

Modeling Interaction of Society, State Administration Bodies and Business in the Field of Environmental Safety on the Basis of Cognitive Methodology

Svetlana Mukhametdinova
Department of Applied Informatics in Economics
Siberian State Automobile and Highway University
 Omsk, Russia
 ORCID: 0000-0002-3063-3269

Evgenia Tyumentseva
Department of Chemical Technology
Omsk State Technical University
 Omsk, Russia
 ORCID: 0000-0001-6767-0883

Oleg Luchko
Department of Informatics, Mathematics and Natural Sciences
Omsk Humanitarian Academy
 Omsk, Russia
 ORCID: 0000-0001-8476-8954

Bakyt Irmulatov
Department of Agriculture and Innovative Technologies Research and Production
Center for Grain Production named after A.I. Baraev
 Nauchnyj, Kazakhstan
 info@baraev.kz

Abstract—One of the most urgent problems of modern metropolises is to ensure environmental safety, since industrial enterprises are concentrated exactly in large cities, which are the main sources of environmental pollution. Despite the fact that environmental problems are receiving more attention from both the state and society, there are no significant positive changes in the environmental condition of the millionaire cities, including Omsk city. The absence of a system of effective interaction of society, government and business in the field of environmental safety is a major factor that has a negative impact on the environmental condition of metropolises. Purpose of research: designing a system of effective interaction between government agencies, business and society in the field of environmental safety to improve the environmental situation in metropolises using cognitive methodology. The study used methods of expert evaluation and cognitive modeling. The main factors influencing the effectiveness of interaction between government agencies, business and society in the field of environmental safety were identified, a corresponding cognitive model was developed and simulation experiments were carried out on its basis, which allowed to predict the degree of influence on target factor and on individual control factors. Based on the simulation results, recommendations for designing a system of effective interaction between government agencies, business and society in the field of environmental safety of metropolises were developed. In the future, using cognitive methodology, it is planned to expand the range of studies of various aspects of environmental problems, considering the specifics of different cities, regions and countries.

Keywords—*environmental safety, cognitive model, simulation, interaction.*

I. INTRODUCTION

Today, the society pays special attention to environmental issues. Environmental security is one components of national security, describing the security environment and vital interests of citizens from possible negative anthropogenic impacts, threats of emergencies and their consequences. Despite the need to increase the country's energy and environmental efficiency, issues in the field of environmental development and environmental responsibility, improving the quality of life and human health, adjusting and forming the regulatory framework in the field of environmental management, environmental protection and environmental safety come to the fore. Ensuring environmental safety is the responsibility of public

authorities and local governments, which is based on the provisions of the general state law.

Over the past 25 years, a number of Federal laws have been adopted on general environmental issues, environmental expertise and environmental insurance, environmental safety, industrial ecology, as well as the Environmental doctrine of the Russian Federation (2002, 2012) [1-3], which determined the most important directions for improving the environmental situation in the country. The Order of the Government of the Russian Federation dated 17.11.2008 N 1662-p (ed. dd 28.09.2018) [1] presents the main directions of ensuring environmental safety, economic development and improvement of the ecological environment of human life. Priority areas are human ecology (creation of ecologically safe and comfortable environment in the places of residence of the population, his work), environmental business and environmental ecology (preservation and protection of the natural environment). However, the current Russian legislation regulating environmental safety issues in some cases does not comply with international legal norms, which is the subject of hot discussions [3].

A.I. Lagunova [4], N.A. Makhutov, M.M. Gadenin [5-7], G.A. Timofeev, O.M. Orlinkaya [8] pay attention to environmental safety as the basis of a national security strategy. Group of A.Yu. Yanchenko has studied standardization mechanisms to improve the environmental situation in the regions [9]. N. Ridey, Yu. Rybalko, Yu. Kicherenko, S. Palamarchuk, D. Shofolov, E.Yu. Tyumentseva, V. L. Shtabnova, E.V. Vasilyeva [10,11] noted the role of ecological culture as an indicator of sustainable development of relations between society and nature.

We study the environmental situation in the region and want to establish the level of relations and balance between society, business and the state. In the Ecological doctrine of the Russian Federation [3] it is noted that the main factors of degradation of the natural environment of the Russian Federation include: predominance of resource extraction and resource intensive sectors in the economy structure, which leads to the rapid depletion of natural resources and environmental degradation; low efficiency of the mechanisms of nature management and environmental protection, including lack of rent payments for using natural resources;

sharp weakening of the management, especially control state functions in the sphere of nature management and environmental protection; high share of shadow economy in the use of natural resources; low technological and organizational level of economy, high degree of depreciation of fixed assets; effects of the economic crisis and low standard of living of the population, and low level of ecological consciousness and ecological culture of the population.

In modern economic conditions, one of the most priority tasks of the state is to promote small and medium-sized businesses for their development, as well as strengthening the interaction of business and public environmental control. With this interaction, joint legislative initiatives are developed within the framework of open events (round tables, conferences, discussion platforms, etc.). At the same time, everyone wins: power, business, society. Socially-oriented business strengthens its position in the market, leading a policy of openness and accessibility for public control, and unscrupulous business under public pressure will be forced to stop their activities or will work honestly and openly and, as a result, society will benefit.

On the one hand, at state level, legislation is being improved, business is provided with concessions, the system of state environmental control and monitoring is being modernized. Thus, the requirements of environmental legislation have been significantly reduced for small and medium-sized enterprises (SME). First, it is an exemption from the obligation to develop a waste project and the absence of a 5-fold fee for exceeding the limits. When issuing passports for hazardous waste, there is no need to conduct additional laboratory tests to determine their composition. At the same time, the state for three years (2016-2018) canceled scheduled inspections of supervisory authorities for SME. However, the degree of destruction of the environment suitable for human biological existence has reached such a scale that it is possible to speak about the "deficit" of this environment, generating a specific need for it, which, considering the mediated reaction of social communities to anthropogenic changes in the natural environment, has a complex socio-ecological character.

What contradictions exist? Despite all the calls of the country's leadership, public environmental control is practically not involved in public control and supervision activities, environmental decisions at the stage of development and implementation of programs and projects are made behind closed doors and with unclear prospects for the residents of the surrounding areas. The quality of monitoring the implementation of environmental legislation is extremely low, and in cases of environmental and man-made disasters, the existing system of bodies and services is not able to provide assistance to victims quickly and effectively. The current legislation contains incomparably soft sanctions to violators of the environmental legislation, at the same time foreign experience regarding ensuring ecological safety of the state and fight against offenses in the field of environmental protection is poorly used [8]. Most of the industrial facilities, whose emissions and waste are the main threat to the environmental safety of the country, are in federal or private ownership, and there are inconsistencies in the legislation for the possibility of full control by the regional authorities over the observance of environmental legislation by enterprises. At the same time, there is an acute problem of the growth of corruption among the state and municipal authorities

exercising this control. Low level of ecological culture and education [10,11]. In a rapidly changing world, education is not enough for a specialist to work effectively and comply with environmental legislation. It is necessary to raise and maintain the appropriate level of knowledge for both managers of enterprises, decision-makers, and specialists responsible for environmental protection at the enterprise. Given that the consequences of environmental disasters can simultaneously violate the right of citizens to a favorable environment simultaneously in several countries and continents, it is necessary to approach environmental security as a collective security [2,3,9].

Purpose of research: designing a system of effective interaction between government agencies, business and society in the field of environmental safety in order to improve the environmental situation in metropolises using cognitive methodology.

II. MATERIALS AND METHODS

The study was based on the analysis of Internet sources on environmental issues for three years, as well as methods of expert assessment and cognitive modeling.

The method of expert assessment was used to identify the controlling factors that have the most significant impact on the effectiveness of interaction between public administration, society and business in the field of environmental safety of metropolises.

R. Axelrod's methodology of cognitive modeling was used for the analysis of the problem area [12], the scope of which is the solution of multicomponent complex formalizable problems [13], which include the problem of modeling the interaction of state structures, business and society to improve the environmental situation.

Structuring of knowledge about the studied objects or processes considering the relationships between individual components and the environment is one of the first stages of cognitive modeling. The purpose of cognitive structuring is to identify the control factors affecting the entire system under study, the integral characteristic of which is the target factor, in our case - the level of formation of interaction between government agencies, business and society to improve the environmental situation.

Based on the carried-out structuring of knowledge the cognitive model is developed and a series of simulation experiments by means of specialized software is carried out. The results of the experiments allow us to predict the impact on the target factor of impulses affecting other basic factors and to develop effective solutions for the management of the object of study.

III. RESEARCH RESULTS

The real situation is quite evident in the results of the expert survey, publications of social networks and the media. For example, in the Omsk region, according to the annual report on the condition of the environmental situation [14], the dynamics of emissions of the most common air pollutants for the period 2009-2018 is such that in 2009-2012 there is an increase in emissions of pollutants from 214.2 thousand tons in 2009 to 240.2 thousand tons in 2012. In the period 2013-2017 there was a drop-in emission from 213.6 to 192.8 thousand tons. And in 2018 - again a slight increase in emissions to 202.2 thousand tons. At the same time, it is

separately noted that the increase in emissions is due to an increase in the number of economic entities and, accordingly, an increase in the number of pollutants emanating from stationary sources of pollution. However, residents of the city and the region have other "feelings": since 2017, periodic release of ethyl mercaptan has been recorded, causing deterioration of public health. The dissatisfaction of townspeople has increased dramatically. Despite the actions of the regional authorities to identify the source of emissions, the polluter has not been identified. It was at this time that the city's public organizations, caring people in social networks and the media became more active. Statistics are as follows: at the beginning of 2017 – 150-200 monthly publications, since the end of 2017 and in 2018 - about 350 publications on environmental issues. 2019 brought the country a lot of environmental information occasions: the new "garbage" reform "stirred up" the country and the city, and the number of monthly publications has increased to 450 pieces and is kept at this level. Local TV channels invite environmental activists, specialists and administration leaders 2-3 times a week for public speeches and discussions. And all environmentalists argue that there should be interaction between business, authorities and public, and exactly in such triunity it will be possible to really predict the improvement of the environmental situation and ensuring environmental safety.

Based on the results of expert assessments, the study identified the controlling factors that have the greatest impact on the level of formation of interaction between government agencies, business and society to improve the environmental situation (see table 1).

TABLE I. THE MAIN CONTROL FACTORS INFLUENCING THE LEVEL OF EFFICIENCY OF INTERACTION BETWEEN GOVERNMENT AGENCIES, BUSINESS AND SOCIETY IN THE FIELD OF ENVIRONMENTAL SAFETY

Number	Types of factors	Measurement method	Measuring units
<i>Focused factor</i>			
A	Efficiency of interaction of state structures, business and society in the sphere of ecological safety	Semantic differential	Points
<i>Managing factors</i>			
B	Legislation of the Russian Federation in the field of environmental safety	Expert assessments	Points
C	Omsk region legislation in the field of environmental safety	Expert assessments	Points
D	Coordination of regional and federal legislation in the field of environmental safety	Expert assessments	Points
E	State bodies of monitoring and control of indicators of ecological condition of megalopolis	Expert assessments	Points
F	Independent laboratories, including mobile ones, constantly monitoring the indicators of the ecological state of the metropolis	Expert assessments	Points

G	Mechanisms of implementation of legislative norms in the field of environmental safety	Expert assessments	Points
H	Financial mechanisms of impact on business structures in the field of environmental safety	Expert assessments	Points
I	Favorable conditions for the implementation of environmental business projects	Expert assessments	Points
J	Social environmental advertising	Expert assessments	Points
K	Level of environmental education of the population	Expert assessments	Points
L	Level of ecological culture of the population in the sphere of ecological safety	Expert assessments	Points
M	Social activism in the field of environmental safety	Expert assessments	Points
N	Permanent platforms, including in the Internet, on television and radio, the purpose of which is to organize the interaction of government agencies, business and society in the field of environmental safety	Expert assessments	Points

Considering the identified factors and the relationships between them, a cognitive model of the effectiveness of interaction between government agencies, business and society in order to improve the environmental situation in the metropolis was developed (see Fig. 1).

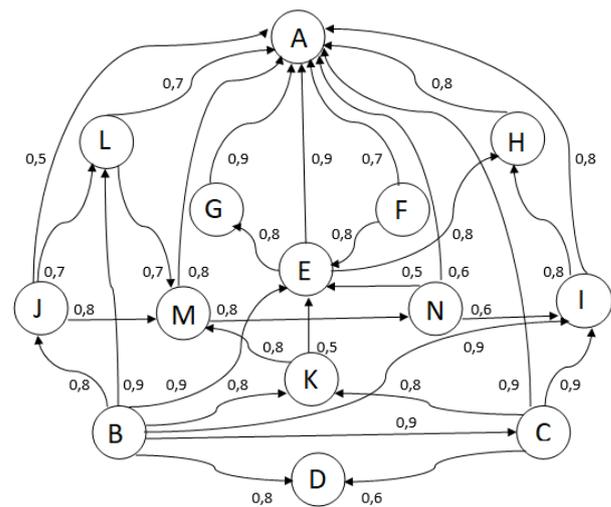


Fig. 1. Cognitive model of the effectiveness of interaction between government agencies, business and society in the field of environmental safety.

Based on the created cognitive model the matrix of influence of managing factors on the target factor A – efficiency of interaction of the state structures, business and society in the sphere of ecological safety was developed.

Further, using the functionality of a specialized software tool that allows to automate the process of cognitive modeling, simulation experiments were conducted to predict the impact on the target factor of influences of different intensity on the control factors.

In simulation experiments, the values of impulses affecting one or more control factors were changed step by step (in percent). The results of the experiments were changes in the values of impulses affecting the target factor - the effectiveness of interaction between government agencies, business and society in the field of environmental safety and other controlling factors. In particular, an increase of 20% of impulses affecting factors O, H and M, respectively, led to an increase in the impulses affecting the target factor A by almost 160% (see Fig. 2).

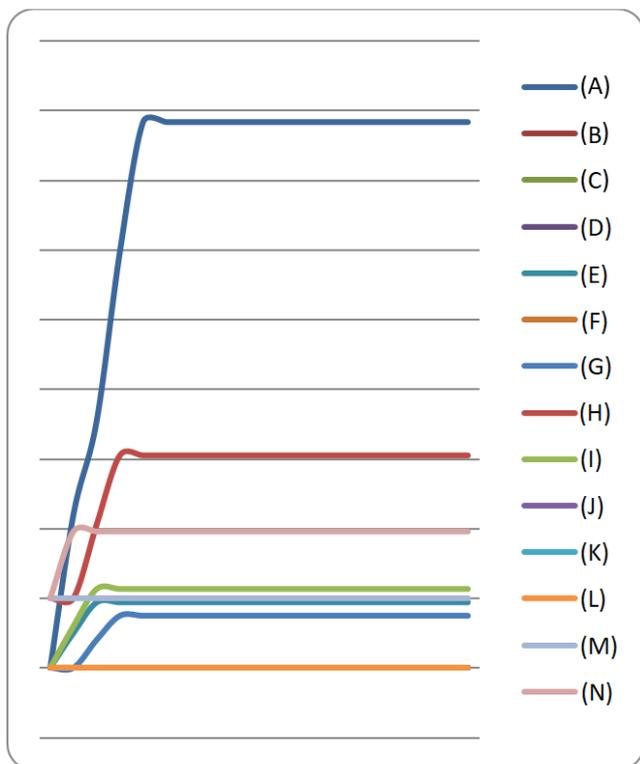


Fig. 2. The impact of increasing impulses affecting factors O, H and M on other control factors and factor A - effectiveness of interaction between government agencies, business and society in the field of environmental safety.

The above results of the simulation experiment are the most indicative, since the combination of the impact of impulses on factors that largely depend on the representatives of the state, society and business of the metropolis was considered.

IV. RESULTS AND DISCUSSION

According to the results of the study, the following conclusions can be drawn:

1) The application of the methodology of cognitive modeling for the analysis and forecasting of the development of such a multifaceted problem area as the design of a system of effective interaction between government agencies, business and society in the field of environmental safety is promising.

2) Despite the fact that the state, state and municipal authorities are paying more attention to the problems of environmental safety of metropolises and much is being done in this direction, however, the number of citizens dissatisfied with the environmental condition of metropolises, in particular city of Omsk, is not reduced.

3) Social environmental advertising, environmental education and upbringing, the formation of an active civil position among the residents of the metropolis are the most important components of the system of effective interaction of state structures, business and society in the field of environmental safety, and therefore should become priority areas of activity of the relevant state and municipal authorities and educational institutions of various levels.

4) The formation of a system of effective interaction between government agencies, business and society in the field of environmental safety in metropolis is impossible without presence of permanent sites, including in the Internet, on television and radio, where open discussions on topical environmental problems would be held.

5) To solve the problems of environmental safety of the metropolis, it is necessary to create favorable conditions for attracting business representatives to participate in environmental projects, creating more environmentally friendly enterprises and upgrading existing ones, such as, for example, tax holidays or a reduction in the tax rate, lending to businesses on preferential terms, wide public recognition of achievements in the field of ecology, etc.

V. CONCLUSION

Environmental issues at the local, regional and global levels are interrelated. Environmental crisis in its scope and consequences can often be much more dangerous than political, economic, financial or informational, and its overcoming can last several decades or even several centuries. The problems of environmental safety affect the entire population of the modern metropolis, and without the consolidation of efforts of representatives of state structures, society and business on a mutually beneficial basis, their solution is impossible. However, the design and formation of a system of effective interaction is impossible without relying on the results of scientific research using modern methods and approaches to the analysis of the problem area.

REFERENCES

- [1] Order of the Government of the Russian Federation of November 17, 2008 N 1662-r (as amended on September 28, 2018) "On the Concept of Long-Term Socio-Economic Development of the Russian Federation for the Period Until 2020". http://www.consultant.ru/document/cons_doc_LAW_82134/
- [2] Federal Law "On Security" dated October 28, 2010 No. 390-FZ. http://www.consultant.ru/document/cons_doc_LAW_108546/
- [3] Order of the Government of the Russian Federation of August 31, 2002. No. 1225-r, "Environmental Doctrine of the Russian Federation". http://www.consultant.ru/document/cons_doc_LAW_92097/
- [4] A. I. Lagunova, "Environmental safety policy in environmental doctrine: Russian national security strategies," *Lichnost'. Kul'tura. Obshchestvo* (Person. The culture. Society), Vol. 13, No. 4 (67-68), pp. 277-283, 2011. (in russ.)
- [5] N. A. Makhutov and M. M. Gadenin, "Ecological Safety and Ecological Heritage in Problems of National Safety," *Ecology and Industry of Russia*, Vol. 20, No. 3, pp. 47-51, 2016. (in russ.) <https://doi.org/10.18412/1816-0395-2016-3-47-51>

- [6] N. A. Makhutov, M. M. Gadenin, F. F. Svetik, and V. G. Makartum'yan, Security of Russia: legal, socio-economic and scientific-technical aspects, Vol. 3. MGOF Znanie, 2015. (in russ.)
- [7] National Security Issues: Expert opinions, analytical materials, proposals 2008-2010, N.P. Laverov, Eds. Moscow: Nauka, 2011. (in russ.)
- [8] G. A. Timofeev and O. M. Orlinskaya, "Ecological safety in the system of national security of the Russian Federation," *Vlast (Power)*, Vol. 25, No. 2, pp. 69-74, 2017. (in russ.)
- [9] A. Yu. Yanchenko, N. V. Androsenko, and G. N. Ivanova, "Modern Mechanisms of Standardization for Improving the Ecological Situation in the Regions," *Economy of Region*, Vol. 14, No. 2, pp. 516-529, 2018. (in russ.) <https://doi.org/10.17059/2018-2-14>
- [10] N. Ridei, Y. Rybalko, Y. Kycherenko, S. Palamarchuk, and D. Shofolov, "The Role Of Ecological Culture as an Indicator of Sustainable Development of Relations between Society and Nature," *European Scientific Journal, Special Edition*, Vol. 2, pp. 14-23, 2013.
- [11] E. Yu. Tyumentseva, V. L. Shtabnova, and E. V. Vasilieva, Environmental education and upbringing as a factor in the sustainable development of society. Omsk: Omsk State Institute of Service, 2014. (in russ.)
- [12] R. Axelrod, *The Structure of Decision: Cognitive Maps of Political Elites*. Princeton: Princeton University Press, 1976.
- [13] O.N. Luchko, S. Kh. Mukhametdinova, and O. Yu. Patlasov, "Using the tool-kit of cognitive modeling within the analysis of a vector educational migration," *Novosibirsk State Pedagogical University Bulletin*, Vol. 7, No. 6, pp. 232-248, 2017. <http://doi.org/10.15293/2226-3365.1706.14>
- [14] Report on the environmental situation in the Omsk region for 2018, the Ministry of Natural Resources and Ecology of the Omsk Region. Omsk: Omskblankizdat LLC, 2019. (in russ.)