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CORPORATE KNOWLEDGE BASE AND SCIENTIFIC APPROACHES TO SECURITY RESEARCH OF NATURALLY-TECHNOGENIC OBJECTS STATE

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Abstract

The article deals with topical issues of knowledge system implementation in research, enterprises work, IT companies as a base for decision making on certain innovative issues. Attention is paid to environmental security research as a major component of national security and providing a sound solution to human and environmental (E) health tasks.

The basic tendencies in the knowledge-oriented databases formation as knowledge bases for scientific research of system objects of the type "natural-technogenic system – environment" are considered. Priorities are given in corporate knowledge bases creation, which is the base for conducting complex studies of complex systems and obtaining new knowledge. The scientific basis for methodological support creation in comprehensive study of system objects has been determined. The benefits of cooperative methodology for assessing the state "system – environment" are substantiated. It is suggested to use cognitive and entropy approach for state conformity estimation and complex systems functionality with knowledge about requirements of equilibrium "system – environment", use of theoretical base and knowledge of named approaches for solving problems of complex systems (system objects) modeling for their state and functional correspondence estimation, software for implementation of such assessment in accordance with the methodological foundations of these approaches. The advantages of these methods in the study of complex objects from the standpoint of their versatility and the possibilities of using in creating the necessary knowledge base and obtaining complex models of system objects and working with them to identify the estimation state characteristics and development tendencies of interacting with the environment systems are shown.

Practical application results of the proposed solutions to the security for system objects "system – environment" on the example of a technological solution for the protection of the environment from man-made slurry contamination, showing the universal ability of developed methodological support for the study of complex structured systems is given.

Keywords: Knowledge-system (KS), Knowledge Management Systems – KMS, system object, cognitive approach, complex evaluation, equilibrium, entropy state function, research model, natural-technogenic system, environmental assessment

Problem statement. Introduction: relevance, aim and research objectives. Regardless of the time and business situation, the guarantor of the successful scientific research of complex systems, manufacture work has always been the fundamental knowledge system, the so-called Knowledge-system (KS), and knowledge management system – knowledge management, which consists of knowledge management systems – KMS. Globally, IT companies have successfully used KM to capture best practices, improve project management and customer service, develop innovation, reuse software code, and extend the boundaries of technological generations and different market maturity levels.

Knowledge system is considered as a system formation, organizationally and technically connected with the provision of the company's activities and development. According to the generalization of various information sources definitions it is proposed to consider the Knowledge Management System (KMS) as an information system that provides a high level of effective company activity based on its application for solving the following tasks:

– management of organizational knowledge to support and improve the creating knowledge process, storing / searching, transferring and using them;

– achievement of an effective communication mechanism between the organizational and technical structure and company staff;

– ensuring hierarchical organization compliance of gathering information into the knowledge base and its distribution through a certain set of channels, processes and protocols [1].

Search model meaningfulness should reflect the physical and chemical nature of the research object "system – environment" due to certain information saturation and functional capacity of elements and connections in combination with heuristic techniques for constructing topological structures. Relationships complexity in the system and its connection with the external environment is established thanks to operational causality concept with considering rules marks, formally logical connection substance flows rules in local space point and association rules individual blocks and elements in a coherent diagram that allows to develop topological communication structures (communication diagrams). Problem solving synthesis and optimization regulatory decision-making is based on certain topological model type in form of parametric flow graphs (PFG), material flow graphs (MFG) and energy or information flow graphs (EFG or IFG).

In order to study the structural properties, behavior and development system based on the experiments scenario results, establishing processes that lead to desired solution, it is advisable to topological modeling, with some input data by previous system state consideration, go to identify it as a cognitive model. This allows to determine factors by significance of violation in system "object – environment" and to establish the conditions for returning to the original structure, finding a new systems ordering in object and its internal and external submission connections [2].

There are no infinite straight lines in nature, so there is invariance at infinite scales number in nature. Each system can be highly organized, that is, have a developed and complex structure, less organized with a simple structure, completely chaotic, when its elements are distributed randomly and, on average, in a homogeneous manner. According to the fundamental provisions structures formation theory in irreversible processes, there is necessity appeal to fractal geometry with getting connection between the basic concepts of chaos and structure, the entropy of different nature systems state quantitative assessment.

Systems structural organization measure entropy function is adopted in relation to the implementation of equilibrium or imbalance, the direction determination of structures development or degradation in the system object.

In process of development and evolution (new structures sequence) of a complex system by important factors in maintaining stability and integrity are the self-organization within the systems internal environment and their interaction with the environment, the links maintenance that homogenize the system space, not allowing voltage points creation – an entropy explosion, the chaos realization. The main task for complex systems synergetic analysis is to identify the main factors at each stage of successive and irreversible transition from one systems state to another with the implementation of a certain internal organization level and the structural elements connection degree with the predominance of a certain communication type between them. To identify pre-crisis states, an integrated signaling approach is implemented based on modern synergetic, multifractal and wavelet analysis methods, entropy methods, graphological models, etc [3].

Analysis of the recent researches and publications. in today's knowledge the Knowledgebase [KB] is defined as a set of software that provides the search, storage, transformation and recording of complexly structured information units (knowledge) that form a holistic description that corresponds to a certain level of awareness of the subject under study, event, problem, etc. [4–12].

The corporate knowledge base is a single information space (SIS) of the company [12, 13]. Knowledge resources vary by industry and applications, including leadership, newsletters, customer information, competitor information, and data accumulated in the workflow.

In artificial intelligence systems, knowledge bases are generated for knowledge-based experts and systems, in which computers use withdrawal rules to get answers to user questions. Knowledge acquisition is based on modern developments of KB in KM, which are related to solving the following issues:

– providing knowledge in a form suitable for perception,

– software for processing this knowledge.

Knowledge acquisition is based on self-regulation theory in terms of knowledge management consists of two main dimensions: the collection frequency and the information gathering intensity; transfer it during performing any work, including life cycle research [4–13].

The main disadvantage of the proposed methodology of organizing system objects regarding their quality and safety management is the application of concepts, definitions, formalized representations, etc. the traditional synergetic G. Haken concerning the self-organizing ordering in order to obtain purposeful systems in the plane of the concepts of chaos and the order by random nature trajectory of systems motion in the phase space [14, 15], the introduction of a synergetic information theory for statistical representation of the chaotic system state in form of its uniformly distributed elements by any sign value [16]. In defining the system state from the thermodynamic approach standpoint, according to I. R. Prigogine [17 – 19], is used concepts of stability and destabilization with disorder maximization, that is, the entropy growth and bifurcation point attainment.

Self-organization concept as a transition from a chaotic to a more orderly state is the base of dissipative structures formation. Such systemic transitions are the result of irreversible non-equilibrium processes considered [20–22].

To describe the relations with available input and output information in the form of knowledge about the state and process, data on the intermediate variables that determine the transformation in the system using logical networks [23].

Imitation models are widely used in the study of the environment and individual objects, usually to determine their state and forecast changes in order to avoid environmental hazards, planning threats elimination measures [24]. At present, an appeal to the information component of the external person world is relevant. In this sense, the use of models based on the theory of information entropy, namely the Shannon entropy, which is used to solve problems from many different knowledge fields, first of all, the study of ecological and economic systems became widespread. Thus, based on the results of remote ecosystems sensing, the prospect of applying this approach in natural objects monitoring data assessment [25] has been established. The prospect of the entropy approach introduction is also defined for the social issues analyze, for example, the assessment of business processes development and economic decisions adoption [26, 27]

In general, in a large number of decision-making tasks, the analysis of the man-made object state of socio-ecological and economic content and its quality management is based only on experimental data (training sample) [28]. Decision-making in the conditions of local information and implicit knowledge leads to errors in the decision-making on the homeostasis maintenance in natural-technogenic formations. The sequence of factors, events, conditions of real processes is characterized by a certain causal connection of explicit and implicit dependencies. The formalization of implicit dependencies is associated with indirect causative relationships based on the construction of formal algebra-logical models of implicit selection constructs [29].

Statement of the problem and its solution

The study of complex systems is associated with the solution of problematic tasks, so it must rely on the knowledge system, which is responsible for the information resource about the state of task solution components of object state "system – environment", knowledge about the methodology of studying such system objects and obtaining new knowledge.

Problem solving requires a conceptual approach in studying the cooperative dynamics of systems involved in the structure of an object, in particular, such are natural-technogenic systems, processes and tasks related to its equilibrium (stationary) stable functioning.

In the paper, approaches based on system analysis are proposed, which allow to identify, in general, knowledge gaps for solving problems of system objects research (to focus on all aspects of problem tasks). In this connection, the following issues are considered:

1) analyze the main advantages of introducing the knowledge base and KMS to support complex system research and possibilities of choosing an approach to study them;

2) substantiation of a comprehensive framework for the study of systemic objects, in particular cognitive and entropy;

3) putting into practice the proposed propositions regarding the combination of knowledge bases and information and software support in solving problem tasks comprehensively.

To study system objects state, a complex information base should be created in the form of a corporate knowledge system for the purpose of its use as a resource capital, which allows to provide dynamic abilities of knowledge obtaining and transfer in the course of work on set tasks solution for the study state and functioning of system objects in the conditions of interaction with environmental systems, the basis for innovative proposals to find approaches in such task solution. To this end, it is suggested, according to resource theory of knowledge management [4], to allocate the target and value aspects of the knowledge base (KB) and to manage the available and up-to-date information resources in the research related to the accumulated experience of internal and external origin (fig. 1).

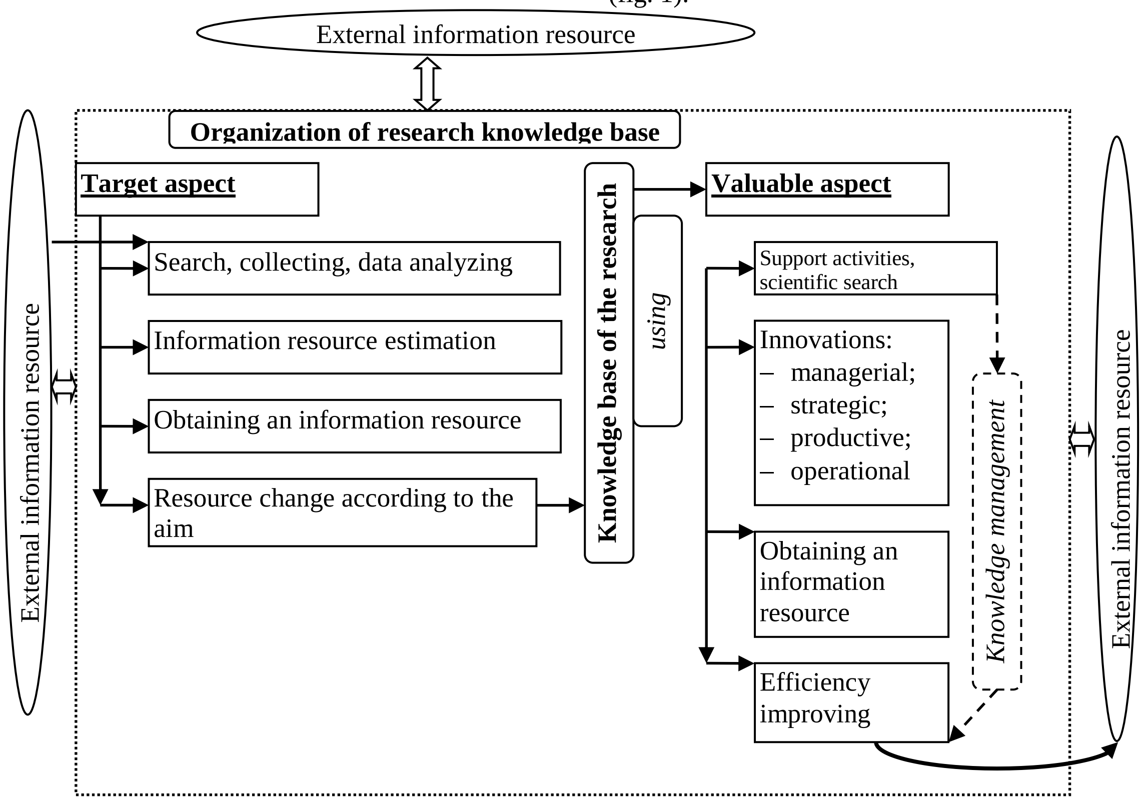

Figure 1 – Definition of company's target knowledge base according to the resource theory (proposed by the authors)

The KM system provides an order for working with information resources to provide access to knowledge and reuse them using modern information technology. Knowledge is classified and categorized according to structured databases and knowledge bases.

Knowledge base (KB) is a special kind of database designed for knowledge management, i.e. collecting, storing, searching and passing knowledge [5, 6]. The section of artificial intelligence, which studies knowledge bases and methods of working with knowledge, is called knowledge engineering.

In the activities of any company, organize information subject to ensuring its receipt, manage and update. In this case, a complex of informational materials is provided, which is provided in the form of separate documents, databases, information systems, which form a kind of corporate knowledge base (CKB).

Data repositories are significant. For example, the Chase Manhatten Bank has a storage capacity of over 560 GB, MasterCard OnLine – 1.2 TB [6]. Provided that data is stored in a single repository, it is possible to study the relationships between individual data elements and their analysis, which allows to obtain new knowledge. Additional, hidden in the given knowledge reveal through the so-called alternative approach "intelligence of knowledge".

In today's knowledge the Knowledgebase [KB] is defined as a set of software that provides the search, storage, transformation and recording of complexly structured information units (knowledge) that form a holistic description that corresponds to a certain level of awareness of the subject under study, event, problem.

The corporate knowledge base is a single information space (SIS) of the company [30]. Knowledge resources vary by industry and applications, including leadership, newsletters, customer information, competitor information, and data accumulated in the workflow.

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– providing knowledge in a form suitable for perception,

– software for processing this knowledge.

Knowledge acquisition is based on self-regulation theory in terms of knowledge management consists of two main dimensions: the collection frequency and the information gathering intensity; transfer it during project life cycle.

For KMS formation is used, as shown above, different technologies: e-mail; databases and data warehouses; group support systems; browsers and search engines; corporate networks and the internet; expert systems, knowledge base systems; intelligent systems. Thus, KMS is formed as a system education, which generally includes a database, a knowledge base and an organizational structure or knowledge management system. To implement the KM approaches for knowledge processing in the any applied research field and in practice, an important element of KM corporate system is the knowledge management provided by the concepts and tools of different functional areas, which promotes understanding KM approach oriented on work in the IT space.

Thus, according to Ronald Mayer's research papers [7, 9], the corporate system KMS is defined as a structured system of KM models to support decision-making on the effective исследовательской work, indicating 3 information areas (fig. 2):

1. A knowledge management task and flow model combines several models for describing KM processes at the operating level and knowledge strategies level in scenarios (see Fig. 1). This model defines the design of information flows associated with collection systems, information organization according to learning + e-training system (area 3 at fig. 2), which affects tasks and flows in knowledge management.

2. The model of knowledge management roles and teams is the structure of structural scenarios organization (area 2 at fig. 2).

3. Knowledge type classification determines the KMS content, primarily aimed at the KM initiative (area 1 at fig. 2).

Knowledge structures associate diverse, individual or group elements of knowledge with the basics of a decentralized organizational framework that has been developed independently. This allows you to decide on the navigation of the entire organizational knowledge base – many knowledge processes cross the boundaries of organizational units or entire organizations, standardization of knowledge representation methods, for example, based on XML-themed maps, plays an important role in providing organizations of exchange (documented) knowledge.

Knowledge should be maintained by official organizational units, such as working groups, departments, departments or projects, etc., so that resources are accountable to them. This is the main mechanism for integrating knowledge from the following components:

– formal organizational design focused on effective day-to-day work (working groups, business processes) and work processes improvement (projects);

– informal secondary and personalized knowledge organization.

Based on the above analysis of the knowledge system definition, KMS and KM, and their composition and type, it is proposed to present the structure of the corporate knowledge system in according to an integrated knowledge management approach to increase the efficiency of software development processes under the IDEF0 modelling standard (fig. 3).

The knowledge base undergoes modification and development in according to company's development, the technologies it employs and the products it produces or distributes. Effective use of it for training personnel requires the development of compact training courses focused on the particular person being trained, taking into account the knowledge of the CKB. The proposed structure of the corporate knowledge system is presented at Figure 4 as packages in the UML notation.

Information system creating task in both object of analysis and its own toolkit, corresponding information shell in scenario-target approach, which allows evaluating and integrating into single information space knowledge about the system and process. Such space is a constant information purposeful knowledge system from state aim reflection, functionality, stability or adaptability of study various nature objects.

According to defined concept of creating research object as a systemic integrity, which directs its activities to achieve the goal, it is proposed to use cooperative links between systems and the formation of corporate associations.

To develop methodological approaches for informational decision-making support on establishing state and functionality of system objects based on the analysis and evaluation of information flows using knowledge bases models is proposed (fig. 5).

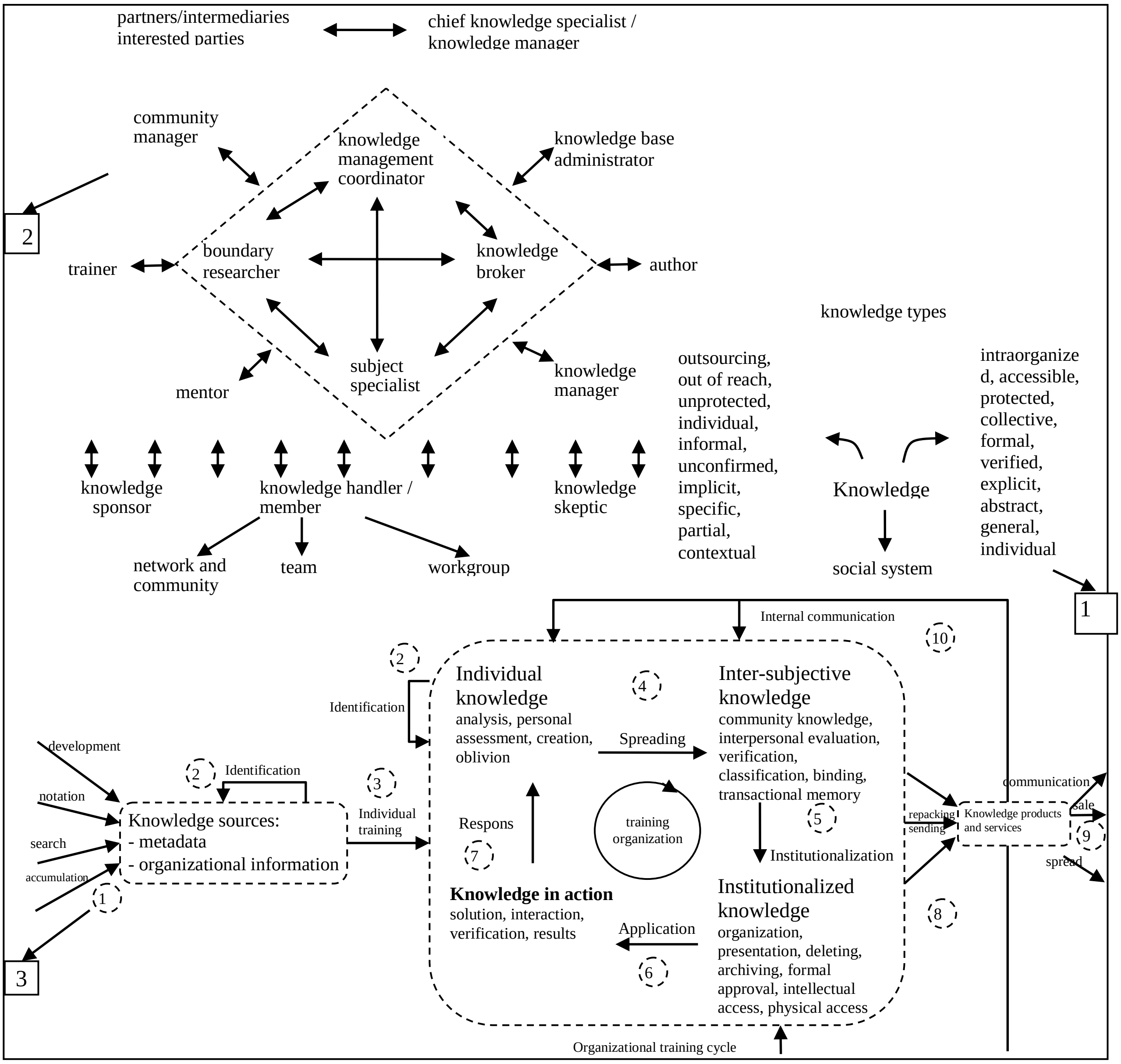

Figure 2 – Schematic structure of corporate knowledge system and knowledge management model [7, 9]

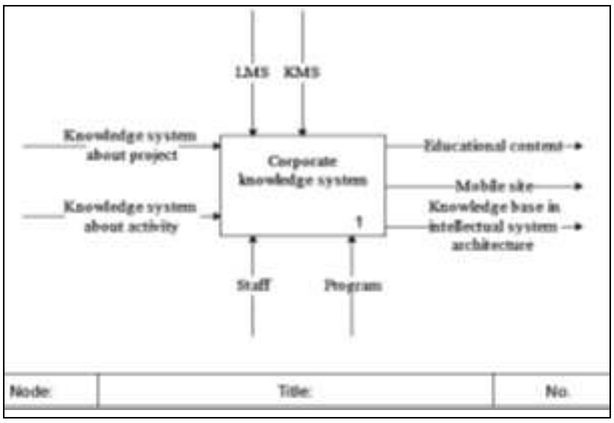

Figure 3 – Functional model development of the corporate knowledge system (author's proposal)

Objects, tasks and research methods of system formation diversity are avoided due to introduction of an entropy-information quality assessment (fig. 6).

On condition of complex objects study more possible is reliable data (information from natural state of object) $\eta = y_j$ and the conditional distribution $\xi : P\{\xi = x_i \mid \eta = y_j\} = p_{i|j}$. Usually, in study of natural-technological complexes monitoring information and knowledge base is used (phenomenological approach) for system analysis and formation within it models and decisions on quality management "object social and natural environment".

Information amount to set the exact value ξ in the presence of known and sufficient volume of values $\eta = y_j$ equals

$$S(\xi \mid \eta = y_j) = -\sum_i p_{i|j} \log_2 p_{i|j} , \qquad (1)$$

which is on average

$$MS(\xi \mid \eta) = -\sum_j P(\eta = y_j) \sum_i p_{i|j} \log_2 p_{i|j} , \qquad (2)$$

where $S(\xi \mid \eta)$ – conditional entropy η at $\xi = x$; $MS(\xi \mid \eta)$ – expected value of conditional entropy at value ξ [31].

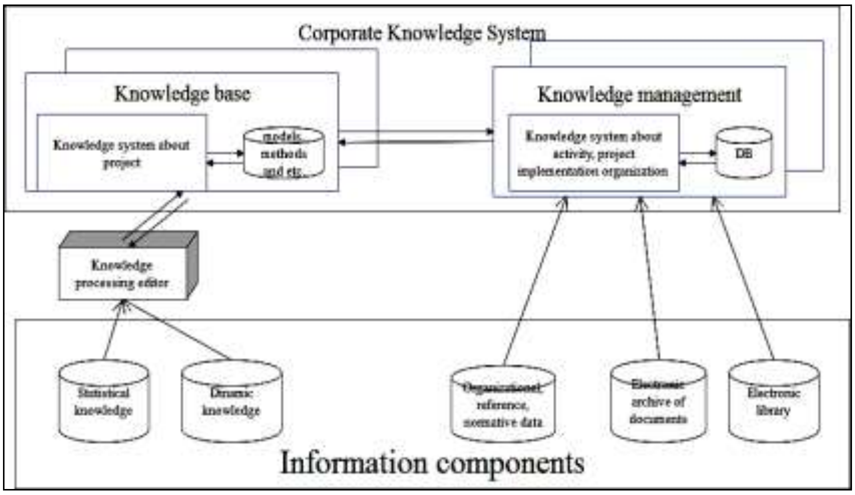

Figure 4 – Scheme of the proposed corporate knowledge system structure

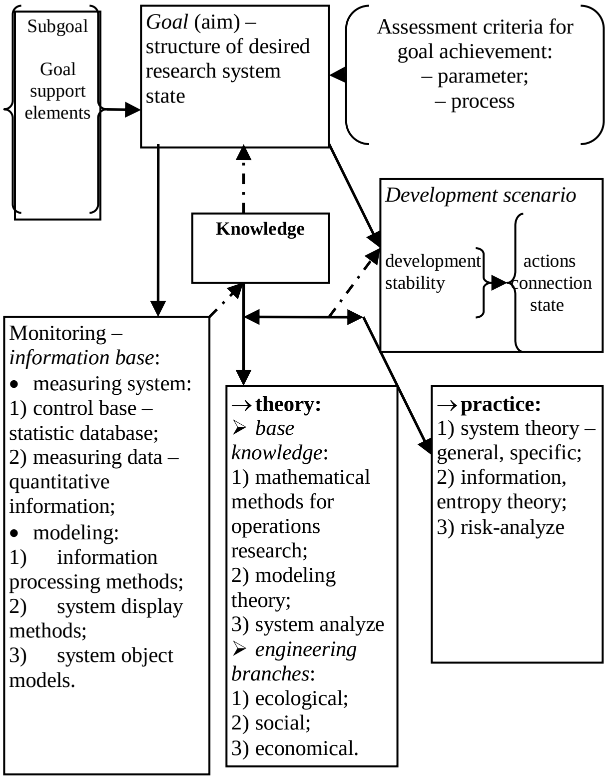

Figure 5 – The scenario-target approach in forming knowledge-oriented systems: - · ► – information support in uncertainty overcoming

For analysis according to the problem of complex systems quality by chosen algorithm (fig. 6), the amount of information relative to ξ, which is contained in results of previous stage (task) or determined by the characteristic for system η, is equals to difference

$$I(\xi \mid \eta) = S(\xi) - MS(\xi \mid \eta);$$

$$I(\eta \mid \xi) = -\sum_i p_{ij} \log_2 \frac{p_{ij}}{P\{\xi = x_i\} P\{\eta = y_j\}}, \qquad (3)$$

At the final decision-making stage on object state conformity carried out on research requirements its quality approaches are used to determine Kolmogorov's entropy [31], with attribution to certain specified stages of analysis in following sequence: algorithmic, probabilistic, (combinatorial, probabilistic).

Within the system object analysis, this means that, for both stationary and dynamic conditions, their state is described by a certain function whose changes indicate an approximation to a certain point of homeostatic relations with the environment ($S_\varepsilon(K)$),by establishing factors that are significant in destabilizing the situation in the "object – external nature environment" and "object system – internal object environment" ($C_\varepsilon(K)$). Interaction between systems ξ (set X) and η (set Y) according to their existence space requirements $X \times Y$ realized on the set of possible pairs U at $a \in X$ for such y from Y_a provided $(a, y) \in U$, conditional entropy is determined by the equation

$$S(y \mid a) = \log_2 N(Y_a), \qquad (4)$$

where $N(Y_a)$ – number of set elements Y_x.

State system information ξ (in x) regarding the available information about η (relatively y) is set by the formula

$$I(x : y) = S(y) - S(y \mid x). \qquad (5)$$

If necessary regulation / management justifies measures to support stabilizing processes, increase the factors of positive changes / influence on system based on the results of combinatorial approach on base of algorithmic data using integral conditional entropy (information) function.

The overall unambiguous representation of continuous variables of real objects for which entropy is infinite through the function of information in a wide variety of cases is finite by the probabilistic concept (3):

$$I_W(x, y) = \iint P_{xy}(dxdy) \log_2 \frac{P_{xy}(dxdy)}{P_x(dx) P_y(dy)} \qquad (6)$$

Compliance to natural homeostatic condition, the final object quality assessment is established on knowledge-oriented systems base (fig. 7).

In the case of a system object from different monitoring sources, which consists of unrelated or loosely related information (metrics, factors, measurement parameters, etc.) subject to certain probabilistic patterns, a probabilistic approach is practical.

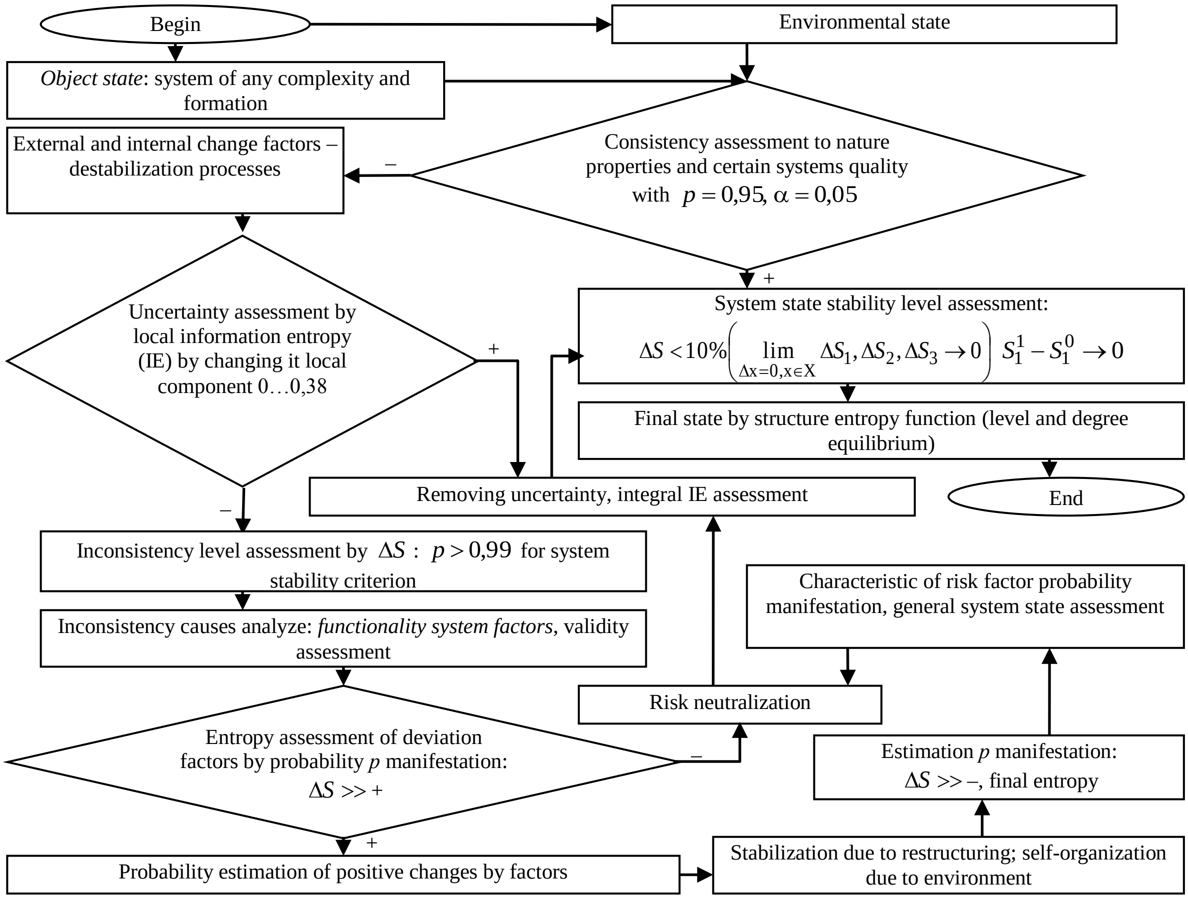

Figure 6 – Probabilistic-entropy system state and risk-factors assessment

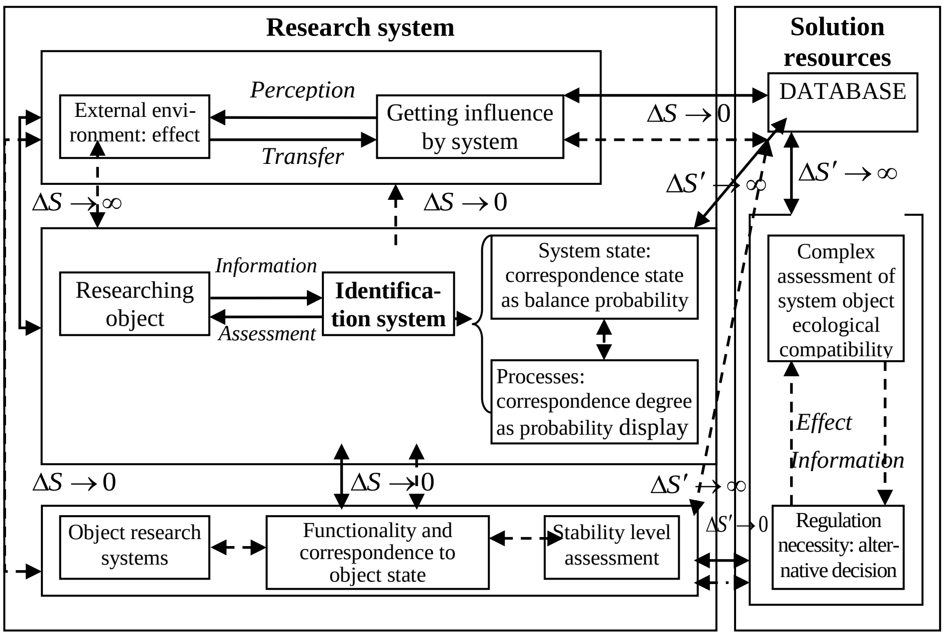

Figure 7 – Imitation model material information support assessment of system object ecological compatibility: $\Delta S, \Delta S' \to 0$ – balance state with correspondence of target cooperation "system – environment" in term of difference between influence result and stabilization object state (ΔS) and difference between result and correspondence requirement ($\Delta S'$); $\Delta S, \Delta S' \to \infty$ – stationary state of infinite system progress in term of target balance correspondence

Within its limits, mixing of probabilities and frequencies is allowed at considerable time and volume of observations; formation of mathematical expectation for entropy $MS_W(y \mid x)$ and information $MI_W(x : y)$, the value of which can take different value (in the combinatorial approach, it is always a positive value, which should be in the representation of information amount). According to Kolmogorov A.N. [16] the true information amount measure is central importance $I_W(x, y)$, characterizing the density of communication between systems ξ and η, state parameters x, y symmetrically: $S_W(x\,|\,x)=0$, $I_W(x:x)=S_W(x)$, $I_W(x,y)=MI_W(x:y)=MI_W(y:x)$ despite the fact that $S_W(y\,|\,x)$ and $I_W(x:y)$ is functions from x. For system analysis imposed values as defined by (1–5):

$$S_W(x)=-\sum_x p(x)\cdot\log_2 p(x);$$

$$S_W(y\,|\,x)=-\sum_i p(y\,|\,x)\cdot\log_2 p(y\,|\,x);$$

$$I_W(x:y)=S_W(y)-S_W(y\,|\,x). \qquad (7)$$

The choice of an effective system development way (object) at expense of internal regulatory mechanisms requires a certain information amount, its receipt, storage, transmission and processing – knowledge-oriented databases formation. Correspondence state for analyzed systems by Martin-Leof proposal [32] and introduced provisions of comparator identification is established in accordance with

– zero relative measure:

♦ 0 – constructive –achieving natural quality probability by condition and functionality – $\Delta S\to\min\to 0$;

♦ 1 – disorder, accidental –stationary violation, low probability of self-recovery manifestation and organizational mechanisms of homeostasis stabilization – $\Delta S\to\infty$.

– the entropy-information evaluation base of consequences:

– S_1 – planned events in range $[t_0\; T]$ with self-regulation processes, self-organization in avoiding negative events;

– S_2 – permissible deviations from acceptable events development S_4, S_5 (at this time interval or throughout the time), compliance with stationary state and functionality in general;

– S_3 – structure disorder with self-organization of new steady state: S_0' – changes in interaction nature between object components; S_0'' – stabilization state, norm.

According to monitoring information initial data samples are formed, taking into account presence of well-known and sufficient values amount $\eta=y_j$ to set the exact value ξ (1), which are educational sample base in such form:

$$\left(x_1^{(\eta,\xi)}, x_2^{(\eta,\xi)}, y^{(\eta,\xi)}\right)\left(\eta,\xi=\overline{1,K}\right), \qquad (8)$$

where $x_1^{(\eta,\xi)}, x_2^{(\eta,\xi)}, y^{(\eta,\xi)}$ – respectively, input and output variables value from experiment objects characteristics $\eta=y_j$ and ξ; K – total number of experimental data in training sample.

Among the monitoring objects characteristics set their minimum and maximum values, which under these conditions reflect the ability to achieve desired goals. Similarly source data is analyzed – systems state at unsatisfactory ($y^{\min}$) and conforming to requirements at an acceptable natural / permissible level ($y^{\max}$):

$$x_1\in\left[x_1^{\min}, x_1^{\max}\right],\; x_2\in\left[x_2^{\min}, x_2^{\max}\right],\; y\in\left[y^{\min}, y^{\max}\right].$$

The discrepancy conditional entropy is defined:

$$S(\xi(x)/\eta(x))=-\int_{-\infty}^{\infty} f(x)\ln f(x)\,dx=\ln\sqrt{2\pi\sigma}\int_{-\infty}^{\infty} f(x)\,dx+$$

$$+\frac{1}{2\sigma^2}\int_{-\infty}^{\infty} f(x)x^2\,dx=\ln\sigma\sqrt{2\pi}+\ln\sqrt{e}=\ln\sigma\sqrt{2\pi e},$$

where $\int_{-\infty}^{\infty} f(x)\,dx=1$, $\int_{-\infty}^{\infty} f(x)x^2\,dx=D=\sigma^2$.

For the information-entropy system assessment according to analytical expressions (4–6), functional is used:

$$I(x)=\log_2 n+\sum_{i=1}^{n} p(x_i)\cdot\log_2 p(x_i). \qquad (9)$$

Object interaction with external systems is characterized by unstable dynamic equilibrium with an objective reduction of ordering due to exchange variations of information, substance and energy. The irreversible processes in time and the future uncertainty are identified as entropy dynamics, the quantitative characteristics of which according to the content of a certain level allows the membership function to be accepted as changes in entropy ΔS.

The implicit situation with regard to the processes in the system is characterized by the existence of several alternatives and the need to synchronize selected events within the fixed changes made. The implicit choice is thus determined by combining the synchronization and selection structures [14]. So, processes P_1 and P_2 can lead to changes in processes functioning P_4 and P_5, which ultimately stabilizes the system (fig. 8), taking into account intermediate events t, which contribute to the satisfactory flow of processes by entropy assessment $-S\to\max, \Delta S_{\text{proz}}\to-\max, \Delta S_{\text{syst}}\to\min$.

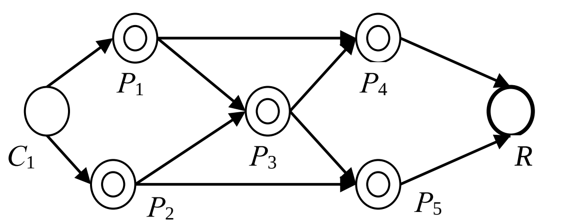

Figure 8 – The situation of implicit changes processes choice in the system between P_4 and P_5 at realization of initial situation C_1 into result of R

Thus, it is proposed to avoid uncertainty at decision way to manage system objects of socio-ecological and economic content using constructive mathematical logic models, combining the state and processes analysis in the systems and beyond with environment**.**

In order to acquire knowledge in uncertainty conditions and to support the adoption of weighted decisions, mathematical structures are used in form of sets, graphs, hypergraphs, frames, algorithms, which represent the real relationships and relations between any objects in nature. The quality of such structures is determined by their effectiveness in seeking a non-standard solution for a certain cognitive load.

According to the sequence of obtaining knowledge adaptive strategy implementation about the object on evolutionary modeling base used micro, macro and mega-level research and data analyze with the general information definition based on physical, substantive, syntactic, semantic, declarative, procedural knowledge with access to meta-knowledge are used – knowledge generalization based on fuzzy (synergetic) knowledge [33, 34].

IS has 3 DB units: general knowledge of certain science branches, knowledge about internal system connections, applied knowledge about processing and knowledge organization – rules, limitations, algorithms, etc. Knowledge bases are represented in frames form (a set of procedural declarative knowledge, consisting of slots – knowledge about particular situation), hypergraphs, graphs. The frames are associated in whole knowledge of the situation and predict objects state and their functioning conditions, which is displayed and analyzed on graphical representation base.

In this case, maximum information principle as the base for obtaining knowledge is realized:

$$I(X,Y)=\max\,,\;\; S(X,Y)=S(X)+S(Y)-I(X,Y), \qquad (10)$$

where X – environmental conditions, external action and system state; Y – useful result, efficiency and knowledge gains.

According to (10), greater mutual information (knowledge) and close connection in the system allow us to obtain a stable system, that is, with a minimum entropy voltage level or value $S(X,Y)$. Information maximum determines the state, system behavior, development processes, adaptation, growth, adaptability, etc., that is, comprehensively knowledge about the system:

– conclusions based on monitoring, transition to argumentation;
– validity problem;
– explanations generation;
– search for relevant knowledge;
– understanding of the state, processes, changes, implementations, etc.;
– cognitive graphics;
– many agent systems and as a consequence a network model (graphic);
– meta-knowledge [3, 34].

When planning the content of CKB materials it is necessary to consider which CKB area sufficient for studies of integrated systems interacting with the environment. The CKB-model should be a valid cognitive map with the relationship between the concepts: the concept is included in the model, if it contains all the concepts, to its previous. The resulting numerical cognitive map is a weighted graph oriented graph that reflects the use of knowledge in the research process (fig. 9).

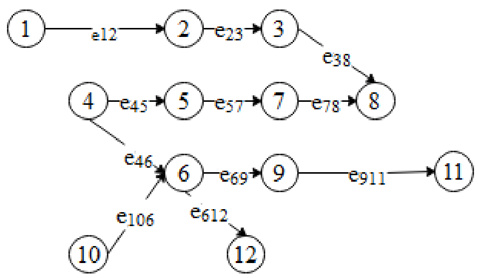

Figure 9 – An example of numerical cognitive map:
1–12 – concepts from the CKB materials,
e_{ij} – arcs, the connection between the previous and the next concept, $i \neq j$, i,j=1,2…,12

For the network models analysis and design of subject areas and for constructing algorithms for adapting the content according (accordaning) to the purpose and knowledge level, use the following characteristics: one concept influence on another; concept influence on the system; system influence on the concept [35]. Thus, in the matrix to the given graph (see fig. 9), the last table column contains the values of the total concepts influence on the map, and the last row is map influence value on the concepts (table 1).

Table 1 – An example of the cognitive map concept influence

	1	2	3	4	5	6	7	8	9	10	11	12	**Σij**
1		$w_{1\,2}$	$w_{1\,3}$					$w_{1\,8}$					
2			$w_{2\,3}$					$w_{2\,8}$					
3								$w_{3\,8}$					
4					$w_{4\,5}$	$w_{4\,6}$	$w_{4\,7}$	$w_{4\,8}$	$w_{4\,9}$		$w_{4\,11}$	$w_{4\,12}$	
5							$w_{5\,7}$	$w_{5\,8}$					
6									$w_{6\,9}$		$w_{6\,11}$	$w_{6\,12}$	
7								$W_{7\,8}$					
8													
9											$w_{9\,12}$		
10						$w_{10\,6}$			$w_{10\,9}$		$w_{10\,11}$	$w_{10\,12}$	
11													
12													
Σji													

Matrix elements w_{ij} determine the influence of the i-th concept on the j-th with the established weights calculated by the formula

$$w_{ij} = \max_l \prod w_{k_s}, k_{s+1},$$

where w_{ij} – are weight between i-th and j-th concept; l – way number from i-th to j-th concept $R_{ij}^l = \{k_0, \ldots, k_{m_l}\}$.

According to the results of a linear summation, identify the knowledge elements that significantly affect the learning process and the sum of the impact assessments on the columns determine the sensory elements to knowledge acquisition model state – system impact on the concepts state. Thus, the coherent construction of individual training courses models, the base of personnel models and the corporate knowledge base according to their logical and physical organization in accordance with the stated goal of supporting the staff capacity allows obtaining the content of employee knowledge model (EKM).

The availability of experimental or statistical data (the a posteriori object model) allows us to determine the structure of systemic formation and the processes that take place in the established interactions on the constituents of the external environment and the corresponding connections of internal nature.

For a structural model (matrix) elements are determined by entropy load changes in system, which is compliance entropy function with co-operation requirements, that is, the conditions for self-organization, on operating factor transformation probability.

Organism system state entropy its components and elements identifying the probability of processes progress in the human body when deviation occurs in the state or functioning of organs and systems according to available information calculated, taking into account the nature of quasi-stationary organism state destabilization as a biochemical system in this way [36, 37]:

1) destabilization actions according to minimum recorded:

$$\sigma(X) = \sqrt{\frac{\sum_{i=0}^{length(X)-1} (X_i - min(X))^2}{length(X)-1}};$$

2) composition destabilization probability according to the functional capabilities:

$$P(X, x_1, x_2) = \frac{1}{\sqrt{2\cdot\pi}\sigma(X)} \begin{bmatrix} \frac{-1}{2}\cdot \mathrm{erf}\left(\frac{1}{2}\sqrt{2}\frac{(-\max(X)+\min(X))}{\sigma(X)}\right)\frac{\pi}{2}\cdot\sqrt{2}\sigma(X) + \\ +\frac{1}{2}\cdot \mathrm{erf}\left(\frac{1}{2}\sqrt{2}\frac{(-\mathrm{mean}(X)+\min(X))}{\sigma(X)}\right)\cdot\frac{\pi}{2}\sqrt{2}\sigma(X) \end{bmatrix}$$

3) violations entropy assessment $S(P)$, information entropy as a generalized characteristic of conformity level $SS(PP)$:

$$S(P) = \ln[P(X, x_1, x_2)];$$

$$\sigma(X) = \sqrt{\frac{\sum_{i=0}^{length(X)-1} (X_i - 0)^2}{length(X)-1}};$$

$$PP(X, x_1, x_2) = \frac{1}{\sqrt{2\cdot\pi\sigma\sigma(X)}} \begin{bmatrix} \frac{-1}{2}\mathrm{erf}\left(\frac{1}{2}\sqrt{2}\frac{(-\max(X)+0)}{\sigma\sigma(X)}\right)\cdot\frac{\pi}{2}\sqrt{2}\sigma\sigma(X) + \\ +\frac{1}{2}\mathrm{erf}\left(\frac{1}{2}\sqrt{2}\frac{(-\min(X)+0)}{\sigma\sigma(X)}\right)\cdot\frac{\pi}{2}\sqrt{2}\sigma\sigma(X) \end{bmatrix}$$

$$SS(PP) = -PP(X, x_1, x_2)\cdot\ln[PP(X, x_1, x_2)]. \quad (11)$$

The system state and the destabilization factors are determined by estimating disturbances deviation probability from organism quasi-stability state, considering the deviation probability more than 0.2 is significant. According to obtained results from the entropy assessment, the disturbances level and system stabilization direction are determined by changing the entropy values to the maximum values and minimum deviations.

In practice, this objective systematic study of complex objects has been tested in solving environmental problems in the study of the sludge treatment module of the Kurakhovskaya Coal Mine Effluent Plant and the sludge enrichment plant. It is necessary to determine the optimal conditions for suspended solids sediment kinetics from the sludge water as a condition of final purification samples when using a stirrer and under conditions of natural deposition. When determining the optimal sediment conditions for the obtained samples, a measure of non-compliance with the target requirements for the entropy function n of the measured characteristics of the calculation L is established.

$$S = \frac{L}{\sum_{i=1}^{n} L_i}, \quad (12)$$

The results obtained for each entropy characteristic are analyzed according to the search for the segments where the system reaches its maximum and minimum:

$$[\min; \min + \Delta S\cdot 0{,}38]; \ [\max - \Delta S\cdot 0{,}38; \max], \quad (13)$$

where $\Delta S = S_{\max} - S_{\min}$ – the segment length of the analyzed values distribution.

If the considered characteristic falls within the specified interval $[a, b]$ – interval for max / min (4), then get the optimal value identified by the rule:

$$K = \begin{cases} 1, x \in [a,b]; \\ 0, x \notin [a,b], \end{cases}$$

Since the system requires multiple parameters to be calibrated, it is advisable to enter a conjunction to meet all the constraints at the same time:

$$t^{\min} \wedge H_{\mathrm{i}}^{\max} \wedge H_{\mathrm{s}}^{\min} = 1,$$

where t – sediment kinetics time, min., H_{i} – illuminated solution height, H_{s} – condensed sediment solution height.

To ensure continuity of production processes, rapid response to industrial hazard situations with the system-environment interaction “system – environment”, software security control in the form of a mobile application is offered. The software is aimed at users of gadgets with the Android operating system, which is distributed on many common electronic devices, which makes it possible to quickly determine the state of complex natural-tech entities. The design of the software takes into account the difference between operating system versions with the ability to install the application on various electronic devices, from Android 4.1 to the latest version 6.0. Developments take into account phone and tablet engaging situations. Software development on the Android operating system allows to obtain quantitative conformity calculations of production processes with the target functionality, for territorial objects – security level assessment (Fig. 10) [38].

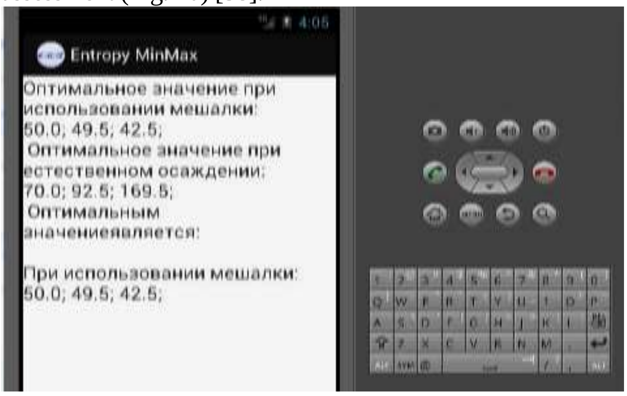

Figure 10 – Territorial determination of study points

Conclusions

1. Establishing, thus, exhaustive information about the system is determined by an integrated approach in obtaining knowledge about object, knowledge organization about environment, which forms intellectual knowledge-oriented systems base. The most recent practical aspects in decision-making are taken as follows:

– systems working with knowledge;

– intellectual tasks solving means;

– systems that imitate human activity and are related to work with informal and vague information;

– concept in of information technology field (fig. 1–4).

2. In the proposed system of system objects complex analysis methods, firstly, the spatial and functional approach in research object simulation through the successive flow of the acquired information through a number of methods is provided: a topological analysis to create a complex system "object – environment" (system object) (see fig. 5–9); an entropy assessment of the state and processes compatibility with synergetic's elements for determining the final state, that is, the detection of a dominant base level attractor, which is crucial for the balance of system "chaos – order" and the formation of system object stable structuring (see fig. 5–7); establishment of a development vector, future state parameters on the base of object systems cognitive analysis (fig. 9).

3. On the basis of the proposed methodological support for entropy-information assessment of systems state compliance with the established requirements, software development of support of measurement and calculation operations, a security control system for the study of production processes and quality management at level "system – environment" (see. fig. 10).

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КОРПОРАТИВНА БАЗА ЗНАНЬ ТА НАУКОВІ ПІДХОДИ ДОСЛІДЖЕННЯ СТАНУ БЕЗПЕКИ ПРИРОДНО-ТЕХНОГЕННИХ ОБ'ЄКТІВ

Стаття присвячена актуальним питанням запровадження системи знань у наукові дослідження, роботу підприємств, ІТ-компаній як база прийняття рішенн за певними інноваційними питаннями. Увага приділена дослідженням в галузі екологічної безпеки як головної складової національної безпеки і забезпечення зваженого рішення щодо завдань охорони здоров’я людини та його навколишнього середовища (НС).

Розглянуті основні тенденції у становленні знання-орієнтованих баз даних як баз знань для наукових досліджень системних об’єктів виду «природно-техногенна система – навколишнє середовище». Надані пріоритети у створенні корпоративних баз знань, що є фундаментом для проведення комплексних досліджень складних систем і отримання нових знань. Визначені наукові основи для створення методичного забезпечення всебічного вивчення системних об’єктів. Обгрунтовані переваги кооперативної методології з оцінки стану «система – навколишнє середовище». Запропоновано використання когнітивного та ентропійного підходу з оцінки відповідності стану й функціональності складних систем знань про вимоги рівноваги «система – НС», використання теоретичної бази і знань названих підходів щодо розв’язання задач моделювання складних систем (системних об’єктів) для оцінки їх стану і функціональних відповідностей, програмного забезпечення реалізації такої оцінки відповідно до методичних засад названих підходів.

Надано результати практичного застосування запропонованих заходів вирішення питань безпеки саме для системних об’єктів «система – НС» на прикладі технологічного рішення з захисту навколишнього середовища від техногенного забруднення шламовими відходами, що показує універсальні здатності розробленого методичного забезпечення дослідження складно структурованих систем.

Ключові слова: система знань, система управління знаннями, системний об’єкт, когнітивний підхід, комплексна оцінка, рівновага, ентропійна функція стану, модель дослідження, природно-техногенна система, екологічна оцінка.

Козуля Т. В., Козуля М. М.

КОРПОРАТИВНАЯ БАЗА ЗНАНИЙ И НАУЧНЫЕ ПОДХОДЫ ИССЛЕДОВАНИЯ СОСТОЯНИЯ БЕЗОПАСНОСТИ ПРИРОДНО-ТЕХНОГЕННЫХ ОБЪЕКТОВ

Статья посвящена актуальным вопросам внедрения системы знаний в научные исследования, работу предприятий, ИТ-компаний как базы принятия решений по определенным инновационным вопросам. Внимание уделено исследованиям в области экологической безопасности, как главной составляющей национальной безопасности и обеспечения взвешенного решения относительно задач охраны здоровья человека и окружающей его среды (ОС).

Рассмотрены основные тенденции в становлении знания-ориентированных баз данных как баз знаний для научных исследований системных объектов вида «естественно-техногенная система - окружающая среда». Предоставлены приоритеты в создании корпоративных баз знаний, является фундаментом для проведения комплексных исследований сложных систем и получения новых знаний. Определены научные основы для создания методического обеспечения всестороннего изучения системных объектов. Обоснованы преимущества кооперативной методологии по оценке состояния «система – окружающая среда». Предложено использование когнитивного и энтропийного подхода к оценке соответствия состояния и функциональности сложных систем знаний о требованиях равновесия «система – ОС», использованию теоретической базы и знаний названных подходов к решению задач моделирования сложных систем (системных объектов) для оценки их состояния и функциональных соответствий, программного обеспечения реализации такой оценки в соответствии с методическими основами названных подходов.

Представлены результаты практического применения предложенных мероприятий для решения вопросов безопасности именно для системных объектов «система – ОС» на примере технологического решения по защите окружающей среды от техногенного загрязнения шламовыми отходами, показывает универсальные способности разработанного методического обеспечения исследования сложно структурированных систем.

Ключевые слова: система знаний, система управления знаниями, системный объект, когнитивный подход, комплексная оценка, равновесие, энтропическая функция состояния, модель исследования, природно-техногенная система, экологическая оценка.