DOI:
UDC 658.338

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ARCHITECTURE DEVELOPMENT OF INFORMATION SYSTEM OF AN ENTERPRISE

In the paper the analysis of methods of modeling of activity of the enterprise is carried out. It is shown that at present there is no single commonly accepted method for modeling the activity of an enterprise. And this, in turn, prevents the development of a single tool for its simulation. This circumstance follows from the initial position of the theory and practice of enterprise modeling and business processes, namely, the process approach to the presentation of the activity. The method of establishing unambiguous correspondence (likeness) of architectures of the functional, organizational and infor-mation representations of the enterprise is proposed.

Key words: *system; representation; similarity; information representation; functional representation.*

Проаналізовано методи моделювання діяльності підприємства. Показано, що нині немає єдиного загальновизнаного методу моделювання діяльності підприємства. А це, зі свого боку, перешкоджає розробці єдиного інструментарію для його моделювання. Ця обставина випливає з вихідної позиції теорії та практики моделювання підприємства й бізнес-процесів, зокрема процесного підходу до подання діяльності. Запропоновано метод установлення однозначної відповідності (подібності) архітектур функціонального, організаційного та інформаційного подань підприємства.

Ключові слова: *система; подання; подібності; подання інформації; функціональне подання.*

Проанализированы методы моделирования деятельности предприятия. Показано, что в настоящее время нет единого общепризнанного метода моде-

лирования деятельности предприятия. А это, в свою очередь, препятствует разработке единого инструментария для его моделирования. Это обстоятельство следует из исходной позиции теории и практики моделирования предприятия и бизнес-процессов, а именно процессного подхода к представлению деятельности. Предложен метод установления однозначного соответствия (подобия) архитектур функционального, организационного и информационного представлений предприятия.

Ключевые слова: *система; представление; сходства; представление информации; функциональное представление.*

Problem formulation. Any modern enterprise is considered to be a complex system, the studying of which has to be done using the appropriate business models. So occurs the task of forming an integrated representation of the enterprise on the basis of relevant models.

According to the international standard ISO 19439 [1] next terms for the following models of representation of enterprises were defined:

- 3.32 *function view*: enterprise model view that enables the representation and modification of the processes of the enterprise, their functionalities, behaviors, inputs and outputs;
- 3.40 *information view*: enterprise model view that enables the representation and modification of the enterprise information as identified in the function view;
- 3.52 *organization view*: enterprise model view that enables the representation and modification of the organizational and decisional structure of the enterprise and the responsibilities and authorities of the individuals and organizational units within the enterprise;
- 3.61 *resource view*: enterprise model view that enables the representation and modification of enterprise resources.

But this standard doesn't cover requirements for formulating models according to defined views. Also the task of integrating these representations of enterprise models is not covered. In this case, under integration you can understand the formation of an integrated modeling environment. Therefore, there is the task of studying the methodologies for the formation of these models of enterprise representation. An important issue is finding answer to the question: is there an internal link between the models or not?

For example, the definition of information representation tells us that this representation "allows you to represent and change the information about an enterprise identified in a functional representation". It means that the information is identified in a functional representation and then presented in an information representation. It follows that these two representations must be connected. So next question appears: in what form this link is realized?

Analysis of recent researches and publication. In article [2] was presented an analysis of existing tools for modeling business processes with the use of information technology, and their comparative characteristics. A. M. Vendrov mentioned [2]:

"The main area of application of business models is the reengineering of business processes. It provides the construction of models of current and future activities, as well as the plan and program of transition from the one state to another. Any modern enterprise is a complex system, its activities include performing tens of thousands of functions that mutually influence each other and operations. Man is not able to understand how such a system functions in detail – it goes beyond capabilities. Therefore, the main idea of creating so-called "AS-IS" models (as it is) and "AS-TO-BE" (as it should be) is to understand what the enterprise is doing (and will be doing) and how it is operating (and will be operating) to achieve its goals".

The most known are next models of business processes:

– function analysis method **SADT** (Structured Analysis and Design Technique), that was formalized and published as IDEF0 in 1981 [3];

– method for process modelling **IDEF3**. The IDEF3 method is a scenario-driven process flow description capture method intended to capture the knowledge about how a particular system works [4];

– data flow model also known as **DFD** (Data Flow Diagram) [5];

– method **ARIS** (ARchitecture of integrated Information Systems) [6];

– Ericsson Penker extension of UML (Unified Modelling Language);

– modelling method used in **RUP** (Rational Unified Process) [7].

For business processes modelling next perspective research is being carried out:

Project UEML (Unified Enterprise Modelling Language) [8]. The basis for the project are the models of GERAM (Generalized Enterprise Reference Architecture and Methodology) and Zakhman.

The OMG project is a consortium of software developers and users representing various commercial, government and academic organizations with a total of 800 participants [9]. The work of OMG in the field of business process modeling relates mainly to the concept of Model Driven Architecture (MDA) [10]. According to [11]:

"MDA also known as Model Driven Architecture. This is an architecture that describes a new way of software development. As it is flows from the model name within the framework of this architecture the creation of applications is based on the development of a program model. The obvious advantages of this approach are:

– independence of the model from the development tools provides the possibility of implementation on any software platform;

– an application implemented in the MDA architecture can be easily migrated from one operating system to another;

– significant savings in resources while implementing the program on several software platforms simultaneously;

– the architecture allows some kind of automation for the programming process".

In [12] mentioned:

"In fact, the development of enterprise architecture can solve one of the significant problems of interaction between business and IT, which has the name "alignment" that means synchronizing the capabilities and needs of business and IT... Thus, the use of information technology to solve business problems occurs through the following processes, which, as usual, go parallel way:

– modeling of information (development of the information architecture), which ensures the execution of business processes of organization (meeting existing information requirements);

– formation of a portfolio of application systems (definition of the architecture of applications), which process this information in accordance with some functional requirements;

– construction of infrastructure (technological architecture forming), which provides the work of application systems at the level described in the operational requirements (reliability, scalability, etc.)".

From the above review of the latest research and publications, the task of integrating the enterprise with the means of information technology is relevant and at present time number of projects are being implemented it.

However, it should be noted that the determining factor in the formation of the investigated methodologies is the approach in the form of representations of the enterprise "AS-IS".

At the same time, various forms of representation for an existing enterprise are formed on the basis of consideration of its activities from different points of view.

On the other hand, the question arises whether there is at least one of the views defined in ISO 19439, which can be recognized as an ideal, independent of the forms of activity of any enterprise? That is realization of the concept "AS-TO-BE".

After all, if such a representation exists, then there is a problem of matching between this representation and other representations, as it is supposed, for example, in the ARIS method.

In work [13] was performed a comparison of the functional representations of human activity architectures on the basis of the functional system architecture, in accordance with the theory of functional systems of academician P. K. Anokhin and the architecture of the functional representation of the control system for a certain stratum of control parameters according to M. Yu. Melzer's theory of dialogue management [14]. Their similarity has been proved, which ensured the establishment of an ideal architecture for the functional representation of the enterprise.

On the basis of this model, in work [15] was performed a comparison of the functional representation architecture of the enterprise and the architecture of its organizational representation. On the basis of the fact that the functions defined in the functional representation of the enterprise are realized by specialists who are part of the respective functional units of the enterprise, similarity is established between these representations. In this case, the architecture of a functional representation is recognized as the primary in relation to the architecture of the organizational representation.

So, the problem of determination the level of relations between the functional representation of the enterprise and information representations on the one hand, and organizational representation and information on the other arises. At the same time, two approaches to solving the problem should be considered: on the basis of the principles of physiological cybernetics and on the basis of the principles of technical cybernetics.

Purpose of the article is to determine the level of relations between the functional representation of the enterprise and information representations on the one hand, and organizational representation and information on the other.

Main material. From the above it follows that the solution of the set of tasks is possible by analyzing the functional view and identifying on its basis the information view on the basis of the principles of technical cybernetics, or by analyzing an organizational view that is similar to the functional in accordance with the principles of physiological cybernetics and the identification on its basis the information view.

Unfortunately, the theory of functional systems, like physiological cybernetics, develops independently from the theory of information systems, which is part of technical cybernetics.

In order to establish correspondence between functional and informational views in terms of technical cybernetics, one must first consider the method of SADT functional simulation, as well as the method of modeling DFD data flows.

A. M. Vendrov characterizes the method of functional modeling in the following way [*2*, 9]:

“The SADT method is most suitable for describing the top level management processes. Its main advantages are as follows: ...the completeness of the description of the business process (management, information and material flows, feedback)”.

In this methodology, information flows link the corresponding functions (functional blocks) among themselves. In this case, the functional model in the form of the IDEF0 diagram only displays the information links between the functional blocks. In this presentation there are no important elements of the company’s information view: sources of data and sources of knowledge, which are the basis for the formation of relevant databases and knowledge bases of information

management systems of the enterprise. Also the task of forming an ideal architecture of a functional representation of activity, that is, in the form of "AS-TO-BE", is not covered.

According to [*2*, 13] method of data flow modeling DFD:

"...is defined as a hierarchy of diagrams of data streams describing the asynchronous process of transforming information from its introduction to the system to the consumer. Sources of information (external entities) generate information flows (data streams) that transfer information to subsystems or processes. Those, in turn, transform information and generate new streams that transfer information to other processes or subsystems, data stores or external entities-consumers of information".

According to this methodology, "sources of information generate information flows that transfer information to subsystems or processes". That is, the specified flows in this approach are recognized as dependent on the functional representation of the activity and are determined by the architecture of the system of processes and subsystems, as well as the presence in this architecture of processes and subsystems of data drives. This methodology corresponds to the SADT methodology of functional modeling, since it is based on a process approach to enterprise performance representation.

This methodology does not imply the establishment of an ideal information representation architecture in the form of "AS-TO-BE". Instead, the principle of forming an information representation architecture in the form of "AS-IS" is implemented. Consequently, the functional view of the enterprise and its corresponding presentation in the form of data flow diagrams will always be unique for each enterprise.

A similar situation arises when applying the ARIS modeling method [*2*, 19]:

"The ARIS modeling method is based on Professor August-Wilhelm Scheer's theory of integrated IC construction, which defines the principles of visual representation of all aspects of the operation of the analyzed companies. ARIS supports four types of models that reflect different aspects of the researched system: organizational models...; functional models...; information models...; management models... The ARIS method allows you to describe the organization's activities from different points of view and establish relationships between different models. However, such an approach is difficult to implement in practice, as it entails a high cost of resources (human and financial) for a long time. In addition, the ARIS tool environment is expensive and difficult to use".

In this method of enterprise integration it is possible to "establish connections bet-ween different models"; however, the task of forming at least one representation in the form of "AS-TO-BE" – the ideal representation – is not covered.

It follows that in the theory of information systems (technical cybernetics) at this time there are different approaches for modeling the enterprise in the form of different views. The task is to integrate these views in two ways:

– establishing links between different model representations (ARIS method);

– formation of an integrated modeling environment for specific forms of business representation (ISO 19439).

On the other hand, in the theory of physiological cybernetic systems on the basis of the theory of functional systems, the architectonics of a functional system, that does not depend on the level of organization of the organism, is proposed. In [13] it is proved that the specified architecture is similar to the architecture of the control system for human machine (automated) systems. At the same time, the architecture of the control system for the strategy of control parameters is similar for all five control parameters that are formed in the hierarchical production management system.

Proving the similarity of the architecture of functional and organizational views [15] allows us to proceed to the solution of the similarity problem between the functional and informational views, as well as organizational and informational views.

The functions defined in the functional view carry out the transformation of the information coming into the functional blocks, that is, it is possible to establish the form and content of the input and output information for each functional block. However, the functions implementation involves the transformation of information. This aspect in the functional representation is not disclosed. It can only identify data sources. Therefore, it is possible to develop a method for modeling DFD data flows. In the functional representation in the explicit form there are no sources of information and knowledge. So it is not possible to establish a correspondence between the functional and informational representation.

While considering the architecture of an organizational view, which is similar to the functional representation architecture, there is another situation. Fig. 1 shows the proposed organizational structure of the enterprise [15]. The structure of the organizational representation architecture includes the units responsible for implementing the corresponding functions according to the architecture of the functional view. It is clear that these divisions are generally sources of data, information and knowledge. Depending on this, in the architecture of the information view of the enterprise activity, it is necessary to provide appropriate data storage, information and knowledge in the form of the appropriate databases.

In the proposed architecture of the information view of the enterprise activities, sources of data, information and knowledge have been identified. They are specialists of the relevant units. On the basis of their knowledge, conceptual models of the corresponding subject areas are formed. At the same time, the data are formed into relevant databases using known database management systems. Knowledge, as a rule, is presented in the form of expert systems. Fig. 2 proposes the creation of a knowledge base in the form of an automated workstations.

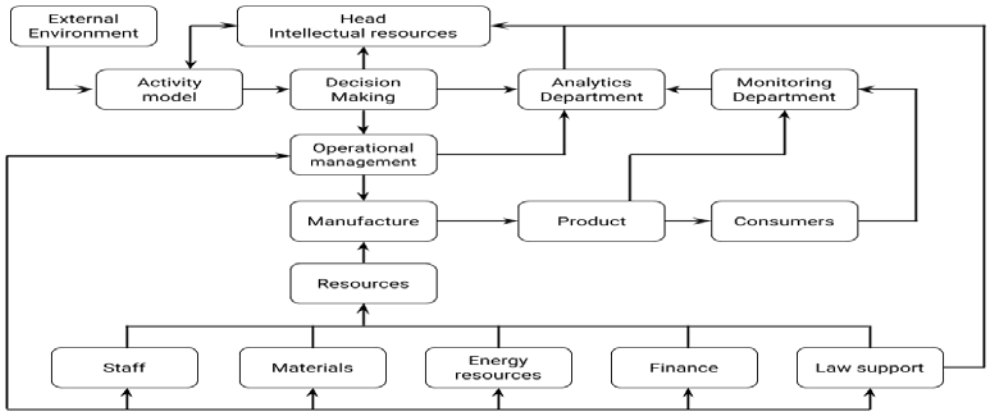

Fig. 1. Organizational structure of the enterprise

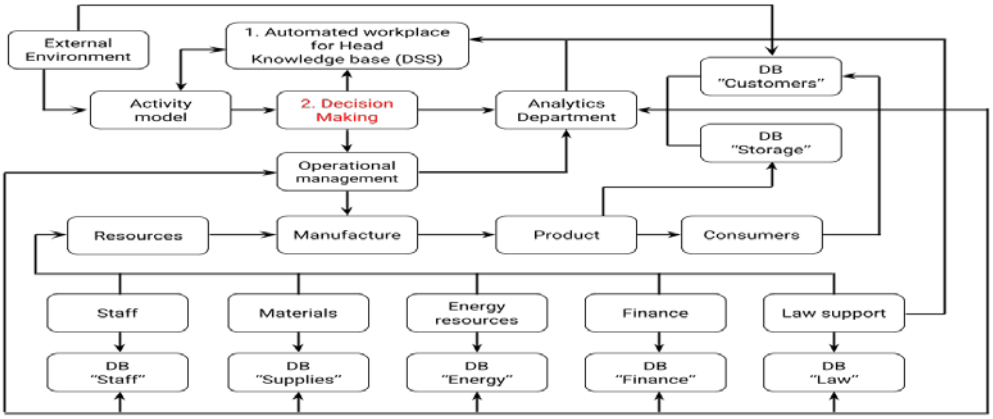

Fig. 2. Architecture of information ensuring of the enterprise

According to the proposed architecture of the information view, the main consumer of data is “Analytics Department”. In accordance with the architecture of functional representation, based on the theory of functional systems, this department implements the function of ensuring the correspondence of the obtained result and the established goals. In this department operative decisions are made to adjust the activity in case of obstacles on the way to achieving the goal of activity.

Fig. 2 shows the architecture of the information view, which corresponds to the architecture of the organizational structure of the enterprise.

From the foregoing we can make a conclusion that there is a similarity between the functional and informational views at the data source level.

In an explicit form, the sources of information and knowledge in the functional view are not identified. Their identification is possible only in organizational view.

It should be noted that the task of unambiguous definition of the content of the concepts of “data” and “information” needs separate consideration.

Thus, the problem of establishing unambiguous correspondence (similarity) of the architectures of the functional, organizational and information views of the enterprise is solved. This allows you to offer a model architecture for the specified views for any enterprise.

Conclusions and further researches directions. From the analysis of the modeling techniques of the enterprise, it follows that at this time there is no single universal method of modeling the enterprise. And this, in turn, prevents the development of a single toolkit for its simulation. This circumstance stems from the original position of the theory and practice of enterprise modeling and business processes, in particular form the process approach to the presentation of activities. Since the result of the process always depends on the management and used resources, it is always unique. Therefore, the model of any process will always be unique.

Unambiguousness can only be realized if the result of the process will always be the same, that is, independent of the resources used, external conditions and control actions.

From the made review of the methods of forming the architectures of views of the activities of enterprises follows:

1. The architecture of the functional view of the enterprise activity is isomorphic for all levels of organization of the enterprise.

2. The architecture of the functional view of the enterprise activity is primary in relation to the organizational view architecture.

3. The architecture of the functional view of the enterprise is the basis for the development of a similar organizational architecture to it.

4. The architecture of the organizational view of the enterprise’s activity is isomorphic for any enterprise, since the architecture of the functional view of that activity is also isomorphic.

5. The architecture of the organizational view of the enterprise is the basis for the development of an information view’s architecture similar to it.

6. The architecture of the information view in general should include three levels of representation: the data level; the level of information; the level of knowledge.

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