International Journal of Engineering & Technology, 7 (2.28) (2017) 296-298

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Decision Support Systems on Complex Situation Governance Based On Scenario Approach

I.V. Chernov, D.I. Makarenko*

V.A. Trapeznikov Institute of Control Sciences of Russian Academy of Sciences
**Email: makarenko.dm@gmail.com*

Abstract

Governance of modern situations arising in regional systems requires the development of distributed decision support systems in governance network. The paper proposes a strategic decision support scheme based on a combination of tools supporting the process of constructing multifactor situation models, and agreed models, taking into account different stakeholders' opinions, scenario analysis tools for forecasting and searching for control actions as well as tools for monitoring situation change by factors. At an acceptable level of maturity of technologies of structuration and formalization of knowledge about the situation in the form of models, the means of supporting scenario analysis and synthesis of control activities on complex situations are critical.

Keywords: *Decision Support System; Complex Situation Governance; Scenario Approach.*

1. Introduction

The situations, modern decision makers are facing, are characterized not only by rapid changeability due to interactions of many diverse and interdisciplinary factors, but also by presence of active stakeholders, whose beliefs and interests generate much variability with regard to the direction of the situation development. The decision-making concerning governance of a complex socio-economic system or situation (socio-political, cultural, economic, etc.) depends mostly on collective decision-making, expert knowledge and available information analyses. It is important to note that substantive complexity within governance networks is not so much caused by the complexity of problems and lack of information and knowledge, but lack of consensus on the nature of problems, their causes and solutions. Governance problem solving and policymaking involve diverse stakeholders. They have different perception of the situation and different interpretation of available information. Therefore, collecting information and extracting expert knowledge cannot solve the complex problems in conditions when these problems are interpreted in different ways.
The tasks of developing the regional system, the tasks of strategic monitoring of situation development [1, 5] on the basis of analysis and scenario modeling, the tasks of developing an agreed strategy are based on the assembled decision making tools involved in the governance processes by active stakeholders via the use of new information and communication technologies (Figure 1).

2. The general scheme of DSS tools for complex situation governance

For distributed support of decision-making in a regional system governance, it is sufficient to combine means of supporting the formalization of the situation expert knowledge in the form of cause-effect models, the means for creating integrated models reflecting representations of the stakeholders and the initial data for scenario analysis, the means for supporting information monitoring in data sets and unstructured information from primary sources (mass media, social media, etc.).

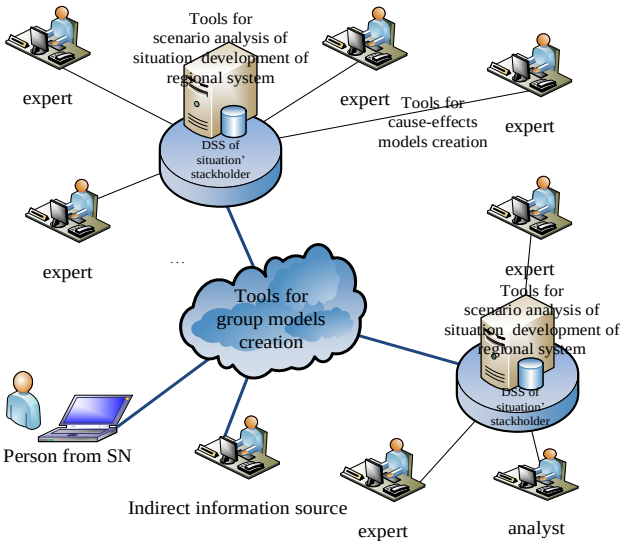


Fig. 1: Tools needed for complex situation analysis

The use of DSS by an expert requires a network multiuser access to the model structure. Models of complex systems may cover various domains: scientific, social, economic, industrial, political, etc. There are no experts with universal knowledge in all these areas. Therefore, the DSS has to support a mechanism for layer-by-layer representation of the model. A single layer may include a subset of factors and relationships between them that relate to one

Copyright © 2018.V. Chernov, D.I. Makarenko. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

or more of the individual activities of the object. Layers can overlap by included factors or be combined into a layer of a higher level.

In software-tool supporting models creation, there should be another way for organizing the collective work of experts. It is associated with the creation or modification by each expert (group of experts) of individual models in the areas of activity of the modeling object. After these models are created, they can be combined into a single working model of an object or situation using a special software module. Some tools supporting formalization process can be found with more or less level of quality of obtained models (an example of supporting network-expertize can be found in [2]).

As modeling in the nodes of the governance network of a complex system, a base of models accumulates in the distributed decision support system, which can form the basis for constructing an integrated model of the object or situation. When analyzing stakeholders' views of the situation, such typical models can serve as a basis for representing the position of the stakeholder and the basis for verifying the current situation model by analyzing the relationships in the data sets and information sources (Figure 2).

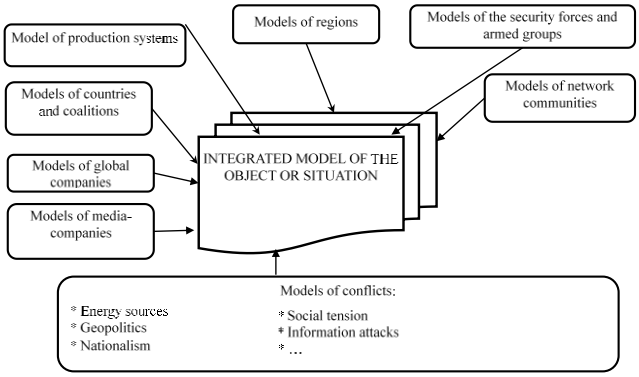


Fig. 2: Creating an integrated model

If there are tools to support the process of formalizing knowledge about situations, the tasks of forming an agreed strategy, analyzing and forecasting the development of situations under different conditions are solved with support of scenario analysis and synthesis software [4-5].

3. Software-tool to support scenario modelling of complex situation

To solve applied and practical problems of scenario analysis of regional governance processes, a pilot version of a specialized analytical software package (ASP) is developed. ASP is based on the mathematical language of sign graphs and provides information support of the processes of forming and exploring alternative scenarios of the situation development in order to assess the effectiveness of decisions to ensure social stability. The developed ASP runs under MS Windows and provides (Fig. 3):

1. automation of creation and modification of graph models in the dialogue mode with the help of built-in visual design tools;
2. formation of graph models in the form of a set of vertices and directed arcs between them that provides storage and access to models using a tree structure, recording names of models in the form of long names, deleting, copying, transferring and combining models, both in the tree structure and inside a tree-like directory;
3. modification of models by the user in the visual mode (drug-and-drop): adding and removing vertices and arcs, giving weights to arcs and changing it, giving the arcs a temporary delay in the passage of the impulse and "breaks" in the tacts of simulation (the weight of the arcs can be given by decimal positive and negative numbers, arithmetic and standard functions of the values of the factors of the vertices and passing impulse through the arcs);
4. storage of model structure and simulation results in one of the most common formats - DBF, which facilitates their possible use in other applications (the presence of common means of access to storage formats: ODBC, OLE DB);

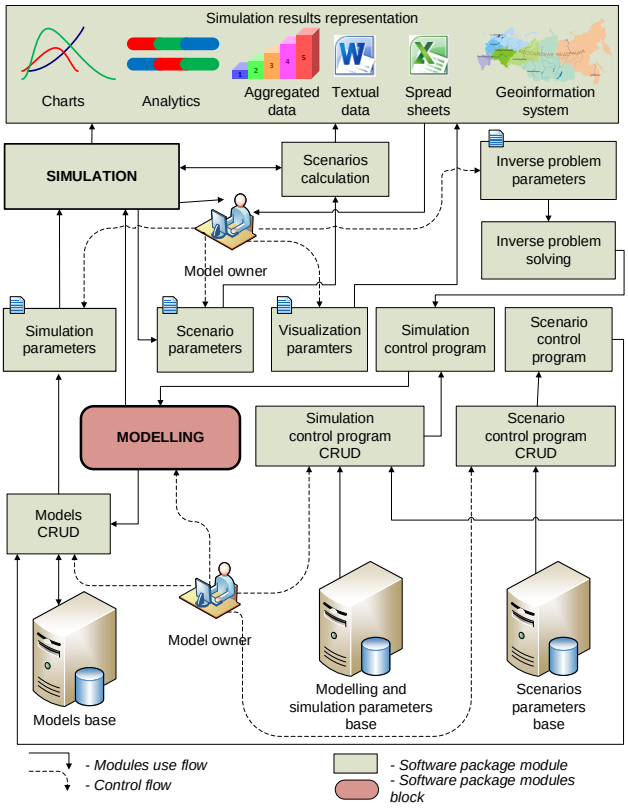


Fig. 3: Functional scheme of scenario analysis tool

5. modeling (model research): carrying out step-by-step modeling with setting the number of steps at each stage, returning the simulation procedure to a specified number of steps, restoring the previous state of the model, making changes during the simulation (adding, deleting and changing the parameters of vertices and arcs) impulses and values at the vertices of the signed graph at any stage of the simulation;
6. solution of the inverse problem: the formation of scenarios of control impact for a purposeful and specified change in the properties of the simulated objects, systems and processes, i.e. solving inverse problems for the purposes of planning and managing the development of complex system and ensuring regional security in conditions of uncertainty;
7. delivery of simulation results: the results of scenario studies are provided by the software complex in text form in natural language (using the built-in function of automatic generation of a text description of the received scenarios of complex system development), in table form (by exporting the results to standard MS Excel format), in graphical form with absolute or relative scaling (including the provision of comparative graphs of simulation results and dynamics of changes in the values of the graph model elements) with a possible reference to maps of geoinformation systems.

The processes of automated formation and study of models are shown in Figure 3 respectively. The software package allows the export of intermediate or final simulation data via telecommunication channels to the situation centers of regional government bodies.

4. Conclusion

The developed strategic decision support scheme based on a combination of tools supporting the process of constructing multifactor situation models and the appropriate analytical software package provide:

- diagnostic analysis and evaluation of the situation;

- development of the object model, choice of performance criteria and assessment of their relative importance;
- generation of possible development scenarios;
- assess the scenarios developed (primarily management processes of prevention and liquidation of consequences of ES), and selecting the best of them for a given criterion of efficiency;
- monitoring and continuous analysis of information on the situation and making the appropriate changes in the structure of the models on the basis of the data obtained;
- assessment and selection of control actions;
- dynamic analysis of possible consequences of control actions;
- collection of the results of the implementation of scenarios and assessment of data.

The opportunity of software support of the methodology of scenario analysis and modeling is approved by the Ministry of the Russian Federation for Civil Defense, Emergencies and Liquidation of Consequences of Natural Disasters (EMERCOM of Russia).

With decision support tools in the nodes of the management network, it is possible to collect models and scenarios on generalized models that integrate stakeholders' representations. At the same time, the configuration of the proposed scenario modeling module does not change in principle.

Acknowledgement

The reported study was partially funded by RFBR, research projects № 18-07-01044 A, № 16-07-00245 A.

References

[1] Avdeeva ZA & Kovriga SV, "On the approach to statement of control problems of the situation with many active stakeholders to support a dynamic goal-setting". *Proceedings of 11th IEEE International Conference on Application of Information and Communication Technologies*, (2017), to be published.

[2] Avdeeva ZK, Ermakov AN & Raikov AN, "Big Data Refining on the Base of Cognitive Modeling", *IFAC-PapersOnLine*, Vol.49, No.32, (2016), pp:147-152.

[3] Gray SA, Zanre E & Gray S, (2014), Fuzzy cognitive maps as representations of mental models and group beliefs: theoretical and technical issues. Fuzzy cognitive maps for applied sciences and engineering, Springer, 29-48.

[4] Kulba V, Zaikin O, Shelkov A & Chernov I, (2016), Scenario Analysis in the Management of Regional Security and Social Stability. New Frontiers in Information and production Systems. Intelligent Systems Reference Library, Vol.98.

[5] Schulz V & Kulba V (editors), (2012) Models and methods of analysis and synthesis scenarios of socio-economic systems, Nauka, 2012 (in Russian).