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Methodological Regulation of Business Processes Reengineering in the Modern Construction Development System

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Abstract: The article presents methodology of business processes reengineering (BPR) in the modern construction organizations adapted to dynamically changing conditions of the internal and external environment. The study developed a formulation of the task of reengineering business processes on the basis of component methodology of the enterprise's structure. It is advisable to apply a systematic approach to determining the functions and patterns of interaction of business processes. The concept of a methodology for reengineering business processes is theoretically substantiated based on the adequate construction of a conceptual system model from the components displayed in the modern enterprise management system. The formalization of the business process reengineering task at five stages on the basis of a systematic approach and component technology is described. Formalization of the BPR methodology ensures the combination of reverse and direct reengineering stages. The results of the study allow solving urgent problems of increasing the competitiveness of construction organizations through reengineering design. The scientific significance of the study lies in the development of a component methodology for modeling reengineering of business processes. The practical significance of the use lies in the application of the study in the real sector of the economy during the restructuring and reform of construction organizations. The scientific novelty of the study lies in the development of a methodology and conceptual provisions for systemic management of business process reengineering of building organizations based on the use of the process approach.

Keywords: business processes reengineering, BPR, component methodology, formalization of the business processes structure, restructuring, reorganization.

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I. INTRODUCTION

Business process reengineering is one of the most important tools aimed at updating or rebuilding business processes at construction enterprises to achieve a radical increase in the efficiency of their functioning.

The meaning and content of reengineering is a radical rethinking and fundamental redesign of business processes in order to achieve significant (tens or even hundreds of times) growth of key performance indicators of the enterprise.The main ultimate goal of business process reengineering is flexibility and efficiency of adapting to predicted changes in consumer requests: appropriate adjustment of strategy, technology, organization of production and management, based on which effective automation currently lies.

In scientific works [1–3], individual elements of the reengineering of managerial business processes are formulated. The theory of reengineering was developed into an independent management concept at the end of XX century in the works of M. Hammer, J. Champ, T. Davenport. The main reason for this served as a decrease in the efficiency of business models and management approaches.

The authors M. Hammer and J. Champy [4] define the reengineering of business processes and understand the fundamental rethinking and radical modification of business processes to achieve a turning point in improving critical current indicators, such as costs, quality, service and speed of business processes.

In articles [5, 6] it is indicated that the object of reengineering is business processes, and not the structure of enterprises or their individual functions. Based on the analysis of the theory and practice of business process reengineering, it is proposed to consider unproductive operations and relationships between performers as a separate business process as a subject of reengineering.

The authors [7] define the reengineering of business processes as a philosophy of improvement, the main task of which is to achieve fundamental improvements by redesigning the process to maximize value and minimize other indicators.In the work [8] describes two types of business process reengineering. The first type is a systematic reengineering, which involves the study, documentation and analysis of an existing business process for better understanding and the systematic creation of new, better processes.

The second type is reengineering from scratch, involving the complete elimination of the existing business process, its radical rethinking and the creation of a new business process from scratch.Scientific studies [9, 10] indicate such types of business process reengineering as crisis reengineering, which means a fundamental redesign of business processes, and development reengineering, which involves improving business processes.

The authors of the work [11] describe radical transformations of business processes in order to increase the efficiency of the enterprise, to overcome the crisis, lead to deep structural changes that have both negative consequences and positive results. The importance of the positive effect of reengineering business processes is confirmed by the fact that the authors consider it as a tool for managing innovative activities.

The articles [12] and [13] are devoted to the use of information technologies which are determining factors in the modern development of business process reengineering. Without information technology, the role of reengineering in management, its effectiveness would be negligible. It is information technology that allows creating a variety of tools to describe business processes as a key element of reengineering.

The authors of the papers [14-18] consider the links of reengineering with other management concepts such as restructuring and reorganization. Restructuring refers to the development and implementation of measures to bring the organization in line with the needs of a particular market Business process reengineering aims to create a flexible business model that can easily adapt to the requirements and market shifts of various markets. Restructuring allows you to find a way out of existing problematic situations, and reengineering allows you to use the opportunities, potential of the company. Reorganization involves changing the external structure of the business, while reengineering aims to transform the internal structure.

II. PROPOSED METHODOLOGY

The object of this study is the reengineering of business processes aimed at the effective restructuring of construction enterprises in accordance with their strategic goals and specific operating conditions. Restructuring of enterprises is interpreted not just as organizational restructuring, but a change in the strategy of financial and economic activity, which determines the transformation of the methods of functioning of the enterprise. Restructuring leads to a change in the nature of production activities, the redistribution of financial, material and human resources, attracting additional sources of financing. The effectiveness of the enterprise is determined by the correct strategic positioning in the market, the ability to introduce new activities, rebuild or abandon existing ones, establish partnerships with other enterprises.

It is proposed to use reengineering of business processes that implements a process approach to enterprise management as an effective method of restructuring. The need for business process reengineering is determined by the following factors:

– complex production structure;
– territorial distribution of units; a large number
– cooperative ties; versatility;
– dynamism and client-oriented financial and economic activities of modern enterprises.

Reengineering business processes (RBP) allows concentrating on obtaining the final result of the process, increases the degree of coordination of operations, dramatically accelerates business processes and improves quality work. Concentration of funds on the reengineering of key business processes, in turn, dramatically increases the effectiveness of restructuring enterprises.

The figure 1 shows the relation of reengineering business processes in the modern management system.

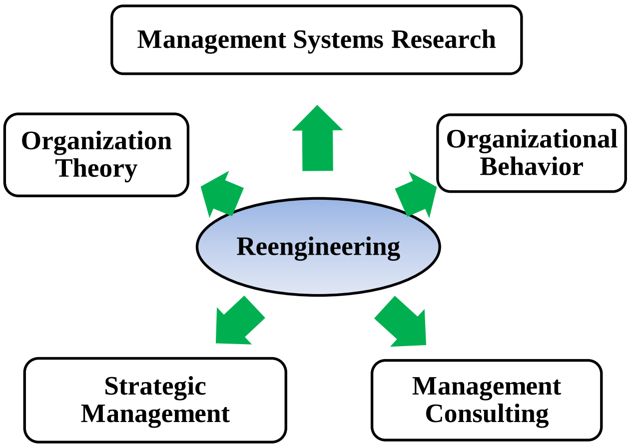

Fig. 1.Relation of business processes reengineering in the modern management system

Significant structural changes to the construction organization during the reengineering of business processes, accompanied by the transition to new principles of work of the organization, require the development and implementation of a special project and the creation of a reengineering team, including both the staff of the organization and invited consultants.

The construction organization proceeds to a new period of development after the intended goals of work on the project of the previous stage are reached. Permanent small upgrades are performed during the ongoing work. it is necessary to re-engineer the organization as the possibilities of gradual improvements, organization, are exhausted. But usually in this case, the project already covers not only the entire construction organization, but only its individual units. Thus, continuous activities to change the organization become part of its daily life in response to the constant changes of various environmental factors: market, technology, customer preferences, competition and so on.

The development of the component methodology of the RBP is an urgent task for the successful restructuring of enterprises. The proposed methodology, in contrast to existing methodologies, allows automating the selection and configuration of adequate components of the structure of business processes that reflect the experience in the implementation of RBP for various types of enterprises.

It is necessary to formalize the formulation of the task of reengineering business processes on the basis of component configuration of the enterprise's structure. It is advisable to apply a systematic approach to determining the functions and patterns of interaction of business processes.

An enterprise is considered as a goal-oriented structure of potential and processes, which is based on the representation of system (S) as a tuple of components:

$$S = \langle C, F, R \rangle, \quad (1)$$

where ***C*** is a set of system components, ***F*** is a set of functions (activities, business processes, operations), ***R*** is a set of relations.

Formalization of the structure of business processes is an important task of their reengineering. From the composition of system elements defined by relation (1), functions that process, use, and form other elements are identified in a separate category. In this way, some transformations and processes are realized, and regularities are determined according to which the functioning of the system is organized.

The set of system components ***C*** is described by such a tuple of sets:

$$C = \langle X, Y, Z, T, G, M \rangle, \quad (2)$$

where ***X*** is a set of input elements, ***Y*** is a set of output elements, ***Z*** is a set of external environment elements, ***T*** is the period of time over which the system, ***G*** is a set of goals of functioning system, ***M*** is a set of methods (strategies, patterns) of functioning system.

The participation of components in functions is defined by certain role relations. Elements participate in the execution of the function as input and output objects, means, people and their organizations participate in the execution of functions as executors, initiators, recipients of the result. It is necessary to determine the goal of fulfillment or a criterion, a method of execution based on the use of a strategy or a specific method of organizing a process that optimizes the achievement of a goal for the implementation of a function. In addition, it is necessary to determine the time interval for the function.

The participation of system components ***C*** in functions ***F*** is defined by certain role relations:

$$\mathrm{R} = \{R_i\}_{i=\overline{1,Nr}}. \quad (3)$$

where *Nr* is the total number of relations in the system, R_i is a *i*-role relation with such structure:

$$R_i = r(C_j, F_k) \quad (4)$$

where C_j is a *j*-component of the system that participates in the corresponding *i*-role R_i in the execution of the *k*-function F_k.

The set of functions F is a converter of the input elements X to the output elements Y:

$$Y = F(X), \quad (5)$$

where $F = \{F_k\}_{k=\overline{1,Nf}}$, $X = \{X_l\}_{l=\overline{1,Nx}}$, $Y = \{Y_h\}_{h=\overline{1,Ny}}$, *Nf* is the total number of functions in the system. *Nx* is the total number of input elements in the system. *Ny* is the total number of output elements in the system.

The set of functions F is divided into subclasses according to the level of aggregation / detail:

$$F = \{A, P, O\} \quad (6)$$

where $F = \{F_k\}_{k=\overline{1,Nf}}$, F_k *is* the a subset of functions of the highest level corresponds to the form activity ***A***, the type of activity is divided into business processes ***R***, the business process is divided into operations ***O***. Then the sequence of operations interconnected by inputs and outputs constitutes a business process, the purpose of which is to create some value object. The type of activity includes a sequence of business processes to create the final result or a value chain.

In general, the decomposition of a separate a subset of functions F_k can be represented as:

$$F_k = \{F_{k1}, F_{k2}, \ldots, F_{ki}, \ldots, F_{kN}\}_{i=\overline{1,Nk}} \quad (7)$$

where F_k *is* the function of the highest level of decomposition, F_{ki} is a subordinate function of a lower level of decomposition.

It is necessary to observe such conditions for a higher function within a subset of functions:

$$\forall k, i \ \ \exists l, h \Rightarrow Y_h(F_{ki}) = X_l(F_{k\,i+1}),$$
$$k = \overline{1, Nf},\ i = \overline{1, Nk-1},\ l = \overline{1, Nx}, h = \overline{1, Ny} \quad (8)$$

The formula (8) means that in the chain of functions among the inputs of one function there is always at least one that is the output of another previous function. For a value chain, such an element is an interface object.

The interface element for all operations is the same for the business process function chain:

$$\forall k, i \ \ \exists l, h \Rightarrow X_h(F_{ki}) = X_l(F_{k\,i+1}),$$
$$k = \overline{1, Nf},\ i = \overline{1, Nk-1},\ l = \overline{1, Nx}, h = 1, Ny \quad (9)$$

The formula (9) means that is one and the same element participates as an input on all operations, while at the output of the operation it receives a new quality.

The configuration of value chains and individual business processes is significantly influenced by set of methods (strategies, patterns) M of functioning system:

$$M = \{M_m\}_{m=\overline{1,Nm}},\ M_m \in M, \quad (10)$$

where M_m is the a certain *m*-method, strategy or pattern, *Nm* is the total number of methods, strategies and patterns of functioning system.

The set of goals G of functioning system is described as follows:

$$G = \{G_g\}_{g=\overline{1,Ng}},\ G_g \in G, \quad (11)$$

where G_g is the a certain *g*-goal or criterion, *Ng* is the total number of goals and criterions of functioning system.

The formulas (2), (10) and (11) determine the composition and types of relations between the components of the system and, accordingly, the type of functional ***f***, which determines the target functions of the system:

$$G_{g1} = f_{\max}(X,Y,Z,T,F,R,M), \quad G_{g1} \in G,\ g_1 \in Ng \tag{12}$$

The type of functional ϕ for defining restrictions on use resources is described as limitation as follows:

$$\phi(X,Y,Z,T,F,R,M) \le G_{g2}, \quad G_{g2} \in G,\ g_2 \in Ng,\ g_2 \ne g_1 \tag{13}$$

Thus, the choice of objective functions and limitations, the allocation of functions and elements, the interaction of all these components in the processes should correspond to some regularity of the enterprise's functioning inherent to its potential and environment.

Analytical expressions of objective functions are relatively easy to obtain for single-criteria and difficult to express in the case of multi-criteria dependencies. Factors determining the objective function can have rather complex dependencies. The tasks of the RBP are becoming poorly formalized; their decisions largely determine the strategy or method of organizing business processes.

In this case, to obtain integral estimates of achieving the goals of the system, qualitative heuristic models are used that operate on incomplete, fuzzy and even contradictory information. It is proposed to use the methods of the theory of artificial intelligence as methods for constructing such models, which make it possible to determine the class of an enterprise that corresponds to some typical patterns of behavior (functioning) that determine the choice of the necessary components of the types of activities and the business processes that form them.

At the same time, it is proposed to extract knowledge about components and their relationships from a knowledge management system based on formalized rules.

The formalized formulation of the task of component configuration of the types of construction development and reengineering business process is as follows.

Let a set of descriptions of the components of activities in the construction management system be given:

$$S = \langle X,Y,Z,T,G,M,F,R \rangle \tag{14}$$

where $M_m \leftrightarrow \langle X,Y,Z,T,G,F,R \rangle_m$, $M_m \in M$.

The projection of system components and activities on the set M can have a fuzzy character. In this case, it is possible to obtain many valid solutions.

Suppose that set of system components for a restructured enterprise U^{rbp} based on reengineering business process, at least, sets of the system elements X, Y, set of the external environment Z and their relations R are known, the set of desired performance criteria and goals G is defined:

$$U^{rbp} = \langle X^{rbp}, Y^{rbp}, Z^{rbp}, T, G^{rbp}, R^{rbp} \rangle \tag{15}$$

where $X^{rbp} \in X, Y^{rbp} \in Y, Z^{rbp} \in Z, G^{rbp} \in G, R^{rbp} \in R$

Next it is necessary to choose a method (or regularity) M_m ($M_m \in M$) such that it's mapping to a subset of functions F_k ($F_k \in F$):

$$M_m(X^{rbp}, Y^{rbp}, Z^{rbp}, T, G^{rbp}, R^{rbp}) \to F_k(M_m), \quad M_m(U^{rbp}) \to F_k(M_m) \tag{16}$$

It will give an optimum subset of goals G_{g1}:

$$G_{g1}(M_m) = f_{\max}(F_k(M_m)), \quad G_{g1} \in G,\ g_1 \in Ng \tag{17}$$

At the same time, resource and external limitations G_{g2}:

$$\phi(F_k(M_m)) \le G_{g2}(M_m), \quad G_{g2} \in G,\ g_2 \in Ng. \tag{18}$$

The set of system components for a restructured enterprise based on reengineering business process (15) taking into account the formulas (16)-(18) is proposed to be quantified using heuristic, mathematical and simulation models.

It is proposed to use information technology of design automation (CASE-technology) and component configuration based on the construction and maintenance of the model of the problem area, reflecting both structural and evaluation aspects of its functioning.

III. RESULT AND DISCUSSION

Studies on the reengineering of business processes at Ukrainian enterprises in the construction industry have shown the high efficiency of the measures taken, despite the fact that the process turned out to be quite labor-intensive and took two years to complete.

The figure 2 shows the sequence of stages for applying methodology business process reengineering in the construction management system.

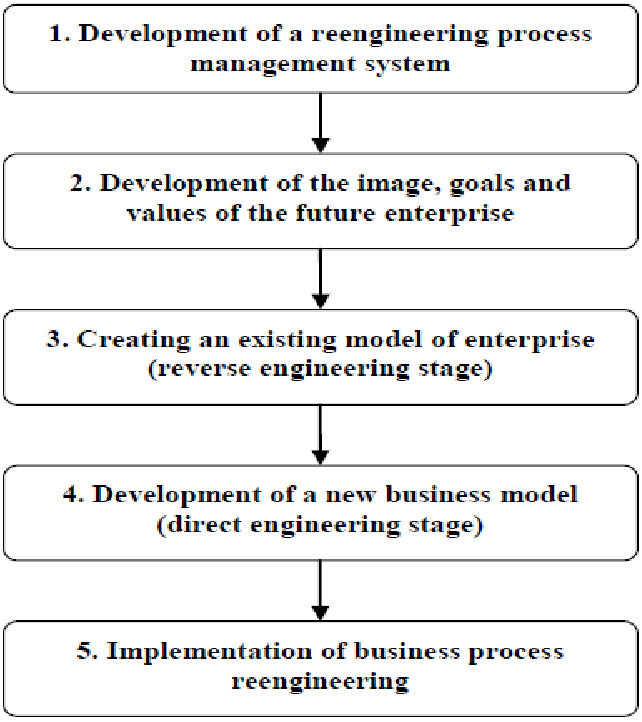

Fig.2.Stages of applying methodology of business process reengineering in the construction management system

At the first stage (preparatory), a reengineering process management system was developed. Specific employees were selected, appointed and approved - participants in the BPO, their functions and responsibilities were determined, employees were motivated to innovate, a scheme for their interaction was developed, etc.At the second stage, specialists formed the image of the future enterprise, determined its goals and values. The problems that the enterprise has have been identified and clearly formulated. The choice of business processes for reengineering was determined, which are the most significant for the enterprise and its customers, that is, both strategic and creating value. For the implementation of business process reengineering, the allocation of the required additional material, human, financial and time resources was organized. Working groups were created that began to work on the development of the RBP project.

At the third stage of "reverse engineering", the specialists of the working groups formed at the previous stage conducted analytical work on the state of production of the enterprise in question. The detailed description of the status of all operations and production processes available at the enterprise was carried out. As a result, a model of existing business processes was created. The necessary documentation was prepared and approved only for basic business processes, which made it possible to get a general idea about them and determine the key vectors of their reorganization.At the fourth stage of "direct engineering", a design solution for an updated business was developed based on the existing enterprise model. In the new model, a characteristic of newly developed business processes was given. After determining the basic directions at the enterprise, they began to develop subsystems that ensured the functioning of the new business organizational system, including new information technologies.At the fifth stage, new and reorganized business processes were introduced, their testing was carried out and their performance and efficiency were evaluated. Based on the assessment results, the management of the enterprise decided to conduct the next step of business reengineering.As a result, after the created business processes were put into operation, the specialists of the enterprise carried out an analysis of the implementation of the markers of the functioning efficiency of the enterprise in question determined at the initial stage of business reengineering.The figure 3 shows graphical representation of dependency of reengineering expenses over time. It shows starting points of five stages of a reengineering business processes.

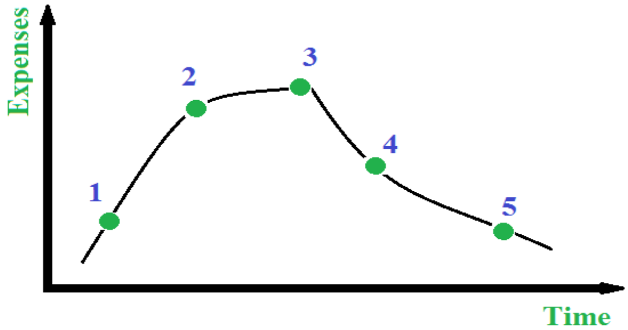

Fig.3. Graphical representation of starting points of the five stages of a methodology business processes reengineering

The experimental results of the study of the methodology of business processes reengineering are based on its implementation at 11 large construction companies in Ukraine.

The processing of the results is presented in tables' I-III. The leaders of construction companies were asked to assess the level of importance of the most problematic organizational business processes.

Processing the results of the estimates is presented in table I. Process transformation performance evaluation is presented in table II. Effects of process transformation in organizations are presented in table III.

Table I: The most problematic organizational business processes

N	*Business process description*	*Average importance score (0-5 points)*
1.	Preparation of initial permits	4,8
2.	Land allocation	4,5
3.	Search for investors	4,1
4.	Getting loans	3,8
5.	Object Acceptance	3,5
6.	Work with providers	3,1

Table II: Process transformation performance evaluation

N	*Conversion quality criterion*	*Average mark (from 0 to 5)*
1.	Process cost reduction	0,8
2.	Reduced process time	1,2
3.	Process quality improvement	2,5
4.	Increase customer satisfaction	2,8

Table III: Effects of process transformation in organizations

N	*The essence of the changes in business processes*	*% cases*
1.	Redesign of individual subprocesses: 1. work with private investors 2. work with providers 3. formation of budget documentation 4. control of work performed	57,5 28,7 14,3 7,3 7,2
2.	Process simplification	14,5
3.	Improvement based on personification of responsibility	7,5
4.	**Reengineering** according to the some goals and criteria: 1. criteria of efficacy 2. fundamentality 3. breadth of coverage 4. effectiveness	20,5 5,5 5,3 5,0 4,7
	Total	**100**

In addition, it is necessary to consider the possibility of zoning the territory not only for its functional purpose, as provided for by the master plan, but also for the possibilities of water supply, heating, electrification and the supply of other necessary communications to the construction site. Such a solution can reduce the possibility of customer errors when choosing a site for construction.

The effects identified in the implementation of these proposals are presented in table IV.

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Table IV: Effects of Business Process Reengineering

Participant of process	*Type of effect*	*Calculation method*	*Efficiency mark*
1. Customer	Reducing the time for preparation of initial permits	Process simulation	3.2 times
	Save time	Calculation of average fixed costs and rent taking into account discounting	12,2 million UAH
	Savings associated with reduced risk of unforeseen costs	Direct calculation of additional costs, the need for which arose during the approval process	0,85 million UAH
	Reduction in transportation costs	Redundant staff payroll	0,15 million UAH
	Reducing the cost of preparation of initial permits	The cost of maintaining their own services for an increase in the cost of registration	1,1 million UAH
2. Supplier	Growth in output from an increase in the number of large customers	The proportion of orders of former customers who refused to work with the company due to the long delivery time	15%
	Lower average cost of the delivery		12%
3. Contractor	Reducing the risk of project changes and underutilization of capacities	Risk reduction methods	8%
4. Investor	Reduced risk of loss of funds	Risk reduction methods	10%
5. Municipality	The effect of reducing the likelihood of a violation of building codes	Estimated average annual operating loss buildings designed and accepted with violations	Under implementation
	Lower control costs	Reducing the number of control structures	

The analysis showed the adequacy of the functioning of the renewed enterprise for the tasks that were set before the specialists in the process of RBP. The changes in the core business processes envisaged by reengineering inevitably entail the restructuring of other fundamental aspects.

Construction production determines the joint activity of a large number of independent enterprises, which in turn indicates the need for a construction organizer to coordinate the work of all participants in investment and construction activities. This approach helps to significantly reduce the risk of increasing the duration of the construction of the construction object and its cost. The project management customer, general contractor, suppliers of material and technical resources partially or fully delegate their functions to the construction organizer in order to isolate and effectively exercise managerial powers based on the principles of reengineering business process.

IV. CONCLUSION

The concept of a methodology for reengineering business processes is theoretically substantiated based on the adequate construction of a conceptual system model from the components displayed in the modern enterprise management system. This methodology provides increased efficiency financial and economic activities in accordance with strategic objectives, potential and operating conditions of construction development.The formalization of the business process reengineering task at all stages on the basis of a systematic approach and component technology is described. This approach allows to effectively managing resources during the BPR. Formalization of the BPR methodology ensures the combination of reverse and direct reengineering stages.

As a result of the parametric description of the subject area, variants of the structural organization of business processes are formed, which are supposed to be analyzed using the tools of heuristic, mathematical and simulation modeling.

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