and $w = u + iv$, where $i^2 = -1$ imaginary unit are solved in [11, 12].

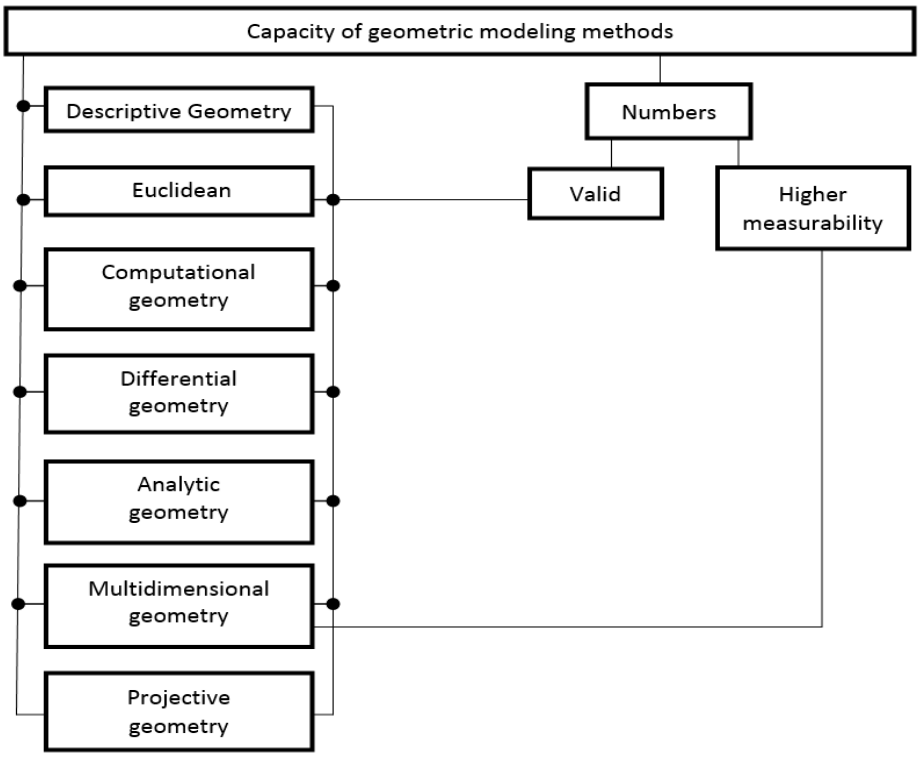

Fig. 8. Structure of capacity of geometric modeling methods.

Capabilities of geometric modeling are demonstrated, when solving **synthesis** problems by using complex numbers, in particular in the case of incompletely specified input. Denote the number of special equipment of one state D1 with valid independent parameter x, and the number of special equipment of the other state D2 imaginary parameter iy. On the basis of expert information character of parameter x changes in time t is set, for example, during the year according to the following dependency (Fig. 9).

The effectiveness of the u use of special equipment of the state D1 in the emergency elimination in the border area subordinates to the law:

$$u=u(x, y)=x^2-y^2. \tag{1}$$

Law of effectiveness v change and also number change of special equipment y in time dimension must be defined.

Function w of efficient use of special equipment of both countries $w = u + iv$ is analytic, ie for components of functions

$$w=u+iv=w(x+iy)=u(x, y)+iv(x, y) \tag{2}$$

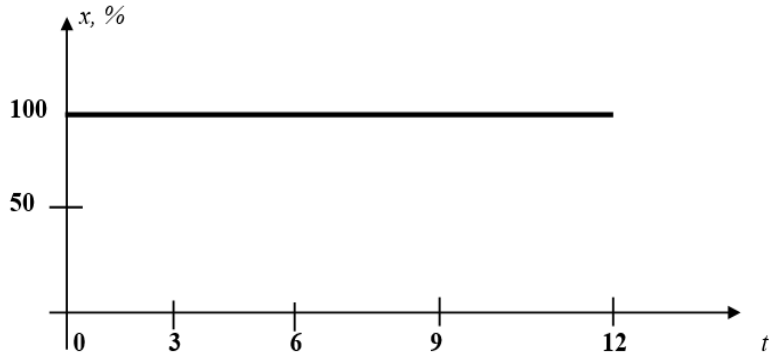

Fig. 9. Dependence of the parameter x change in time dimension

d'Alembert-Euler conditions are performed:

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y};$$

$$\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}. \tag{3}$$

Components to determine the effectiveness of the use of special equipment of the state D2 can be found using equations:

$$\frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y} = 2y = P(x, y);$$

$$\frac{\partial v}{\partial y} = \frac{\partial u}{\partial x} = 2x = Q(x, y). \tag{4}$$

According to the conditions of the problem number of special equipment x is constant; it is equal to x_0 =100%. Range of parameter *y* change within the boundaries $y \geq y_0 \geq 0$ must be defined. The function *v (x, y)* can be found by integrating curvilinear integral [6]

$$v(x, y) = \int_{x_0, y_0}^{x, y} P(x, y)dx + Q(x, y)dy. \tag{5}$$

Substituting dependencies (4) into equation (5), considering dependence of parameter x change, the law of effectiveness v change of using special equipment of the state D2 is obtained:

$$v=2xy. \tag{6}$$

Then dependence of the efficiency of special equipment use of both states D1 and D2 is submitted by analytic function

$$w=u+iv=x^2-y^2+2ixy. \tag{7}$$

Law of number's change of special equipment y must be defined. For this we use the complex Monge draft [4].

In the construction of complex draft three parameters are involved x, y, t. For this case it is convenient to use the net of plane of the three-dimensional state space $Oxyt$ of process of number's change of special equipment. As parameter x is constant in time, interconnections between the three parameters can be presented by graphical dependencies (Fig. 10).

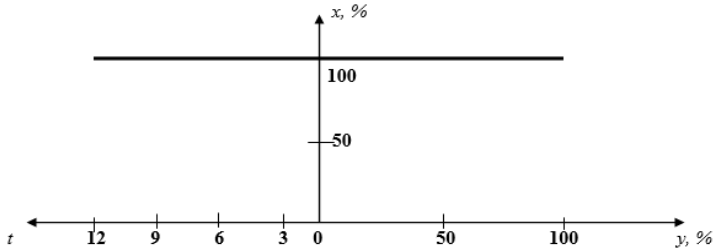

Fig. 10. Net of planes Oxt and Oxy state space Oxyt

Using the third coordinate plane of real variables Oyt, time dependence of parameter y change can be built (Fig. 11).

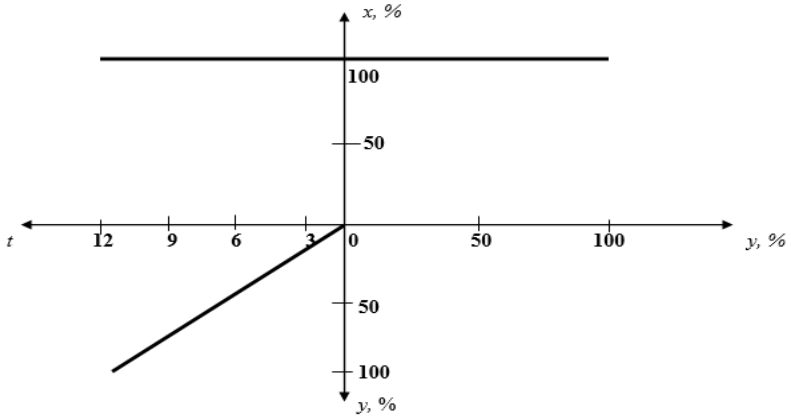

Fig. 11. The construction of time dependence of the parameter y

Conclusions

The carried out researches have shown the effectiveness of using of geometric modeling methods during the implementation of project-oriented management of transboundary systems and operational and rescue subdivisions of emergencies elimination and life safety security. Peculiarities of using models on the basis of targeted choice for solving specific tasks in cross-border areas are shown. In problems forecasting the processes' development and parameters change in working range that is acceptable for the specific cases of the project-oriented approach to the development of cross-border systems and operational and rescue subdivisions, examples of implementation of some models are shown. This indicates the efficiency of modeling means of applied multidimensional geometry, especially in problems concerning analysis and synthesis, of trends of values change of projects parameters and their interconnections in the process of project-oriented management of transboundary operational and rescue subdivisions.

Literature

[1] Code of Civil Defense of Ukraine. - Access mode: http: / zakon 2. rada.dok.ua / laws / show / 5403-17.

[2] Rak. Y.P., Theoretical approaches to the projecting the systems of automation the selection of information in project-oriented management / Y.P. Rak, O.Y. Mykytiv, O.B. Zachko // Project management and production development. – Lugansk : - 2011. – Vol. 1. – P. 433-438.

[3] Creative technologies of project and program management: monograph // Bushuyev S.D., Bushueva N.S., Babaev I.A., Yakovenko V.B., Grisha E.S., Dziuba S.V., Voytenko A.S. - K.: "Summit-Book", 2010. – 768 p.

[4] Bartel K., Geometrya rzutow cechowanych i pewne jej zastosowania, z 48 rysunkami w tekscie i 6 tablicami / Kazimierz Bartel. – Warszawa-e. wende i s-ka: Biblioteka politechniczna. Tom XXX, 1914. - 72 p.

[5] Ljaskovska S. E., Phase trajectories *n* – state space / S. E. Ljaskovska // Geometric and computer modeling. – Kharkiv: KSTUFTT, 2007. - Issue 18. – P. 35-40.

[6] Martyn. E. V., The closed area of complex space / E. V. Martyn // Applied geometry and engineering graphics. – Kyiv: KNUCA, 2007. - Issue 77. – P. 25-29.

[7] Chmiel P. Project-oriented project management of route transportation by means of GPS monitoring // P. Chmiel, Ya. I. Pidgorodeckyi, Yu.R. Olenyuk, E.V. Martyn // Herald LSULS. – L.: LSULS, 2013.-№8

[8] Chmiel P., Modeling tools in project-oriented management of cross-border operational and rescue units / P. Chmiel, E.V. Martyn // Theory and practice of fire extinguishing and emergency response. Mat. V Int. scientifical practical conf. "Theory and Practice of Fire and emergency response". - Cherkasy: AFS, 2013. – P.77-78.

[9] The European Community Civil Protection Mechanism Training Programme. Luxembourg: Office for Official publications of the European Cimmunities. – 2009. -20 pp

[10] Chmiel P. Modeling processes of project-oriented management of fire rescue subdivisions of transboundary areas / P. Chmiel, E.V. Martyn // Herald LSULS. – L.: LSULS, 2013.-№9.

[11] Chmiel P. Geometric means of multidimensional space of projected-oriented management of transboundary operational and rescue subdivisions / P. Chmiel, E.V. Martyn // Mathematics. Geometry. Informatics.- Melitopol: MSPU, 2014.

[12] Chmiel P., Several aspects of modeling process of project-oriented management of transboundary operational and rescue units / P.Chmiel, E.V. Martyn // Problems and prospects of life security. Mat. Int. scientific-practical. conf. young scientists, cadets and students.- L. LSULS, 2014.- P. 189-190.