Basic concepts of formalizing the business process of design and estimate calculations in the construction and repair of oil and gas facilities

R I Khamidullin

Industrial University of Tyumen, 38, Volodarskogo St., Tyumen, 625000, Russia

E-mail: hamidullin_ri@mail.ru

Abstract. The article considers the basic concepts of formalizing the business process of design and estimate calculations in the construction and repair of oil and gas facilities. The advantages and regulation of the main points for modeling business processes for the construction of oil and gas facilities are defined, including oil and gas transportation facilities for improving the competitiveness strategy in the market and optimizing the work of the entire organization as a whole. Particular attention is paid to the choice of the method of economic and mathematical modeling of the business process on the basis of the theory of mass service for the development of our own mathematical model, which will allow qualitative evaluating and optimizing the work of design and estimate activities.

1. Introduction
The current economic crisis is pushing the leaders and analysts of oil and gas design institutes to thinking about improving the productivity of the organization to improve those business processes that most affect the economic performances. Such processes as the preparation of design and estimate documentation for a construction project, or the maintenance of marketing campaigns to attract customers and others. Practice shows that the existing approaches to presenting and improving production and technological business processes, in particular, the business process of building projects management in the oil and gas industry are little formalized.

Today, analysts conduct business process reengineering identifying weaknesses in the transformation and modernization of existing business processes. Based on the research conducted [1] it was proved that reengineering of economically important business processes is not optimal and is not particularly successful in long-term process management. The graph in Figure 1 shows the success probability distribution, depending on the duration of the reengineering. On X, the timing of the reengineering of the business process is indicated, on Y - the relative popularity of the probability, in other words - the probability of falling into a particular period of an accidental successful or unsuccessful process.
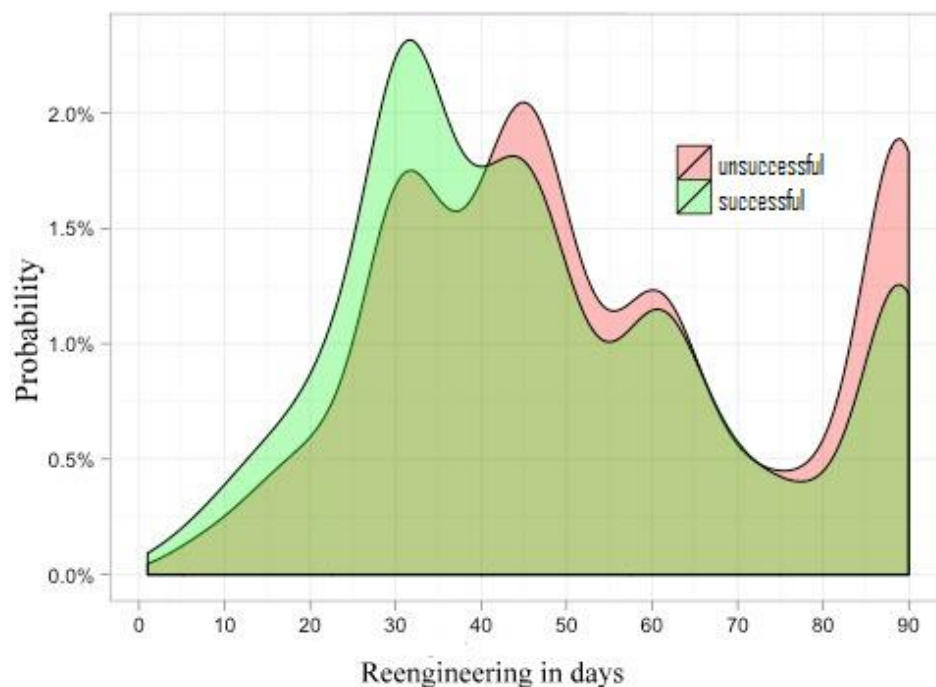
Figure 1. The success of the reengineering of the business process (for example, the development of design and estimate documentation).

As you can see, reengineering only in short periods of time provides efficient management of processes: the longer the use of this method is, the lower the quality of the construction project as a whole is. In the effective management of the project activities of the oil and gas industry instead of reengineering, there is a need for an ordered economic and mathematical model of optimization. Optimization will give a powerful impetus to the effective operation of those weak points that affect the decrease in the performance of the organization as a whole.

Determination of factors of optimization and management of actual competitiveness for the performance of the above-described work is fundamentally dependent on the specific situation in which it is located [2]. However, there are general approaches to the formulation of factors and some general framework in which management strategies and optimization exist. In particular, through the mechanism of competition, the selection of the most effective and promising construction projects takes place, which have competitive advantages and the possibility, on this basis, of long-term development.

Therefore, it is important to identify and evaluate the importance of conducting the project activity of the oil and gas industry as a business process, mathematical modeling of this business process with the designation of optimality criteria and the subsequent development of a universal program tool for automating the development of design and estimate documentation are relevant. At the same time, an important requirement is to improve the quality of the design and estimate department, taking into account the competitiveness in the construction and contracting services market to improve business performance indicators.

The work objective is to describe the basic concepts of formalizing the business process of compiling design and estimate documentation to assess the significance of optimization and automation of this business process in the oil and gas industry. The concepts will give the description and key points in the construction of a full-fledged economic-mathematical model of the business process.

2. Materials and methods

The successful operation of modern construction, repair of oil and gas facilities, including oil and gas transportation facilities, is complex, which requires new forms and methods of management. Undoubtedly, an additional factor contributing to the improvement of the production component of this sphere is the development of market relations and the enlarged emergence of a competitive environment, so attention is also paid to the economic efficiency and optimization of the work of all departments and the organization as a whole.

Ignoring these factors can lead to a situation when a system of management in the organization is in a precarious position, and the system can become inefficient.

Successful optimization of problems in the current conditions of economic development and bypassing economic problems should acquire new and more optimal conditions under which the production component will give the best result. A number of tasks of continuous increase in the efficiency of the work of design organizations become particularly acute incentives for organizational improvement, and should be guided by the need to adapt to all changes in the external environment.

Studies were carried out on the main economic difficulties and the problems that arise in the preparation of design and estimate documentation and the calculation of the cost of repairs in the oil and gas industry. The design and estimate documentation has always been a particularly important element of any construction process or various repair work, where planning of construction activities has always been strictly regulated, because for each project being developed, one writes its own estimate documentation, in which all costs are rigidly ruled, as well as instructions, and there are other standards and basic rules for budgeting.

Also, an analysis of solutions to problems arising in the business structure was conducted. The notion of the wording of the definition of a business process and consideration of the main approaches for identifying business processes where the concept of a mathematical model and a mathematical model of the business process is introduced was also important. The study made it possible to determine the basic concepts for creating a mathematical model for optimizing the business process under study using economic and mathematical methodology taking into account the author's additions.

To solve the problems, the authors relied on the concepts of Harrington D., Esseling K.S. and Nimvegen H. In these concepts there is a presentation of the theory of optimal solutions, where a significant place is given to mathematical modeling of economic processes [3,4]. To build a mathematical model, one need to have a clear idea of the purpose of the functioning and formalization of the system under study, as well as to have full information about the existing limitations.

It should also be noted that many authors of scientific papers tried to solve the problem of optimizing business processes based on various economic and mathematical models, such as Petri nets, graph theory, network models, models under uncertainty, etc. In the course of the detailed analysis, downsides in the use of the above described models were identified and the need for studying such a method in modeling business processes - the theory of mass servicing systems.

A queuing system (QS) is a system that is designed to serve incoming requests, that is, a system in which, on the one hand, there are massive requests or requirements for the performance of some services, and on the other hand, satisfaction of these requests is achieved [5,6]. Requests that come to service in the system (orders, tasks, customers, etc.) form a stream of requests. The elements of the QS that handle the requests are called service channels. In most cases, the time intervals between the time of receipt of applications and/or the times for servicing requests in the QS are random variables. In other words, in most cases it is not known exactly in advance when the next request will be received and how long it will take it to be serviced. Therefore, queuing theory is based on the mathematical apparatus of probability theory and mathematical statistics. The use of QS provides such advantages as:

- taking into account the relationship between the input and output parameters of the system;
- optimization of business processes on the set parameters in real-time.

Based on the chosen method, the business process will be formalized, which is created by a team of people with different qualifications, experience, habits, education, preferences and personal qualities.

The business process model of design and estimate activity is built in order for these people to effectively share knowledge and jointly make decisions in the course of creating a system that will give a new effect in the performance of their job responsibilities. After all, the model is the language of communication between the parties involved in creating a computer system of the model: customers, experts, architects, etc. It will be organized in such a way that each side perceiving the simulated system from their own point of view could effectively contribute to a common understanding of the subject area [7,8].

3. Results and discussion

The scientific literature describes two methods for distinguishing the business processes under study: the principle of customer-oriented chains and product chains. Therefore, our study reflects the process of identifying an end-to-end business process for drawing up design and estimate documentation for the construction and repair of oil and gas facilities on the basis of the principle of product chains. Thus, the business process of calculating and drawing up the design estimates has been singled out, which permeates the activities of such structural departments of the organization as the sales department, the production cycle itself: the construction and finishing department, the structural subdivisions in the form of material and technical supply, and the financing and verification of received documents. Each business design process has an input and an output. At the imput, there are orders from direct customers for carrying out a particular construction service. Outputs are generated by ready-made budget documentation intended for specific clients who coordinate further actions with the management of the organization. It should be noted that the resulting business management process can also be described as inter-functional on the above mentioned characteristics.
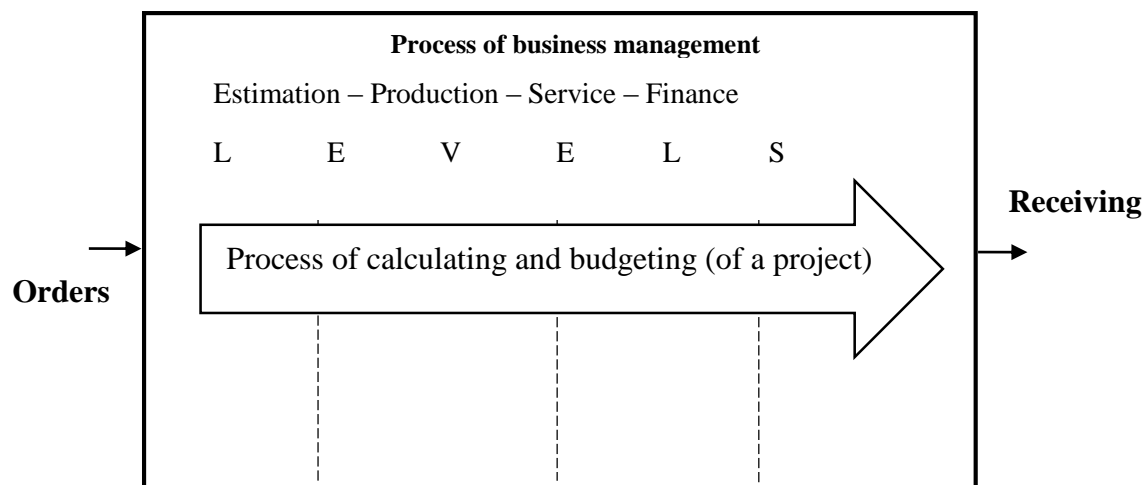
Process of business management

Estimation – Production – Service – Finance

L   E   V   E   L   S

Orders

Process of calculating and budgeting (of a project)

Receiving

Figure 2. Scheme of the cross-functional business process for the preparation of design and estimate documentation.

As Figure 2 shows, this scheme of mapping the business process as interfunctional yields a lot of conclusions about the superior integrity of the functioning of the design and budget activity and the interrelationship of its business processes, that is, all of them are interrelated and in general their target orientation is predetermined by potential customers. Therefore, the project organization can be represented as a certain production system where requests for construction services are received at the imput, and the final version of the estimate documentation is sent to the customers of the organization to confirm the services at the output. The production level that permeates the activity of all key departments of the construction organization from the moment of the customer's request to the organization (sales department) until the approval and signing of the final estimate documentation for the performance of certain construction and repair services for the oil and gas facilities is an indispensable and central element in the developed system.

The design organization performing the design estimates is a very real production system in which it can be represented in the form of a queuing system at different levels (workplace, department), since the business process of the organization is focused on servicing orders in form of a certain production and realization of the rendered service, which is of value to the potential client. Figure 3 gives a visual representation in the form of a schematic illustration of this work as a queuing system.
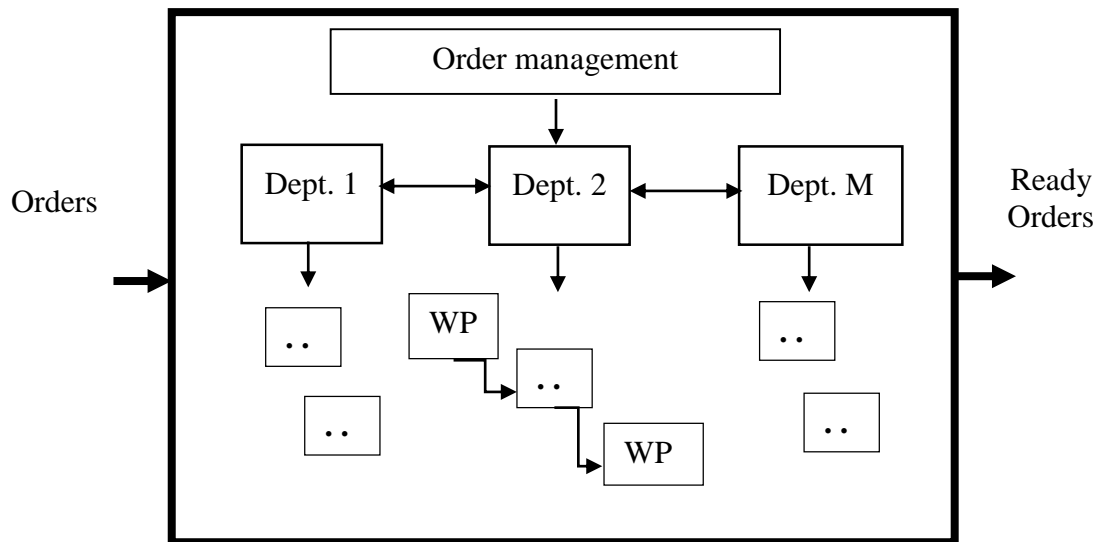

Figure 3. Project organization as a queuing system.

All orders for construction services come from potential clients and customers. Order maintenance starts from one department, ends in another, all departments are interconnected. At the output of this system, the received service is formed. At the same time, each department and workplace is also a queuing system (QS). The essential difference can only be that the existing stream of orders in this case is formed within the system, and the output streams form the results of servicing the given orders within each department (works, orders, documents, etc.).

The very formalization of the model of the business process under study will consist of a chain of sequential actions that will describe the process from all the sides: starting with the input of the business process to the output and regulating services. The input of the business process as a QS will be the number of orders (requests) for the execution of construction services, in particular, the preparation of estimates for the evaluation of ongoing services, where all the requirements of a particular customer are taken into account within the business process. The servicing department of this business process in the QS is represented by a personnel facility with their workplaces and personal computers that fulfill the orders received to compile an estimate with a given quality and a certain intensity. The queue of a business process as a QS is defined as the maximum possible number of all orders at the input in excess of those already in the process of producing the documentation. Under the output of the business process as the QS already compiled and executed design and estimate documentation will be understood, which is determined by quantitative indicators that also meet the requirements of the customer, according to the regulations of the organization.

One should not forget about the application of some restrictions, when developing this model of the business process. With some approximation, we can assume that the current order flow at the input of the simulated business process is a Poisson flow. In addition, it should be noted from the theory of probability and the theory of random processes that the use of a Poisson flow provides the hardest requirements for existing service systems. The very model of business process operations will also take into account the limit on the length of the queue. For a given business process of the specified type, there can be no more than n orders in the existing queue. It follows that if an order arrives for servicing by a business process at the moment when the same n orders already exist in the queue, then

it will not be serviced and, respectively, will not be allowed in the queue. Also, the model of the business process of drawing up the estimate documentation of a construction organization can be represented by a number of indicators that can be described by mathematical expressions used to calculate the characteristics of individual operations, that is, the business functions of this business process that can be considered as open queuing systems [9]:

- business process probability indicators;
- quantitative indicators of the business process;
- economic indicators of the business process.

Therefore, it should be noted that the main task of the developed model (based on the theory of queuing) should be reduced to establishing a rational and optimal ratio between the number of requirements entering the design department and to consider the number of servicing devices in which the total costs for maintenance and losses from the servicing channels idle would be minimal.

4. Conclusion

The development of an optimal model for the compilation of any design and estimate documentation solves not only the problems in formalizing weak points in the conduct of business, but also helps in the subsequent process of creating an automated system that is iterative, so the design model allows for sequential refinements [10]. Ideally, the business process model is built in such a way that when it is detailed, the previously constructed more general elements of the model are not changed, but only new ones are added and improved, with the connection of the work of other departments and the formalization of the activity of the organization as a whole.

The peculiarity of modeling, automation and expertise of budget documents in the oil and gas sector is receiving by the customer not only the comments to estimates, but also the corrected estimated construction cost. In this case, feedback is required from the design institutes. For each observation, the design institute corrects the estimates, sends them for a second examination, and only after the removal of all comments the customer is sent a positive opinion and a ready-made package of documents. For any oil and gas company, it is important to be able to correctly assess the economic efficiency of projects at each stage of their implementation. At the same time, the accuracy of the results, the depth of the project, the amount of resources involved depend not only on the stage of the project, but also on the tasks to be performed by the assessment, the requirements and limitations of the experts conducting such an assessment.

As part of the improvement of this model, a methodology will be systematized and developed, which will include a step-by-step analysis of the investigated business process in order to determine the optimal parameters. Therefore, the computer implementation or in other words the simulation model of this QS will be an algorithm that reflects the behavior of the QS, that is, all changes in the QS state will be reflected in time for given streams of applications that arrive at the inputs of the system, because the essence of the simulation model is to describe existing processes as they would be in real life.

References

[1] Hamidullin R I and Senkevich L B 2017 About necessity of mathematical modeling of the business process of cost estimate calculations in the construction of oil and gas facilities *Higher Educational Institutions News Neft I Gaz* **6** 139-45

[2] Conforti R, Leoni de M, La Rosa M, Aalst van der W M P and Hofstede ter A H M 2015 A recommendation system for predicting risks across multiple business process instances. *Decision Support Systems* **69** 1-19

[3] Dumas M, Aalst, van der, W M P and Hofstede, ter, A H M 2005 Introduction *Process-Aware Information Systems: Bridging People and Software Through Process Technology* (Hoboken: Wiley-Interscience) pp 3-20

[4] Harrington D 2002 *Optimization of Business Processes. Documenting, Analysis, Management, Optimization* (Saint Petersburg: ABC) 205 p

[5]   Hofacker I and Vetschera R 2001 Algorithmical approaches to business process design *Computers and Operations Research* 28 pp 1253-75

[6]   Powell S G, Schwaninger M and Trimble C 2001 Measurement and control of business processes *Syst. Dyn. Rev.* 1 **17** 63-91

[7]   Tiwari A, Vergidis K and Majeed B 2006 Evolutionary multi-objective optimisation of business processes *Proceedings of IEEE Congress on Evolutionary Computation* (Vancouver, Canada) 3091-7

[8]   Tiwari A, Vergidis K and Turner C J 2010 Evolutionary multi-objective optimisation of business processes *Advances in Intelligent and Soft Computing: Soft Computing in Industrial Applications* (Springer: Heidelberg) 293-301

[9]   Turner C J, Tiwari A, Olaiya R and Xu Y 2012 Business process mining: From theory to practice *Business Process Management Journal* **18**(3) 493–512

[10]   Hamidullin R I and Senkevich LB 2015 Automation of the work price calculation engineer construction of estimated LLC «Tobolstroyservis» *Fundamental Research* **11**(1) 110-4