



# Comparative Analysis of Tools for Modelling Business Processes of Organization Management

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## Abstract

The article presents the result of a comparative analysis of software tools that allow modelling business processes of organizations. For comparison, those software tools for modelling business processes that support the BPMN methodology were chosen. As a method of conducting a comparative approach, a comprehensive approach was used, including the use of the hierarchy analysis method, which allows us to find the weight of comparison criteria that were identified on the basis of the analysis of literature sources, Internet resources, and features of the functionality of the business process modelling tools selected for comparison, and a formalized approach that allows calculating the priorities of alternative software modelling tools depending on their grades by dedicated channels on each criterion.

**Keywords:** *business process, modelling, methodology, BPMN, modelling tools, hierarchy analysis method, formalized approach, comparative analysis.*

## 1. Introduction

Modelling and analysis of business processes is now a prerequisite for the successful functioning and positioning of the organization in the labour market, so it is very important to choose the methodology correctly with the help of which the processes that take place in the organization when carrying out its activities will be simulated. There is a large number of methodologies used in the process of modelling the activities of organizations [1], which are independent of the specific software for their use. Currently, within the framework of the ideology of import substitution and promotion of domestic software products, it is urgent to develop competitive software that would be based on a well-known and widely used methodology that will allow further integration of our own developments with the software tools of partners, including foreign ones.

In the framework of the implementation of a comprehensive project for the creation of high-tech production "Development of methodology and tools for creating software applications, maintaining the life cycle of information technology support and decision-making for the effective implementation of administrative and managerial processes within the framework of established powers," six components are implemented, in one of which the central part is occupied by the application of the methodology of organization's modelling business processes. In this connection, the question of choosing the basic methodology was very important to solve. Many authors [1, 2] consider the most common modelling methodologies in their works and give their comparative analysis, but when comparing them they did not take into account the unequal priorities of the various criteria for their estimation, which somewhat distorts the correctness of the conclusions about the preference for a particular methodology.

In the process of research, a comparative analysis of notes was made on the basis of a comparison of quantitative and qualitative indicators, taking into account the features of their functional,

structure, usability and principles of work, the forms of presentation of results. Based on the analysis of notations, it was concluded that the BPMN methodology is one of the most flexible and simple methodologies for modelling, analyzing and reorganizing business processes [1, 2].

## 2. Analysis

A set of elements and rules for notation provides flexibility, and visibility is achieved through visual diagrams of processes and flowcharts. The main purpose of using the BPMN methodology is to provide all user groups with an accessible notation for describing business processes. The BPMN notation uses a basic set of intuitive elements that allow you to define complex semantic constructs. Modelling in this notation is carried out using diagrams with a small number of graphic elements. There are a number of software tools that implement business process modelling using BPMN notation. In this regard, the purpose of this article is to compare and select tools that support BPMN notation and implement it in the best possible way.

Analyzing the reports of analytical agencies and Internet surveys has made it possible to identify a number of tools in which BPMN notation is implemented to some extent: ARIS, ARIS Express, MS Visio, BPM 2.0 modeler for Visio, BPM 'online, eBMPN designer, BPMN Studio, ELMA BPM, Visual Paradigm, Business Studio, Biz Agri Suite, Bizagi Process Modeler, Enterprise Architect, Modelio, IBM Websphere Business Modeler, WebSphere Lombardi Edition, bpSimulator, Gliffy, Drawio, Intalio BPMS, Oracle BPM Suite, SAP Netweaver BPM, TIBCO iProcess Suite, Active Modeler Avantage, Runa WFE, Eclipse SOA Tools BMPN Modeler, etc. [1-12].

Let's look at the Russian-made software ELMA BPM in more detail. The system allows real-time execution and tracking of simulated processes (Figure 1).

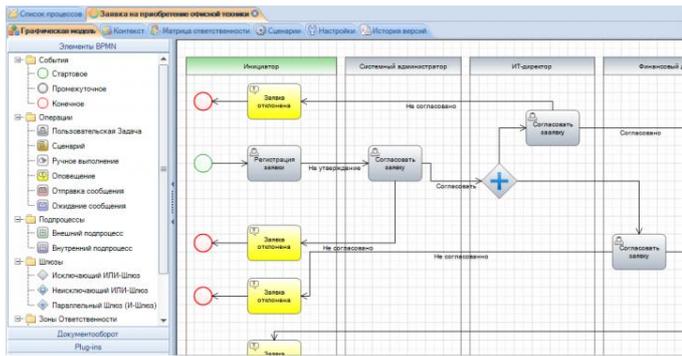


Fig. 1. Window of the program ELMA BPM

Functional and features: building business process models; assigning business process roles to employees; real-time execution and monitoring of processes; system work with document circulation; convenient "help"; monitoring and reporting system; excellent support; integration with IC.

The program is not free, if you want to have a look at it you can install a free version. The drawing of the process diagrams is quite convenient, but the correspondence of the notation is unsatisfactory (the number of elements is insufficient), the program allows using only those elements that are able to automate. There is the checking of the circuits. There is no simulation of the process in the free version. The possibility of processes' automation is here as well.

*Biz Agi Suite* allows you to get not only the models and descriptions of business processes, but also create executable applications for them that transform the developed model into a program. In *Biz Agi Suite* automation and process control is well-implemented. *Biz Agi Suite* allows you to guarantee the execution of processes in accordance with the description. The program is free (up to 20 employees).

Functional and features: modeling of business processes, their verification and analysis; create a description of business processes; creating executable applications based on models; real-time execution and monitoring of processes; assigning processes to employees; assign other resources to business processes; the program in Russian.

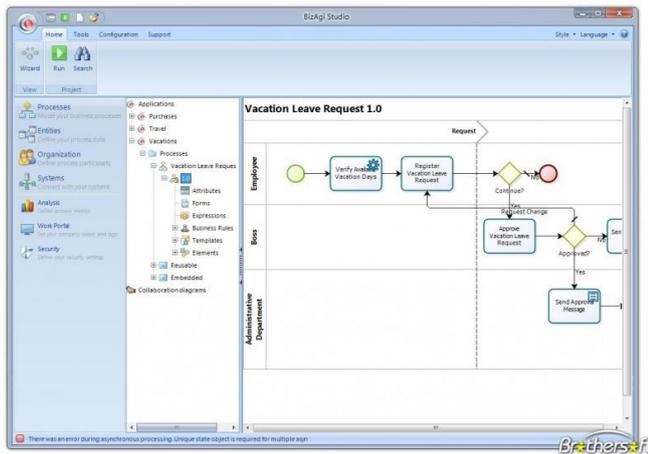


Fig. 2. Window of the program Biz Agi Suite

The system supports collaboration, simulation, export of created models to text editors and other formats.

When analyzing existing software using the BPMN notation, criteria have been singled out that take into account the opinions of different user groups on the problems of choice and use, both the methodology itself and the results obtained with its help. The selected criteria were grouped into 9 classes (Figures 1, 2).

**1. Support for BPMN 2.0 notation**

1. Completeness and correspondence of BPMN 2.0 notation (does not correspond, in part, completely)

2. The convenience of developing process diagrams in BPMN 2.0 notation (inconvenient, rather inconvenient than convenient, rather convenient than inconvenient, convenient)
3. The speed of design (low, medium, high)
4. The possibility of reusing components of previously created models, as well as using the developments of other developers (missing, limited, complete)

**2. Functionality**

1. The possibility of checking the schemes and uploading results in common formats (missing, limited, complete)
2. The possibility of teamwork of a group of designers with the same models (missing, limited, complete)
3. The ability to present data in various formats, including the possibility of developing different types of models in one software tool (missing, limited, complete)
4. Modularity (absent, present)
5. Redundancy of the functional (present, absent)
6. The possibility of efficient manipulation of models, including simulation (missing, limited, complete)

**3. Support**

1. Multilingual support (one language, two languages, multilingual)
2. Spell check (missing, present)
3. Intuitive interface (missing, partially present, present)
4. Availability of a set of tools for documenting models, projects (missing, limited, present)
5. Availability of its own report generator (absent, present)

**4. Information environment**

1. Integration with other software (no, partial, yes)
2. Requirements for the technical platform (non-strict, strict)
3. Requirements for system-wide software (non-strict, strict)
4. Requirements for telecommunications (non-strict, strict)
5. Opportunities to ensure information security (weak, medium, strong)
6. Number of locations for installing custom applications (one, five, five to ten, more than ten)
7. Import of data from any external systems (impossible, possible from analog systems, possible)
8. Updates (absent, long, frequent)
9. Ability to adapt to changes in the external environment (absent, weak, strong)

**5. Product image characteristics**

1. Stable position of the product on the market (its lifetime, product development program, system of reports on problems, set of applications, etc.) (unstable, variable stability, stable)
2. The prevalence of the product (the number of licenses sold, the availability, size and level of activity of the user group) (poorly distributed, medium, strong)
3. Availability of training. Training can be conducted in the territory of the supplier's representative in Russia, the user or elsewhere (impossible, territorially limited, possibly)
4. Availability of materials on the product. They can include computer training materials, study guides, books, articles, information on the Internet, demos (hard to reach, availability with certain difficulties, available)
5. Availability in the national market and the product itself, and services for maintenance, technical support, training in the national language (hard to reach, availability with certain difficulties, available)
6. Product evaluation by analytical companies (low, medium, high)
7. Presence of examples and typical solutions (absent, partially present, present)
8. The presence of hidden errors in the software (reviews) (negative, rather negative, rather positive, positive)

**6. Image characteristics of the manufacturer**

1. Availability of vendor support (missing, partially present, present)

2. The possibility of leaving the software vendor's market and, accordingly, the possibility of losing technical support and restoring the lost distributions by the customer, etc. (high probability, medium, small)

3. Duration of presence of the producer on the market (small, medium, large)

4. Territorial distribution of markets (regional, country level, world)

**7. Cost of ownership**

1. The price of the program itself (high, medium, low, shareware, free) - specify ranges

2. The cost of updating (high, medium, low, shareware, free) - specify ranges

3. Cost of services (high, medium, low, shareware, free) - specify ranges

4. The cost of training users (high, medium, low, shareware, free) - specify ranges

**8. Performance**

1. Robustness (weak, medium, strong)

2. Fault tolerance (weak, medium, strong)

3. Compliance with standards of reliability (partially consistent, fully consistent)

4. Time efficiency (low, medium, high)

5. Stability of work (weak, medium, strong)

**9. Usability**

1. The agility of learning new users (low, medium, high)

2. The agility of results achievement (low, medium, high)

3. Ease of installation (low, medium, high)

4. The convenience of making changes (inconvenient, partially convenient, convenient)

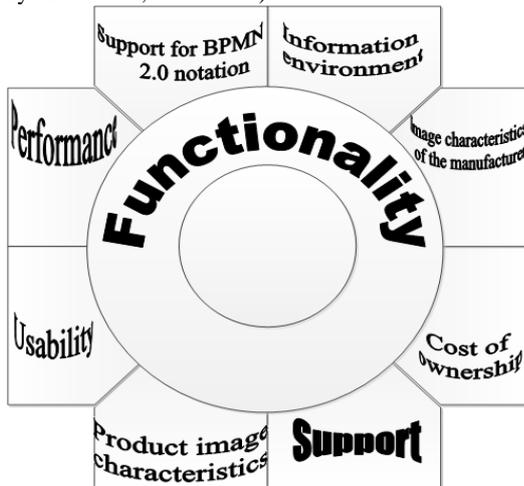


Fig 3 – Classes of criteria

**3. Methods**

Very often in the tasks of choice, the need arises to add new alternatives to consideration. When using the Saaty method, adding even one alternative leads to the need to re-fill all matrices of paired comparisons and recalculation of local priority vectors. In connection with this, it is proposed to use a combined approach that combines the MAI and the methodology of accounting for information criteria [13-17].

To determine the weight of the selected criteria, the hierarchy analysis method was used to order the finite set of real variants  $A_1, \dots, A_m$ , estimated by many quantitative and qualitative criteria  $K_1, \dots, K_n$ , and choosing the best variant for the greatest total value. The task of choice is represented in the form of a hierarchy, which in the simplest case consists of 3 levels: goal (dominant), criteria, alternatives (options). The variants are compared by the values of the numerical value function (priority)  $v(A_i)$ , the criteria for the alternatives are described. For a comparative assessment of the importance of the elements of the hierarchical structure with respect to the higher level, a unified scale is used [13].

The set of matrices of pair comparisons of  $H_i$  and  $H_j$  elements of any hierarchical level  $A^k = \|a_{ij}^k\|_{h \times h}$ ,  $a_{ij}^k = s_i/s_j$ ,  $h$  – is the number of base elements being compared, is a subjective model of rational choice, where the preference of elements for a decision maker is defined as  $H_i > H_j$ , если  $a_{ij}^k > 1$ ;  $H_i \approx H_j$ , if  $a_{ij}^k = 1$ ;  $H_i < H_j$ , if  $a_{ij}^k < 1$ .

The calculation of the value (priority) of the options is carried out by aggregating the partial estimates of the elements of the hierarchical structure, beginning with the lowest level and ending with the highest level.

The private value of variant  $A_i$  from the  $q$ -th criterion  $K_q$

$$v_i^q = v^q(A_i) = c_i^q / \sum_{j=1}^m C_j^q, \quad c_i^q = (\prod_{j=1}^m a_{ij}^q)^{1/m}, \quad a_{ij}^q = s_i^q/s_j^q,$$

the relative importance (weight) of the criterion  $K_q$

$$w_q = w(K_q) = c_q^0 / \sum_{l=1}^n C_l^0, \quad c_q^0 = (\prod_{l=1}^n a_{ql}^0)^{1/n}, \quad a_{ij}^0 = s_i^0/s_j^0,$$

the total value (priority) of variant  $A_i$  in the form of additive convolution

$$v(A_i) = \sum_{q=1}^n W_q v_i^q(A_i) = w_1 v^1(A_i) + w_2 v^2(A_i) + \dots + w_8 v^8(A_i).$$

Complex evaluation of the software tool will be presented as a generalized function (F), which, depending on the quantitative values of the assessments of the quality criteria selected for the analysis, is:

$$F = f(P_i)$$

$j$  – group number (1..9),  $i$  – number of the criterion in the group,  $P_i^j$  –  $i$ -th criterion of the  $j$ -th group

The methodology of accounting for information criteria is based on the assumption that there are criteria that are positive, and there are criteria that have a negative impact. However, the specific nature of this technique allows us to translate negative criteria into positive ones. In addition, the use of only positive criteria will allow to take into account the influence and mutual influence of the criteria on each other both within the same group and when they are in different groups.

Each criterion by expert methods is divided into a series of gradations that determine on a qualitative level its degree of influence on the efficiency of service, i.e. set a gradation scale for each criterion. This allows us to formalize the evaluation procedure; including determining the criteria values of the generalized valuation function. In order to take into account the degree of influence of each criterion in relation to the rest, it is necessary to introduce weighting factors that increase the quantitative evaluation of the criterion and are determined expertly by known methods of carrying out the examination.

This implies two problems. The first is to find quantitative measures of the evaluation of each criterion by its gradation scale. The second is to normalize the quantitative values of the criteria in such a way as to obtain a fairly simple and intuitive form of representation of the result in the analysis of the generalized function.

The generalized function of assessing the conformity of software to the declared criteria is advisable to express it in a normalized form with a value ranging from 0 to 100 ( $0 \leq F \leq 100$ ).

Using quantitative evaluation of  $F$  as an integral criterion, it is possible to establish clear criteria values for a conclusion about the degree of conformity of the considered tool to the claimed requirements.

This method involves determining the measure of evaluation of each selection criterion, on the basis of which it is possible to quantify the degree of their influence on the final result.

This assumes the ranking of factors, the calculation of the corresponding ranks, the rationing of the latter and the calculation of the quantitative values of the estimates of the relevant factors.

The method proposed by Blyumin includes 4 stages:

1. Allocation of the separate criteria that differentially characterize the degree of conformity of the tool to the reference values, which are adopted for their subsequent evaluation in the process of the overall integrated assessment.

2. Establishment of a gradation scale for each selected criterion, each level of which reflects the degree of influence of this

criterion on the overall integral conformity assessment. Gradation scale is set in such a way that the decision maker could expertly simply assess the degree of influence of the criterion by choosing the appropriate gradation. Thus, the task is transferred from the informalizable domain of choice of preferences to the formalization area on the basis of the assigned quantitative values of each gradation and taking these values into account for the subsequent determination of the criteria for the generalized valuation function.

3. Taking into account the calculated ranks of each criterion, and also taking into account their weighting factors and coefficients of standardization of the criteria defined in each group, the

quantitative values of each level of the scale of the gradation division of individual criteria are determined.

4. Questionnaires of expert evaluation of the conformity of the tool to the declared requirements for each group of criteria are prepared. The approach proposed by the authors makes it possible to make changes in the second and third stages of the above technique by switching from calculating the rank of the criteria, their weighting coefficients and the valuation coefficients to the weighting coefficients obtained using analytic hierarchy process. Since the criteria are grouped into 9 classes, first we calculate the priorities of each criterion class, and then we calculate the criteria priorities within each class and weigh their priorities for the corresponding class.

**Table 1** – Evaluation of priorities of classes of criteria

choice	CI1	CI2	CI3	CI4	CI5	CI6	CI7	CI8	CI9	vector
CI1	1	4	7	5	6	8	7	6	7	0,393186
CI2	1/4	1	4	2	3	5	4	3	4	0,176199
CI3	1/7	1/4	1	1/3	1/2	2	1	1/2	1	0,044444
CI4	1/5	1/2	3	1	2	4	3	2	3	0,119342
CI5	1/6	1/3	2	1/2	1	3	2	1	2	0,075077
CI6	1/8	1/5	1/2	1/4	1/3	1	1/2	1/3	1/2	0,027784
CI7	1/7	1/4	1	1/3	1/2	2	1	1/2	1	0,044444
CI8	1/6	1/3	2	1/2	1	3	2	1	2	0,075077
CI9	1/7	1/4	1	1/3	1/2	2	1	1/2	1	0,044444

**Table 2** – Evaluation of priorities of partial criteria within Class2

Class2	P1	P2	P3	P4	P5	P6	Vector of local priorities in Class2
P1	1	1/4	2	3	6	1/2	0,142155
P2	4	1	6	7	9	3	0,450131
P3	1/2	1/6	1	2	5	1/4	0,085183
P4	1/3	1/7	1/2	1	4	1/5	0,057174
P5	1/6	1/9	1/5	1/4	1	1/8	0,024423
P6	2	1/3	4	5	8	1	0,240934

Priorities of partial criteria within the rest of the classes of criteria were calculated in the same way.

As a result, the priorities of each criterion are presented in a Table 3.

**Table 3** – Priorities of all used criteria

Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9
<b>0,237302</b>	0,025048	0,003857	0,016882	0,007458	0,008012	0,024222	0,011464	0,004235
0,051056	<b>0,079313</b>	0,001376	0,004833	0,001831	0,003093	0,003719	0,006297	0,020749
0,022788	0,015009	0,019839	0,006967	0,003126	0,014808	0,006154	0,004058	0,007123
<b>0,08204</b>	0,010074	0,013259	0,002662	0,004385	0,001871	0,01035	0,032388	0,012337
	0,004303	0,006113	0,001671	0,012574			0,020871	
	<b>0,042452</b>		0,010478	0,001727				
			0,027833	0,018415				
			0,010478	0,025561				
			0,037538					

After getting these priorities, we start the use of formalized approach to determine the most preferable tools for modelling business processes.

**Table 4** - An example of a formalized approach

Group Criteria	Scale of Criteria				Total value	
completeness and correspondence of BPMN 2.0 notation						
Scale	does not coincide		partially	totally coincides		
Values						
convenience of developing process diagrams in BPMN 2.0 notation						
Scale	inconvenient		rather inconvenient than convenient	rather convenient than inconvenient		convenient
Values						
speed of the design						
Scale	low		medium	high		
Value						
....						
Scale						
Values						

The following software tools were analysed DP (Developed Platform), ARIS, Visio, ELMA, Visual Paradigm, Business

Studio, Biz Agi Suite, Gliffy, Oracle BPM Suite, IBM WebSphere, SAP NetWeaver BPM, RunaWFE [18, 19].

**Table 5 – Results of the calculations**

	Criteria	DP	ARIS	Visio	ELMA	Visual Paradigm	Business Studio	Biz Agi Suite	Gliffy	Oracle BPM Suite	IBM WebSphere	SAP NetWeaver BPM	RunaWFE
1	completeness and correspondence of BPMN 2.0 notation	totally coincide	totally coincide	partially	partially	totally coincide	partially	totally coincide	totally coincide				
2	convenience of developing process diagrams in BPMN 2.0 notation	convenient	Rather convenient	convenient	Rather convenient	convenient	Rather convenient	convenient	convenient	convenient	convenient	convenient	convenient
3	speed of the design	high	medium	medium	medium	high	medium	high	high	high	high	high	high
49	ease of modification	fully	partially	fully	fully	fully	partially	fully	fully	partially	fully	fully	partially
	Total	82,4	67,23	48,38	48,52	66,59	52,37	81,06	70,3	78,23	76,71	84,30	79,31

After completing the questionnaires, based on the criteria chosen for analysis and the gradation values obtained for each criterion, for each record, you can find its numerical value, and then perform a calculation of the generalized function or a complex assessment of the degree of conformity of the tool to the claimed requirements.

Using a quantitative measure of the degree of conformity of the tool to the claimed requirements will allow it to be quantified, compared at a higher level than simple preference, and to take a more objective decision to choose the most preferred tool.

**4. Results**

1. Out of the 12 selected software products, the final value of the integrated assessment of the degree of conformity of the tool to the claimed requirements exceeded 70% in 7, which indicates a high degree of their compliance.

2. The leader on the results of the study is SAP ERP with the value of the integrated assessment, equal to 84.31%. In second place is the developed Platform with an indicator equal to 82.4%. The discrepancy is within the limits of statistical errors.

3. The most important requirements to consider when choosing a BP modeling tool are: completeness and correspondence of BPMN 2.0 notation, the possibility of reusing components of previously created models, as well as using the developments of other developers, the possibility of teamwork of a group of designers with the same models, the possibility of efficient manipulation of models, including simulation.

4. Comparison of the evaluations of the described development with SAP for each criterion allowed to identify the critical areas in which the Platform is inferior to the capabilities of SAP. The most critical area is Product image characteristics. The developed Platform is not widespread and well-known at the moment.

**5. Conclusions**

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

1. The proposed combined approach is implemented in such a way that there are no shortcomings in each of the methods included in it

2. The use of the hierarchy analysis method was useful for comparing the selection criteria, since their collection is stable for the tools of this type and will not change in the future

3. Using a formalized approach allows you to evaluate new tools without recalculating values for previously considered

4. Of the considered tools already used to model the activities of organizations, the best systems were: SAP NetWeaver BPM, Biz Agi Suite, RunaWFE.

5. Analysis of the component designed in the framework of the development of the exploited platform showed that, in general, it corresponds to the level of leading tools, and by some criteria exceeds them.

**Acknowledgements**

*The research was carried out within the framework of the implementation of a comprehensive project to create a high-tech production "Development of methodology and tools for creating application applications, supporting the life cycle of information technology provision and decision-making for the effective implementation of administrative and managerial processes within the framework of established powers", code 2017-218- 09-187; Decree of the Government of the Russian Federation of April 9, 2010. №218*

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