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Formal methods of analysis and synthesis for decisions options during corporate information system development

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Abstract

The article presents a generalized approach to decision making in the process of application development based on cyclically repeating actions, including the synthesis of solution options and their analysis. They considered the basic methods of analysis and synthesis used in decision-making process on the design of corporate information systems (CIS). The description of the proposed generalized semantic model is given on the example of component interaction of the Integrated complex of high-level development tools and the functioning environment of corporate-level information systems (Platform). They analyzed the process of CIS IT infrastructure on the basis of the Platform and the specific steps of making a management decision for this example.

Keywords: formal methods, decision making, IT infrastructure, corporate information systems.

When they make management decisions in the process of application development to support the life cycle of information and technological support, three significantly different stages can be distinguished: synthesis of options for the decision being made, analysis of the adopted options, and direct decision-making based on analysis results (Fig. 1).

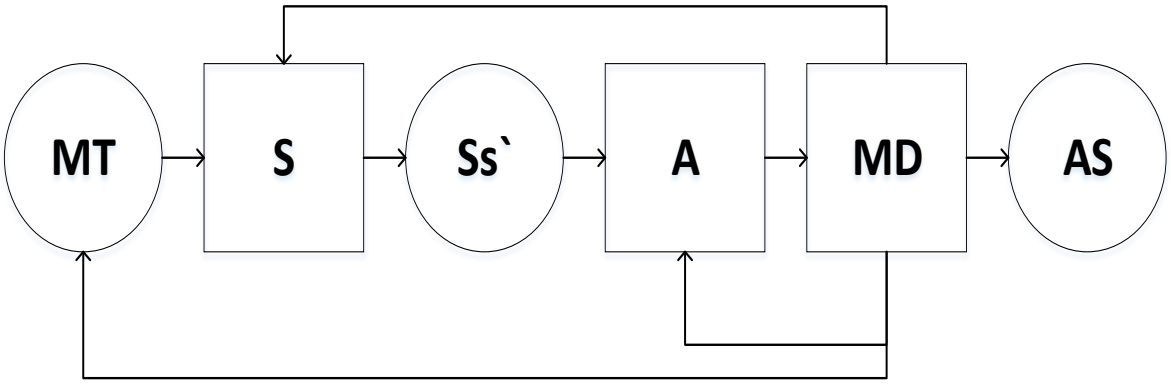

Figure 1 - The stages of decision-making in the process of CIS development

(MT - managerial target, S – synthesis, Ss` - solutions, A – analysis, MD - management decision, AS - adopted solution)

Let's determine the essence of the design process and formulate a general (theoretical) idea of design.

The study of various descriptions of task solution processes, including managerial ones, allows us to talk about their certain common features. Common elements in decision-making processes accompanied by complex processes are represented by the repeatedly occurring actions of synthesis, analysis and decision-making.

The synthesis of options for a decision is one of the characteristic types of activity in the process of process support, which consists in obtaining, and generating one or more solution options (models).

The purpose of synthesis is set in the form of a set of properties (functions, structural elements) that the target system must have. The main task in the synthesis process is to determine the set of functional / structural subsystems, whose properties coincide with the target ones.

In some cases, the synthesis problem can be replaced by the selection of certain options from a variety of well-known ones that are acceptable from the point of view of the semantics and/or pragmatics of the ongoing processes.

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You can also consider the characteristic features of the following synthesis methods: morphological, heuristic, structural-logical and evolutionary.

Advanced evolutionary synthesis redefines the relative importance of various factors, studying several assumptions of the previous synthesis and adding additional causal factors to it.

During the structural-logical synthesis, the synthesized object is represented in the form of a “black box”. Its inputs are any significant effects of the environment (supersystem) on the synthesized object; the outputs are the connections of the object with the environment. The input-output ratio, unfolded in time, represents the synthesized object functioning (function) law.

Morphological synthesis - the methods of searching for new solutions, which are based on the division of the studied system into subsystems or elements; the formation of subsets of alternative options for each subsystem implementation; combination of various options to solve the system of alternative options for subsystem implementation; choosing the best options for the system solution.

Heuristic synthesis is understood as the way of a particular task solution, including a set of mental activity methods, as well as the operations to collect, analyze, process and store information. Heuristic synthesis methods are used when it is necessary to search for as many new rational solutions as possible to implement useful functions of the system, to eliminate or weaken the negative effect of unnecessary and redundant functions, for the effective synthesis of new or rational systems [1, 2].

Analysis is obtaining of information about the behavior of a known object under a certain impact. It involves a set of actions aimed at declared characteristic values determination and their comparison with the required ones.

The analysis procedure of the synthesized solution options reveals the compliance degree of their properties (characteristics, parameters) with the assigned management task [3, 4]. The most common methods of analysis are the following ones: mathematical and statistical, factorial, cluster and strategic.

Decision making is an option selection based on the information obtained during analysis and synthesis. The decision-making procedure involves the selection of one of four possible options for further actions of the decision-maker: repeat the analysis, repeat the synthesis, make the choice of a managerial decision or change the source data.

Thus, speaking about the essence of the selection process support, one can imagine it as multiple repeated actions of synthesis, analysis and decision-making, and repeated actions are possible, both within the synthesis-analysis-decision-making chain, and the chain repetition as a whole.

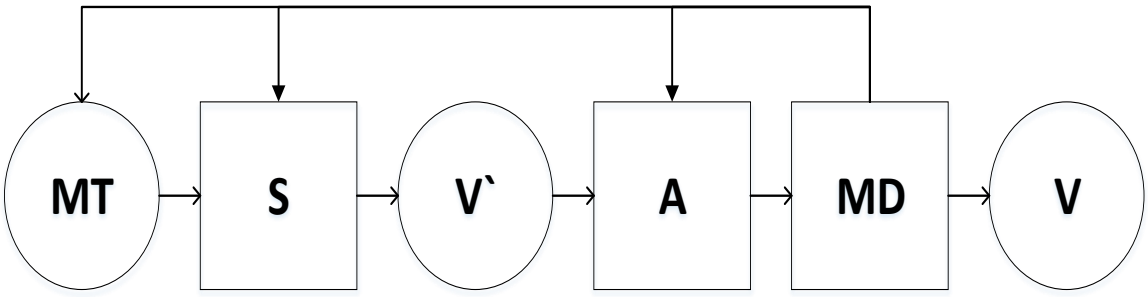

Figure 2 - Common (semantic) model

(MT - managerial target, S – synthesis, V` - variants, A – analysis, MD - management decision, V - variant)

The management decision obtained during the synthesis in the form of a formalized representation is analyzed then. During the decision-making process according to the analysis results, either the final alternative is fixed and the actions end, or the procedures for management decision selection are continued in the form of repeated analysis and/or synthesis actions.

Let's consider the description of the proposed generalized semantic model as an example of the interaction of components of the Integrated complex of high-level development tools and the functioning environment of corporate-level information systems (Fig. 3) [5, 6].

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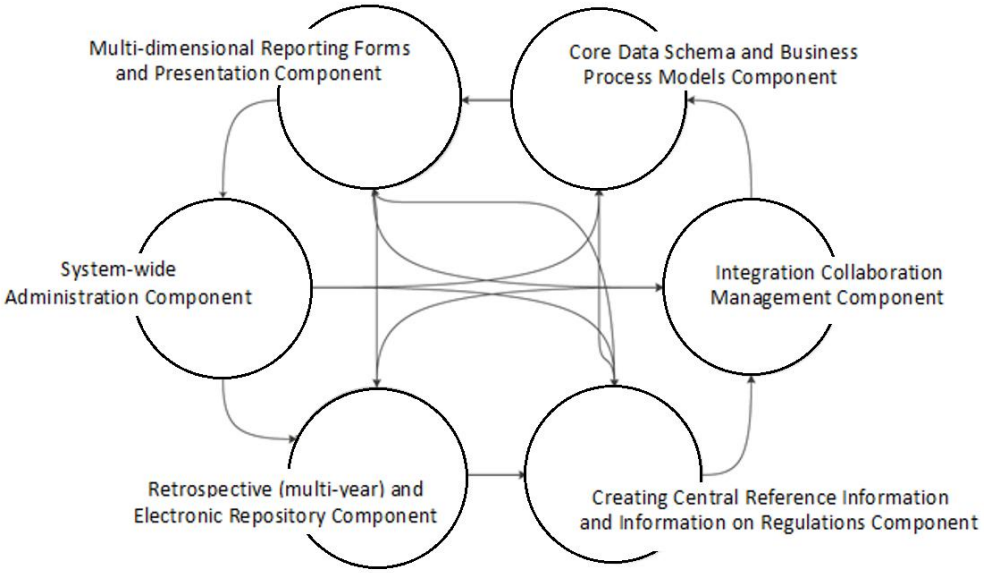

Figure 3 – Interaction of Platform components

The development component of retrospective (multi-year) data repository and electronic documents (Retrospective (multi-year) and Electronic Repository Component) is the part of the IC CLIS and is designed to organize a real-time archive of electronic documents and retrospective information.

The development component of the core data scheme and business process models (Core Data Scheme and Business Process Models Component) is intended for the visual construction of enterprise CIS objects consisting of data schemes, database schemes, screen forms, the models of executable business processes, and interpretation of constructed object metadata during CIS operation.

The component of the centralized reference information development (Central Reference Information and Information on Regulations Component) is intended for the declarative development of centralized management functionality of RI&IR in the developed CIS and the provision of RI&IR to external information systems.

System-wide Administration Component is the part of the IC CLIS and is intended to perform the settings that apply to the Platform and CIS in general.

The development component for report forms and presentation forms of multi-dimensional data (Multi-dimensional Reporting Forms and Presentation Component) is the part of the IC CLIS and is designed to develop reporting functionality and analytical processing and visualization of multi-dimensional data and provides an environment for their functioning.

The integration interaction management component is the part of the IC CLIS and is designed to configure and implement the information interaction of the developed CIS with external information systems.

The steps of making a managerial decision for the considered example [7]:

- Management task: selection of the CIS IT infrastructure option, taking into account the subject area.
- Synthesis: IT infrastructure options.
- Formalized model: a set of selection criteria as a dependence (functional, stochastic, etc.) on the strategy formed on the basis of the subject area analysis.
- Analysis: calculation of compliance degree of each of the options for IT infrastructure with the requirements.
- Decision-making: after step 1 and 2, the selection of CIS IT infrastructure takes place. If there is the lack of necessary information for a decision making, a return is made to the step with the lack of information.
- The specific option chosen for the CIS IT infrastructure.

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The issue of an objective measure determination to assess the complexity of various management tasks is not simple. In this case, we will proceed from systemic ideas about the objects of management and the established types of management decisions.

Since the control object is a set of subsystems S for the enterprise as the subject of the CIS selection, including the subsystems: technical, organizational, methodological, informational, legal, personnel, etc., then the management task in the general case consists of operation principle determination Π of the system, the totality of the elements Γ of the system (subsystems), the structure θ and the parameters E of the relations R, combining the elements of Γ into a single whole, i.e. S={Π, Γ, θ, R(E)}.

Most experts believe that an objective solution can be strictly formalized only by synthesizing the parameters E of the system S with the well-known principles Π, the elements Γ and the structure θ [8].

Besides, it is possible to make an objective solution to the problem of an option selection from a variety set in the presence of a selection criterion.

Let's note the features of the constructed model:

- The set S_s, $S_s = \{S_{re}, S_{cd}, S_{ri}, S_{sa}, S_{mr}, S_{ic}\}$ of various subsystems;
- The set S_{si}, $S_{si} = \{S_{si1}, S_{si2}, \dots, S_{sil}\}$ of different units of each of the subsystems, where l = 1 ... L is the number of units in the corresponding subsystem (Fig. 4);
- Mutual influence of subsystems S_s, i.e. the presence of relations R_s between the subsystems S_s;
- Various levels of detail, taking into account functional modules that implement the groups of functions, grouped into functional units according to the hierarchical principle.

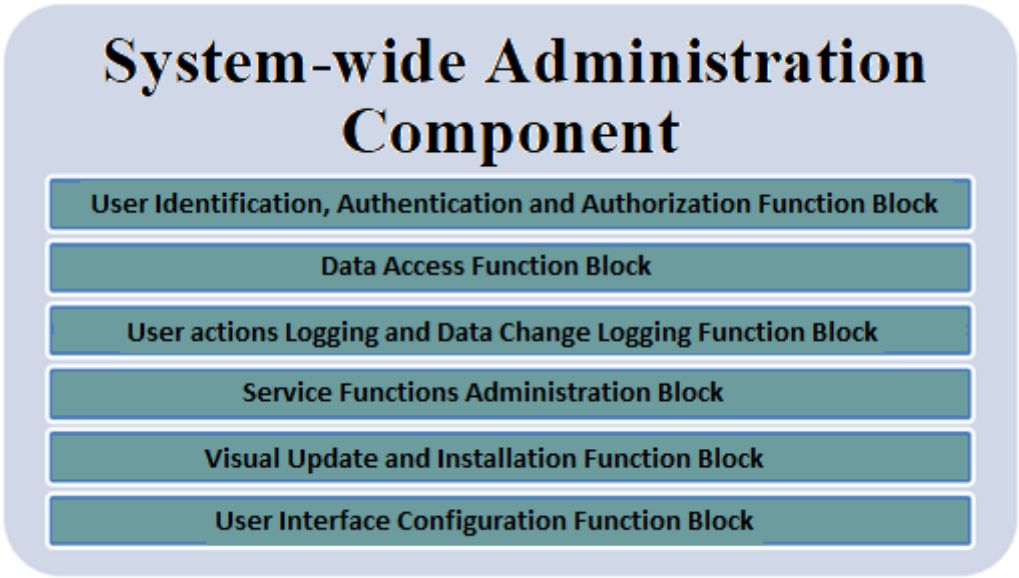

Figure 4 - The component block diagram (using the example of a system-wide administration component)

Thus, the CIS IT infrastructure is carried out according to the synthesis categories on the basis of the following structural elements: stages (Fig. 5), aspects (Fig. 6) and synthesis levels (Fig. 7).

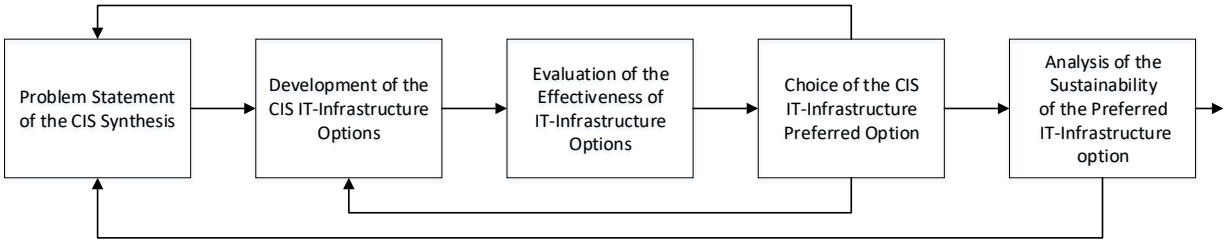

Figure 5 - Stages of CIS IT infrastructure synthesis

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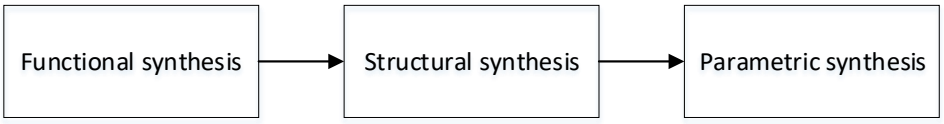

Figure 6 - Synthesis aspects of CIS IT infrastructure

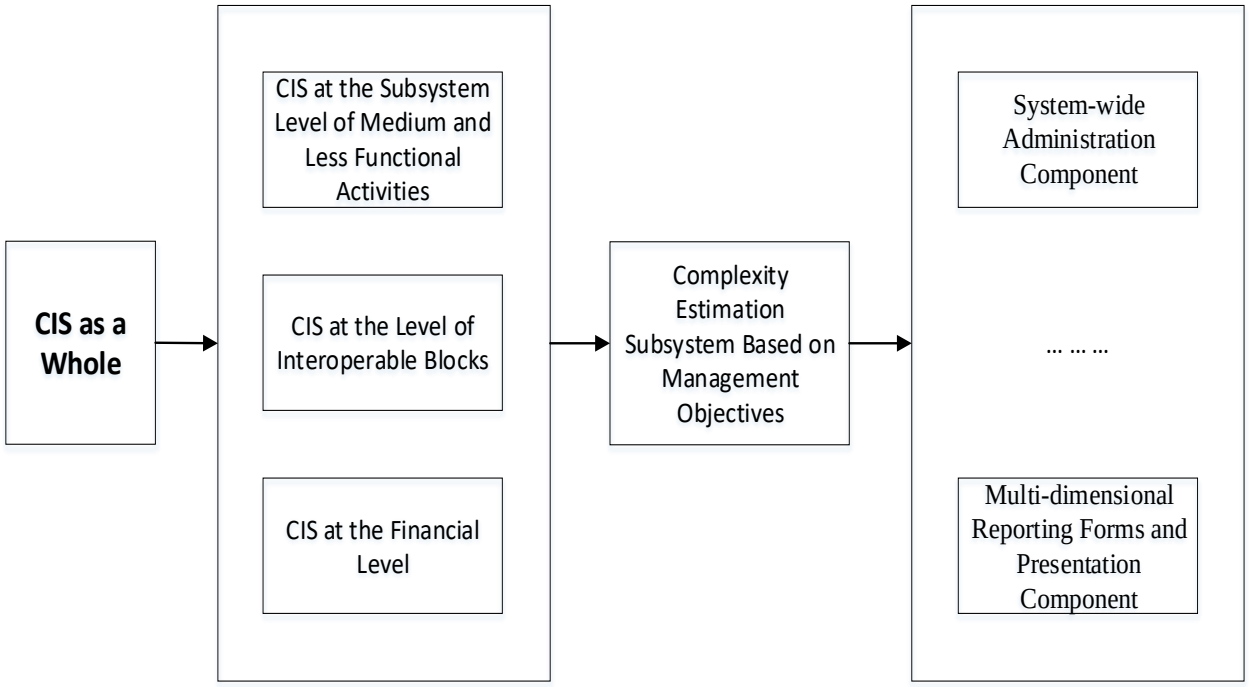

Figure 7 - Synthesis levels of CIS IT infrastructure

Fig. 5-7 show only one cycle of synthesis of IS appearance. In practice, due to the specifics of the decision-making process discussed above, the components, intertwined and combined in various ways, form a multiply connected and mobile structure for synthesizing the CIS IT infrastructure. This necessitates the involvement of an appropriate flexible and structurally complex decision-making system to choose the most suitable CIS IT infrastructure.

Thus, the decision making during CIS IT infrastructure design is formulated in terms of cost reduction, taking into account the following features of the management process [9 - 13]:

1) It is necessary to manage several subsystems S_{re}, S_{cd}, S_{ri}, S_{sa}, S_{mr}, S_{ic}, which in turn are a set of interconnected blocks, simultaneously;
2) It is necessary to take into account their interaction, i.e. accounting for many Rs connections between subsystems and within them;
3) It is necessary to take into account the set of K_1, K_2, ..., K_m, m >= 2 criteria during evaluation of managerial decision results.

CONCLUSIONS

Thus, it should be noted that the proposed approach to the process of CIS development based on the Integrated complex of high-level development tools and the functioning environment of corporate-level information systems on the example of IT infrastructure design allows to formalize the management of decision-making processes based on cyclically conducted synthesis and analysis procedures.

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REFERENCES

1. Oleinikov D.P., Butenko L.N. On the methodology of system synthesis of decision-making methods and automation of its procedures // Open Education. 2016. No4. URL: https://cyberleninka.ru/article/n/o-metodologii-sistemnogo-sinteza-metodov-prinyatiya-resheniy-i-avtomatizatsii-ee-protsedur (reference date: 04.23.2020).
2. Petrovsky A.B. Decision theory: a textbook for university students. - M.: Publishing Center "Academy", 2009. - 400 p.
3. Kuznetsova N.V. Analysis of managerial decision preparation and adoption in practice: to the issue of an optimal method selection / N.V. Kuznetsova. - Text: direct, electronic // Young scientist. - 2016. - No. 27 (131). - pp. 425-433. - URL: https://moluch.ru/archive/131/36505/ (reference date: 04/23/2020).
4. Lifshits A.S. Management decisions: textbook. - M.: KNORUS, 2009. - 248 p.
5. Zaitseva T.V., Lomakin V.V., Putivtseva N.P., Zhukov A.V., Pusnaya O.P. On the issue of the integrated complex composition of high-level development tools and the functioning environment of corporate-level information systems // Advances in Science and Technology: Collection of articles of the XVth International Scientific and Practical Conference, Moscow: “Aktualnost.RF” Scientific and Publishing Center, 2018. - pp. 81-82.
6. Lomakin V.V., Zaitseva T.V., Putivtseva N.P., Pusnaya O.P., Asadullaev R.G., Zaitsev I.M. The composition of the development component of the main data scheme and the models of the integrated complex business processes. // Scientific and Technical Bulletin of the Volga Region. - 2018, No. 10. - pp. 181-184.
7. Mystrov L.E. Principles and categories of information system synthesis for conflict stability provision of large-scale system interaction. / Management of large-scale system development (MLSD’2019) [Electronic resource]: proceedings of the Twelfth Int. confer (1-3 oct. 2019, Moscow) / ed. by S.N. Vasiliev, A.D. Zvirkuna; Institute of Problems named after V.A. Trapeznikov. Rus. Acad. of sciences. - The electron. text data (1 file: 54.2 Mb). - M.: IPU RAS, 2019. - pp. 92-99. - URL: https://mlsd2019.ipu.ru/proceedings_2/92-99.pdf (reference date: 04.25.2020).
8. Kolukov V.V. Fundamentals of RES design and construction methodology: the textbook for universities - M., 2000 - 191 p.
9. Putivtseva N.P., Zaitseva T.V., Lomakin V.V., Pusnaya O.P., Reznichenko O.S. Russian corporate information system selection problem solution using the hierarchy analysis method // Bulletin of VSU SAIT. - 2017, No. 4. - pp. 85-91.
10. Lomakin V.V., Putivtseva N.P., Zaitseva T.V., Pusnaya O.P., Zhukov A.V. Comparative multicriteria analysis of Russian platforms for corporate information system development. // Scientific and Technical Bulletin of the Volga Region. - 2019, No. 12. - pp. 71-76.
11. Lomazov, V.A. Evaluation And Forecasting Of Software Quality/ V.A. Lomazov, V.I. Lomazova, V.V. Lomakin // Journal of Advanced Research in Dynamical and Control Systems,Vol. 11, Special Issue-08, 2019, pp. 3039-3043.
12. Asadullaev , R.G. Software quality assessment using fuzzy parametric characteristics/ R.G Asadullaev, V.V. Lomakin, E.V. Ilinskaya//A JOURNAL OF MULTIDISCIPLINARY SCIENCE AND TECHNOLOGY, - 2019.
13. Lomakin V.V. Multi-criteria selection of a corporate system by using paired comparison analysis/ V.V. Lomakin, N.P. Putivceva, T.V. Zayceva, M.V. Liferenco, I.M. Zaycev// Acta Technica CSAV (Ceskoslovensk Akademie Ved), - №4, 2017

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