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# THE ANALYSIS OF MODERN BUSINESS PROCESSES` MODELING AND DIGITALIZATION TOOLS

*The article researches modern tools designed for modeling and digitization of business processes. A number of scientific approaches from the research of modern specialists are summarized, conclusions are made about a large amount of practical material and at the same time ambiguity and contradiction in defining both a single notation for modeling business processes and in defining professional tools for their automation. A practical study of the modeling of a potential business process at an IT enterprise using the Visual Paradigm PPP was conducted, and the importance of using infographics for better visualization and perception by specialists of individual details of the business process was proven. Five actual principles in modeling business processes are highlighted, as well as seven most famous and widespread business process modeling methodologies. A collective expertise was conducted with the help of an automated desktop application using the Delphi evaluation method, ten project management specialists were involved in the examination, and seven described business process transformation methodologies were admitted to the evaluation according to five possible criteria (modeling principles). Based on the results of the research, it can be concluded that the most relevant and effective approach to modeling business processes today is UML, and the most morally outdated approach is the use of colored Petri nets during the transformation of business processes.*

***Keywords:*** *business process, digitization, PPP, visualization, infographic, diagram, business modeling methodology, collective expertise, UML, business modeling notation.*

*Fig. – 5, Ref. – 6*

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# АНАЛІЗ СУЧАСНИХ ІНСТРУМЕНТІВ МОДЕЛЮВАННЯ ТА ДІДЖИТАЛІЗАЦІЇ БІЗНЕС-ПРОЦЕСІВ

*У статті проведено дослідження сучасних засобів призначених для моделювання та діджиталізації бізнес-процесів. Узагальнено ряд наукових підходів з досліджень сучасних фахівців, зроблено висновки про велику кількість практичного матеріалу та водночас неоднозначність та суперечливість у визначенні як єдиної нотації моделювання бізнес-процесів, так і у визначенні професійних засобів їх автоматизації. Проведено практичне дослідження моделювання потенційного бізнес-процесу на ІТ-підприємстві засобами ППП Visual Paradigm, доведено важливість застосування інфографіки для кращої візуалізації та сприйняття фахівцями окремих деталей бізнес-процесу. Виокремлено п'ять актуальних принципів в моделюванні бізнес-процесів, а також сім найбільш відомих та розповсюджених методологій моделювання бізнес-процесів. Проведено колективну експертизу за допомогою автоматизованого десктопного додатку методом оцінювання Дельфі, до експертизи залучено десять фахівців з проджект-менеджменту, а до оцінювання допущено сім описаних методологій трансформації бізнес-процесів за п'ятьма можливими критеріями (принципами моделювання). За результатами дослідження можна зробити висновок, що найбільш актуальним та ефективним підходом до моделювання бізнес-процесів на сьогоднішній день є UML, а найбільш морально застарілим підходом є використання кольорових мереж Петрі під час трансформації бізнес-процесів.*

***Ключові слова:*** *бізнес-процес, діджиталізація, ППП, візуалізація, інфографіка, діаграма, методологія бізнес-моделювання, колективна експертиза, UML, нотація бізнес-моделювання*

*Рис. – 5, Літ. – 6*

**Formulation of the problem.** In modern business and production activities, the concept of digitalization of business processes plays an important role in increasing the efficiency of their implementation at all levels. The issue of uniform regulation norms, regarding the management of business processes in the automated PPPs` application, remains open. From this issue, another challenge arises at the junction of computer sciences and economic sciences, namely the issue of determining more effective, modern and flexible means of automation and digitalization of business processes than those traditionally used during the last fifty years.

**Analysis of recent research and publications.** Many scientists in the field of economic cybernetics research the importance of using information technologies, in particular the field of data and knowledge organization, in enterprise management, in production and competitive activities.

Alavi M. and Leidner D.E. [1], as two of the first modern organization and knowledge management theory school`s researchers, claim that the process of knowledge management is an important component of strategic management in an enterprise. Researchers believe, that the process of increasing the amount of knowledge and accumulating relationships and regularities

between them is a dynamic and continuous process, and the knowledge itself can be systematized and formalized in the form of a digitized facts` set, and there is no single correct approach in choosing the method of their presentation.

Scholars of the modern economics German school, Lenhert M., Linhert M. and Roeglinger A. [2], believe that business process modeling management has a close connection with the theory of decision-making and multi-criteria data analysis. The authors introduce the concept of a road map as one of the auxiliary means of data visualization.

The representative of the Chinese business analytics and risk management school, Chang V. [3], in his practical study examines various tools for modeling business processes and believes that the degree of comprehensibility, clarity and presentation intuitiveness can be used to determine the level of PPP application. Also, the scientist notes, that taking into account the interests of the target audience provide huge impact, when applying PPP for modeling and further digitization of business processes, in this case it is often possible to distinguish, for example, amateur and professional applications for the business processes development, and they can also be applicable at the testing stage or with an inconvenient interface, or for scientific studies of business processes. These can be tools for companies of a certain size, industry or be suitable according to any other separate criteria of certain organizations. At the same time, more universal modeling systems are valued the most and can satisfy the most diverse needs of business process management in different ways.

An urgent unexplored issue in this area remains the problem of separating business process modeling systems that are suitable in all parameters from more outdated, amateurish, or low-quality environments in any other respect.

**Formulation of research goals.** Tasks setting is to investigate a number of approaches to the automation of business processes on the example of a specific environment, as well as by conducting research to identify the most appropriate and modern approaches based on the principles of modeling from the known approaches to the transformation of business processes.

**Outline of the main research material.** Business process management is a relatively young field of economic sciences, as the first official notation Business Process Modeling Notation appeared only in 2009 under the auspices of the OMG consortium [4].

In general, there are three main types of modeling by means of BPMN, namely: descriptive, analytical and executable modeling. This classification has certain limitations, as it does not take into account all the variety of modern data analysis and visualization tools. Therefore, it will be appropriate to consider certain additional means for greater detailing of the necessary business process, digitization and automation of its additional options [5-6].

Let us consider a specific business process that is often found in IT enterprises. The field was chosen as the most modern and adjacent to business process management, that is, as the most relevant for conducting interdisciplinary applied research.

On the one hand, it may seem that there is a big contradiction - BPM systems support a process approach, while the development of IT products is mainly project work. But in the case of product development, this is not the case at all.

The project approach utilizes working with a finite set of unique tasks for the project, upon completion of which, the entire project will be completed. Tasks, by and large, will no longer be repeated, and the next project will need to be rethought. That is, the project has initially agreed deadlines, budget and necessary work, unique for this particular case.

When a company develops its own product, for example some kind of web application, then development is already a conditionally endless process of iterative improvements, and tasks begin to be performed according to the same algorithms. This means that each of the following tasks is easily described by a business process:

— Implementation of a new functionality

— Accounting for defects (bugs)

Starting a new server

– Purchase / rental of new equipment
— Accounting for servers and equipment
— Analysis of competitors
— Writing an article for a blog or SMM
— Running ads
— Maintaining email newsletters
— Organization of events
— Creating and updating a help article and so on and so forth.

To begin, the business process "Analysis of competitors" for conducting the experiment was chosen and the stages of this business process will be described in table 1.

**Table 1 – Analysis of the business process "Analysis of competitors"***

| Stage Number | Stage Name | Stage Description |
|---|---|---|
| 1 | Gathering information about the market and competitors | Build a model of the target audience, determine consumer preferences, conduct an analysis of the latest marketing research in the area, collect a pool of direct, tangential and implicit competitors, evaluate competitors, information about competitors according to comparison parameters, compare and rank alternatives using artificial intelligence or decision-making methods. |
| 2 | Comparison of competitors by online influence | Conduct an analysis of the Internet site of competitors' services, evaluate site content according to various criteria depending on the industry, evaluate traffic on the site, including with the help of special services, evaluate competitors' content advertising capabilities |
| 3 | Conducting a collective survey | Use the services of collective surveys and evaluations, collect statistics and create a portrait of the audience |
| 4 | Implementation of the final comprehensive analysis | Providing the final comprehensive analysis |

**Source:* generated and supplemented by authors

It is necessary to model the "Analysis of competitors" business process in the Visual Paradigm environment. Visual Paradigm is a modern, convenient tool for modeling UML diagrams, producing infographics, as well as creating business processes according to official notation.

The business process diagram will consist of start, end, six actions events (their number does not correspond to the number of stages, but instead reflects the main sub-processes) and also three basins (data pools), which are used to indicate large participants in the process or groups of participants.

Using the Visual Paradigm toolkit, we will simulate the general concept of obtaining and accumulating information for the "Analysis of competitors" business process. The scheme at the lowest level of detail can have the following interpretation: the interviewer conducts a collective survey using modern means of communication, clients provide information about their preferences, from which the marketer receives the final analysis of the market using modern analytical and statistical tools (figure 2). In order to avoid the human factor, many modern tools related to the automated collection of information are becoming more and more widespread, because conducting digitalized collective examinations and systematization of data allows you to significantly save resources for conducting marketing research.

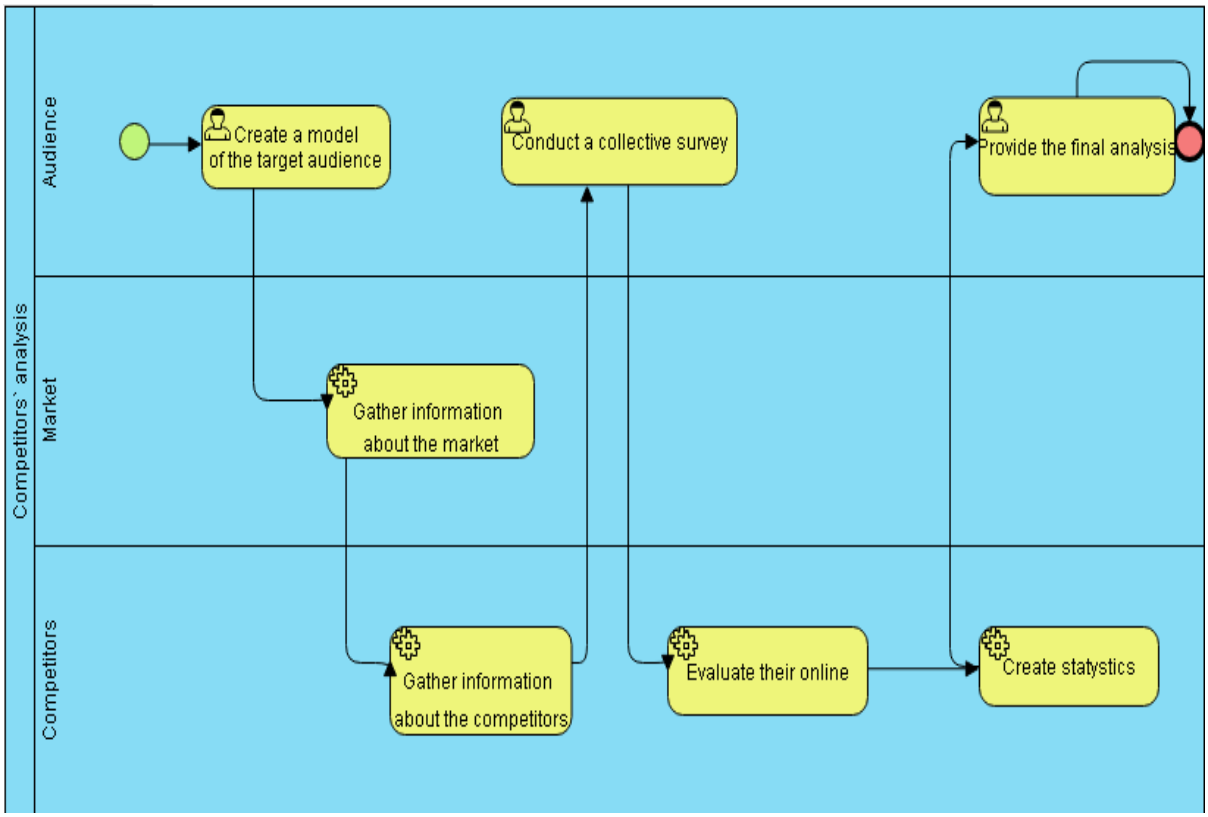


**Figure 1. Business process` the "Analysis of competitors" diagram***

**Source:* built by the authors

And the presence of a strictly regulated scheme for the execution of a certain business process allows it to be divided into smaller sub-processes, each of which can be submitted in the form of an automated protocol of commands, as a result of which data will be obtained in a certain format, and only after checking their validity and relevance will permission be given go to the next subprocess. This model of organizing business processes guarantees the achievement of maximum efficiency when setting up the activities of an enterprise, especially a multifunctional and large one.

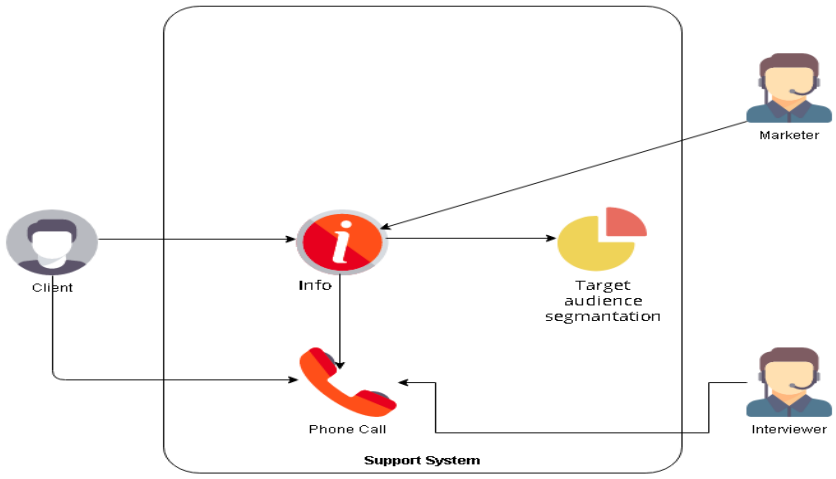


**Figure 2. Business concept diagram of obtaining and accumulating information for the "Analysis of competitors" business process***

**Source:* built by the authors

The use of this approach to modeling by using a separate environment allows to prove the infographics` importance, because the clarity and visibility of the symbols used in the scheme

instead of traditional notations increases the business processes perception` effectiveness at the enterprise. In the future, the simulated business process can be transferred to a higher level of formalization, in order to automate and digitize all sub-processes of the business process. During the formalization of subprocesses, an important challenge is the correct construction of connections within the elements of the business process as an independent closed system. Incorrect definition of relationships between individual entities leads to the appearance of a contradictions` large number between subprocesses, and can threaten the functioning of the entire system as a whole. Such mistakes, in turn, will lead to an incorrect transformation of the business process at the level of writing software code for it (if the goal is to automate it), and therefore the initial goal of increasing the efficiency and transparency of business process design will not be achieved.

Business process modeling is based on a number of principles that make it possible to create adequate process models. Their observance makes it possible to describe a set of process state parameters in such a way that within one model the components are closely interconnected, while individual models remain sufficiently independent of each other.

The main principles of business process modeling are as follows:

-Decomposition principle - each process can be represented by a set of hierarchically arranged elements. In accordance with this principle, the process must be detailed into its constituent elements.

-Principle of focus - to develop a model, it is necessary to abstract from many process parameters and focus on key aspects. For each model, these aspects may be different.

-The principle of documentation - the elements included in the process must be formalized and recorded in the model. Different designations must be used for different process elements. Fixing elements in the model depends on the type of modeling and the chosen methods.

-The principle of consistency - all elements included in the process model must have an unambiguous interpretation and not contradict each other.

-The principle of completeness and sufficiency - before including this or that element in the model, it is necessary to evaluate its impact on the process. If the element is not essential for the execution of the process, then its inclusion in the model is not advisable, because it can only complicate the business process model.

To solve the problem posed in this area, an important research step is to select several basic methods of modeling business processes and conduct the collective expertise with the participation of several specialists in the field of business analytics and project management to determine more relevant and visual modeling methods.

First, it is necessary to highlight the business process modeling methods that will be compared.

-Role Activity Diagram (diagram of roles). A role here means every element that performs one or another function. Each part is described and analyzed separately, and then their interaction is considered.

-Unified Modeling Language is a graphic language for visualization, specification, design and documentation of processes and systems. A complex of nine types of diagrams describing different aspects: classes, objects, precedents, sequences, cooperations, states, activities, components, deployment. The result is a representation of the employees actions` sequence and the work of various objects within the organization. The scheme can be branched out, various conditions and exceptions to the rules are noted in it.

- Data Flow Diagram – an image of data transfer between operations, to characterize the information side of the business process. This allows to observe the data at the entrance to the system and in each operation separately, and the corresponding information at the exit. It also displays the ways in which information is changed and where it is stored. The company's activity is divided into logical information levels, and the basic scheme is improved by adding detailed

descriptions of subprocesses, which also possess their own internal structure.

- ARIS (Architecture of Integrated Information Systems) is a methodology and a corresponding family of software products. They are used for the structured description, analysis and subsequent improvement of the enterprise's business processes. The system clearly shows the rules of the company's activity and the meaning of performance indicators. In this way, it is possible to determine the desired characteristics of the company's work, improve the architecture, improve processes, and rationally allocate resources. The tool determines the entire development cycle - analysis of requirements, specification of the information system and description of the physical implementation.

- IDEF (Integrated Definition for Function Modeling) is a whole set of analytical tools used not only in business management, but also in many other areas. IDEF0 and IDEF3 variants are most often found. The first of these variants is a model of functions, and complex functions are divided into simpler components, and then different blocks are logically combined by means of arrows. When using IDEF3, it is a "behavioral" description: the flow of work or transitional states of objects is demonstrated.

- Color networks of Petri are a graph on which actions and events symbolizing the transition from one stage to another are presented. Thus, it is possible to see what leads to these or other changes, how quickly and effectively.

- Flow Chart Diagram is a way of graphically describing work using special symbols for each operation, set of data, unit of equipment, performer. As a result, the diagram shows the logical sequence of all operations. This is a flexible approach, it makes it possible, if necessary, to consider one set of actions in several options at once.

Ten selected experts in the field will analyze data from seven business process modeling tools (alternatives) using the Delphi method of collective expertise and evaluate them according to the five criteria of compliance with the principles of business process modeling described above. Evaluation is carried out using an automated window desktop application. Figure 3 illustrates setting the initial conditions for the examination, and Figure 4 illustrates the final stage of ranking approaches to business process modeling. The decoding of the serial number of each of the methods will be presented below in Table 2.

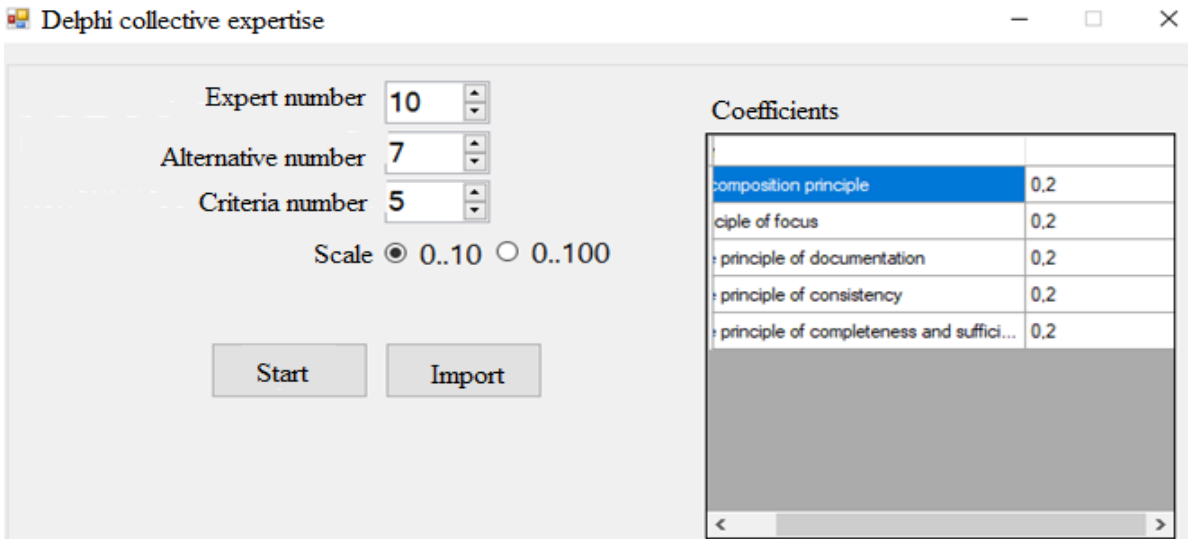


**Figure 3. Collective expertise`s initial conditions***

**Source:* built by the authors


| | z1 (Decomposition principle) | z2 (Principle of focus) | z3 (The principle of documentation) | z4 (The principle of consistency) | z5 (The principle of completeness and sufficiency) | Сумма |
|---|---|---|---|---|---|---|
| x1 | 1,175 | 1,018 | 0,936 | 1,063 | 0,99 | 5,182 |
| x2 | 1,34 | 1,067 | 1,147 | 1,101 | 1,259 | 5,914 |
| x3 | 0,82 | 1,153 | 1,108 | 1,02 | 1,151 | 5,251 |
| x4 | 1,147 | 1,122 | 1,243 | 1,048 | 0,748 | 5,307 |
| x5 | 1,346 | 1,218 | 0,966 | 0,987 | 0,995 | 5,512 |
| x6 | 0,956 | 0,86 | 1,241 | 0,959 | 0,948 | 4,964 |
| x7 | 1,311 | 1,105 | 1,178 | 1,051 | 1,104 | 5,749 |

**Figure 4. Collective expertise`s final ranking**

**Source:* built by the authors

**Table 2 – Serial numbers of the evaluated methods***

| Number | Decoding |
|---|---|
| X1 | Role Activity Diagram |
| X2 | Unified Modeling Language |
| X3 | Data Flow Diagram |
| X4 | ARIS |
| X5 | IDEF |
| X6 | Color networks of Petri |
| X7 | Flow Chart Diagram |

**Source:* generated and supplemented by authors

Figure 5 shows a diagram with placed alternatives (approaches to modeling business processes) for a better infographic of the results of the conducted collective examination.

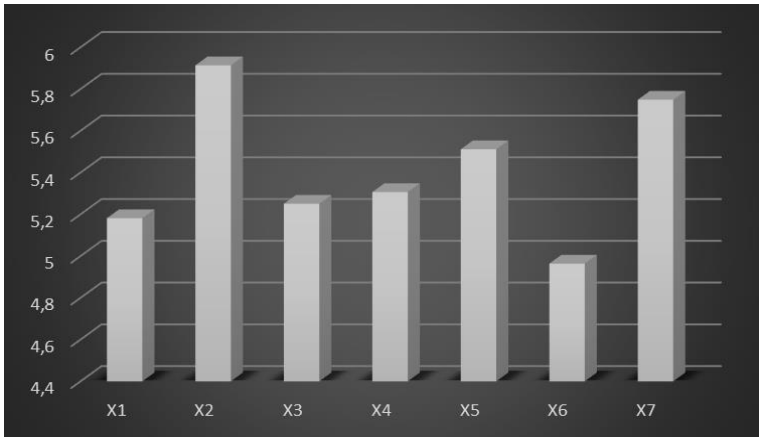


**Figure 5. Final diagram***

**Source:* built by the authors

It is possible to conclude, that the collective opinion of experts shows that today the

environments that automate the UML methodology are the most consistent with the principles of modeling business processes, while the environments that use the colored Petri nets approach are the least optimized and morally outdated.

**Conclusions.** The concept of modeling business processes appeared with the development of digitalization at the junction of information technologies and the economic field, giving rise to such new areas of research as process management and project management. The main reasons for the creation and success of this type of modeling are speed and quality due to automation, the possibility of conducting simulations of individual processes and their optimization, flexibility and convenience for use in a large team.

It is worth noting that despite the clearly regulated notation of business process development, there is no single point of view as to which business process automation tools are uniquely the most effective.

The conducted collective expertise of approaches to business process modeling showed that the UML approach is currently the most effective and transparent according to the opinion of experts, and the use of this approach is illustrated by means of the Visual Paradigm environment.

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