INFORMATION TECHNOLOGY & INTERACTIONS (SATELLITE)

04 December, 2020
Kyiv, Ukraine

ISBN 978-966-2399-61-5

[1] **Volodymyr Polishchuk**
PhD, Associate professor of department of Software Systems
[2] **Mykola Malyar**
Doctor of Engineering Science, Professor, Professor of department of cybernetics and applied mathematics
[3] **Andriy Polishchuk**
PhD student of department of cybernetics and applied mathematics
[1-3] Uzhhorod National University, Narodna Square, 3, Uzhhorod, 88000, Ukraine

THE TECHNOLOGY FOR DETERMINING THE LEVEL OF PROCESS CONTROL IN COMPLEX SYSTEMS

Abstract. A study of the current problem of developing technology for determining the level of process controllability in complex systems, with different modes of operation was done. In this investigation for the first time was proposed a fuzzy mathematical model based on expert hybrid data, using linguistic and quantitative variables.

Keywords: process controllability, fuzzy set, decision-making, modes of system operation.

Information systems and technologies are increasingly replacing intellectual ones, but the desire to represent the future does not disappear. At the present stage of human development, there is an increasing desire to control the processes in the world. Tools for analyzing massive data sets, today allow you to get new, high-quality knowledge from various information. The amount of data is growing rapidly in all areas, with them there is a need for processing, which is reduced to obtaining knowledge, on the basis of which further decisions are made. Such technologies make life more comfortable, more stable, smarter, and most importantly safer.

Today, decision support systems are increasingly using data mining tools. But most of them are designed to make decisions in the safe mode of operation of systems. For conditions where the system is rapidly changing modes from safe operation, emergency to disaster, most decision support models are not able to adequately assess the situation. Proof of this is the work of the municipality, region, state in the conditions of, for example, a pandemic of coronavirus infection (COVID-19).

Every day, due to various circumstances, extraordinary situations occur that lead to material destruction, threat to health or life. Often through the fault of decision-maker, making the wrong management decisions. Management decisions directly affect the safe state of the system environment. Sometimes decision-maker try to control processes in complex systems without suspecting that process control is very low or non-existent. There are circumstances that do not depend on people. However, there is our desire to know whether we can influence certain processes. There are events that we cannot change, but we must work to anticipate them.

At a time when a complex system is moving from a safe mode of operation to a catastrophe, the situation is changing rapidly, the controllability of processes is

declining, the data influencing decision-making are becoming increasingly vague. Any emergency or catastrophe is the end result of a consistent transition of the normal mode of operation of the system, respectively, in an emergency or catastrophic situation.

Confirmation of the above is illustrated by the following example. The investigation of the plane crash shows what factors and influences accompanied the events of the crash. The conclusion of the causes of the crash indicates whether the accident situation depended on the pilots, the technical condition of the vessel, weather conditions and the possibility of avoiding the accident. The factors of the internal condition of the aircraft, the influence of the external environment, the actions of pilots in an emergency situation and human factors in the management of air traffic are indicated. In other words, the assessment of process controllability in a complex ship piloting system is indicated. And most importantly, the International Civil Aviation Organization is taking clear steps to prevent similar situations in the future.

The above, argues and confirms the relevance of our study on the application of intelligent analysis, systems approach, processing fuzzy data to develop technology to assess the level of process control in complex systems from normal to disaster. The relevance of this study proves the need to understand the controllability of processes in different objects of study and different modes of operation, for sustainable operation of systems, achieving its goals, formalization of such processes, especially in a pandemic COVID-19.

The logic of the study is as follows: if the overall assessment of the system is high, the factors influencing the control processes for the appropriate mode of operation, then we can talk about a high level of process control in the system, and competent management decisions will achieve the goals of the system. ensure the appropriate level of security of the system operation environment.

The logic of the study is as follows: if the overall assessment of the system is high, the factors influencing the control processes for the appropriate mode of operation, then we can talk about a high level of process control in the system, and competent management decisions will achieve the goals of the system. ensure the appropriate level of security of the system operation environment.

Let it be known some object of study that we will consider as a complex poorly structured system S. There are many known system goals and many factors that affect the controllability of complex systems. Also known are the indicators of the system that allow to quantify or qualitatively assess the property of the system. Fuzzy models of system evaluation are built on the basis of known indicators. Within this, it is necessary to assess the controllability of processes in the object of study for quality decision-making depending on the modes C: regular situation, out of the regular mode, critical situation, emergency, accident situation, accident, catastrophic situation, catastrophe.

Suppose we have a set of indicators K, according to which we will assess the level of process control in a complex system S. Indicators can be a whole system of criteria, factors and models, based on which a single aggregate assessment is derived. For example: the level of control of the aircraft is influenced by indicators that depend on the factors of the technical condition of the aircraft, external conditions, human factors and risk-oriented situations; the level of safe financing of innovative projects is

influenced by factors of the microenvironment of the project (strength of the idea), environmental factors (competitors, market, policy), factors of risk management and anticipation, and the main level of project developers.

Formally, we can present a fuzzy model for determining the level of process control in complex systems, taking into account the different modes of operation as follows:

$$A(I; M; C) \rightarrow R(\mu), \quad (1)$$

A – an operator that matches a set of output values R, with input variables $I;M;C$. The input data of the model are: I – expert indicator or quantitative assessment of the level of process control in the system, or a combination thereof; M – taking into account the reasoning of the decision-maker on the scenario of unfolding events; C – system operation mode. At the output of the evaluation model we have: μ – assessment of process control in complex systems taking into account different modes of operation on the basis of which the level is determined R.

As a result of the study, the following results were obtained for the first time:

- ✓ a fuzzy mathematical model for determining the level of process control in complex (weakly structured) systems taking into account different modes of operation, based on expert hybrid data, using linguistic and quantitative variables has been proposed. The estimates of the indicators of a complex system are aggregated in relation to the decision-maker reasoning about the scenario of events. One aggregate estimate of the level of process control in a complex system with respect to different modes of operation is derived. Based on the obtained result, can be determined the level of safe operation of the system to prevent negative consequences or confidence in achieving the goals of the system. All this allows to reveal the uncertainties of expert opinions and data obtained, justifying the degree of decision-making and to draw adequate conclusions, taking into account the different modes of operation;
- ✓ experimental testing of the conducted research in the task of determining the level of process control in the airport management's information systems, with data security threats, taking into account different modes of operation was done. A web application was created for the developed model, with the help of which you can configure models and conduct experimental research for various application tasks.

The rationality of the obtained aggregate estimates, the level of safe state to prevent negative consequences of the system, or the confidence of achieving the goals of the system in different modes of operation, proves the advantages of the developed model. The reliability of the obtained results is ensured by the correct use of intellectual analysis of knowledge, system approach, fuzzy set theory, which is confirmed by research results.