Mathematical Methods of Managing Economic Sustainability of the Construction Company

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Abstract. This article presents a long-term research in developing innovative mathematical techniques of managing the contractor's economic sustainability proven by some experimental studies. The article aims at presenting some practical results of applying these techniques to the scientific community. This research presents a description of some applied mathematical models, views, and some results of their practical application in the applied field for the purposes of evaluating operational sustainability and minimizing losses in the process of managing the company. The authors have put the technology they have developed to practical use, and the article presents the results of such application. The authors have put the developed technology to practical use. Company management also means the management of power consumption, which is highly vital both for the construction and maintenance of buildings and structures. The articles also dwell on some possible improvements of managing energy consumption within the framework of the general management of company's economic sustainability, because these phenomena have a tight organic interdependence. The authors continue researching this direction in order to improve the production efficiency of the proposed technologies as well as to eliminate some drawbacks they have spotted.

1. Introduction

Current research features an utmost on the management of building production. This article intends to discuss the problem of economic sustainability of the production system of a building company. Special care should be drawn to economic efficiency in view of the management of power consumption and resources which is highly critical in relation to their dependence on the growth of power consumption. By approaching the meaning of sustainability, we are basing on how the decision makers of the management treat instability in economic processes and economic situations.

The present research includes a variety of functional sub-systems, which nature and manifestation of instability may very substantially. On the other hand, our research treats the nature of decisions versus overall risk, the decisions aiming at stabilizing the entire systems' operations.

These circumstances have influenced our choice of the problem of management of sustainability of production systems as the subject of research. The aim of research is to highlight a few mathematic techniques of the management of production system sustainability.

2. Materials and Methods

According to the world's leading researchers, such as S. Makridakis "Forecasting, Planning and Strategy for the 21st Century" [1], G. Simon, "Administrative Behavior", [2], J. Streit "Cognition, Rationality and Institutions"[3], S. A. Williams "Junior Risk Management and Insurance"[4], the basic directions of rationalizing the organization of production should be an introduction of flexible forms and techniques of production management to satisfy the customer's needs in short time, making use of some expeditious methods of developing and mastering new sorts of products that would be competitive in the world market, substantial increase in the quality of products due to applying systems of enforcing quality, an uninterrupted and stable company's operations by means of applying front-edge managementl technologies to their production processes (increasing operational sustainability).

A few authors argue that there are some objective reasons of why such requirements are most critical in the theory and practice of operational management. Like, V. V. Glukhov 'Economic-Mathematical Methods and Models in Management" [5], B. V. Gnedenko, 'Mathematics and Reliability Theory' [6], P. G. Grabowski "Risks in Contemporary Business" [7] classify company management systems basing on energy efficiency of production processes and cutting down on the costs of power resources. Among the most vital reasons of economic instability, a special part is played by the economic instability in times of transition to market economy. Evidently, instability due to production operations requires clear understanding of how it should be dealt with.

The research made by the staff of the Department of Construction Management published in the last few years is focused on developing the techniques of the management of innovations basing on the mathematical forecasting of the factors of instability and management. Thus, the work by O.V.Kliuchnikova, O.A. Pobegaylov "Rationalization of Strategic Management Principles as a Tool to Improve a Construction Company Services" [8] deals with the ways of traffic management that are closely linked to the investment policy of the engineering and management of construction of underground linearly extended projects.

O.A. Pobegaylov, G.I. Myasishcheva, O.E. Gaybarian "Organization and Management Efficiency Assessment in the Aspect of Linguistic Communication and Professional" [9] discuss the part of the company document and information at choosing the investor-customer-contractor.

3. Results

The investment- construction complex aims at the strategic target of increasing the quality of construction production that calls for sustainability in the development of building industry entities.

In times of economic instability and non-systematic crises caused by some global political, demographic, and economic processes, the main concern should be about preservation of the economic sustainability of building industry companies. Statistics shows that during the crises of 2001, 2007, and 2013-14 business losses, at some peak periods, came up to 30% of the turnover; as a result, many companies, even those with quite a long history of development and existence, lost their profitability and went out of operation[10].

Special care should be give to the company's energy dependence where production activity shows high energy consumption costs due to the growing process of power resources, thus the company's profits never cover their energy expenses. The principles of resource conservation, a choice of effective management patterns in view of power consumption efficiency play the key part in economics.

Presently, effective functioning of building industry is only possible basing on the proper use of a variety of forms and techniques of managerial and economic support of operations. Controlling is spreading out fast as one of the concepts.

The quality of construction and assembly works of the contractor is guaranteed by properly controlling every construction stage, strictly following the technological parameters of their production process and the technological regulations [9]. The process of quality control of building structures, the reliability of processes, especially those responsible for preserving the building, call for substantial investments and should include not only systematic and complex monitoring, but also measures aimed at supporting the project's maintenance characteristics [3] . This means that power consumption of the project is to be arranged basing on the principle of optimal consumption of energy, fuel (for industrial and auxiliary infrastructure facilities), water and other industrial resources. In practice, it is resource overconsumption, especially of power and fuel, that plays a key part in boosting the costs of production and maintenance. Instability in the prices of resources and incorrect distribution of resource expenses makes the contractor's business ineffective.

The shift of the mathematical model is based on the principles of system stability in the conditions of self-supporting stability of technological processes. We believe that the contractor's efficiency features a similar functionality and stability, which may also be included in the mathematical model [4,7,11].

The general stability diagram is the unity of A, B, f, d, where A – a set, interpreted as the space of initial data;

B – a set, called the solution space (conclusions).

f – solution (based on the method or model), i.e. one mapping f:A→B;

d – resilience, i.e., a nonnegative function defined on subsets of the set B and such that from $Y_1 \ni Y_2$ appears $d(Y_1) \leq d(Y_2)$.

According to the formula :

$$E = \{E(x, \theta), x \in A, \theta \in \varpi\} \quad (1)$$

– set tolerance, i.e. the system of subsets of A such that each element of the set of initial data $x \in A$ and each value of the parameter θ from a plurality of parameters ϖ corresponds to a subset E(x,θ) many of the source data. It is called the set of admissible deviations in x when the parameter value equal to θ.

Quite often, stability index D (B M) is determined by means of a metrix or the difference index (proximity index) p as set diameter Y, i.e. there appears a system of circles around the image of initial data in the solution space. In the initial data space, there's a similar system, i.e. E, i.e. the sum of allowances [1,12].

Thus, the problem of ensuring the contractor's sustainability is determined by spotting its key indexes in the zone of stability. It would be essential to note that the stability zone is never static but a dynamic factor of an uninterrupted development of the company, and it only acquires stability in the process of its constant perfection and growth [13,14].

In other words, keeping in view all the factors, including resource-and-power consumption, makes the company successful. These factors, in return, may be treated as mathematically determined values that change due to the dynamics of the company growth or drop in its efficiency.

Monitoring factors that cause instability of production may be possible by creating random and statistic models and ways of their analysis [15,16]. Such factors may be of economic, climatic, technological, social nature; they never act separately causing synergetic impacts on the construction industry [8,10]. Economic factors are most destructive here. The management and technological sustainability of the building production is understood as the company's ability to preserve working parameters within certain bounds and their ability to achieve planned results under some preset production conditions [17]. While analyzing the causes of failures in production processes, we should keep in mind whether they are sporadic or systematic, because an occasional cause may be eliminated by the worker independently, and no process has to be stopped at that. Systematic causes may evolve substantial losses due to production faults, so they require direct involvement in the production process that may end up in the total arrest of building operations and global adjustment [7]. Deviations of corresponding indices may reflect some system's misfires, in particular those relating to the erroneous choice of the contractor's power consumption policy, errors in choosing and maintaining machinery, management errors, evil intent etc. [18].

4. Discussion. Analyzing Company's Stability by Applying Mathematical Modeling

The Department workers have used the OUTSUP program to analyze nine major contractors in the construction market. It was found that most faults in the process of reconstruction of real estate projects (except those relating to new projects) were due to some technological faults either in the disassembly or in strengthening structural elements. Moreover, there should also be included failures relating to the restrained working conditions and malfunctioning engineering networks of the project being reconstructed, and also to poor management due to applying two different technologies (construction and reconstruction of an industrial facility). Reconstruction requires correct distribution of works in time and space, sequence of operations, proper machinery, a correct power consumption plan to optimize the costs of performed operations, the proper estimate of the facility functioning while it is being reconstructed[19].

Practice shows that there are cases where reconstruction was accompanied by boosting power consumption due to the heating of functioning production premises, using some special machinery, errors in choosing low-economy equipment, creating a special indoor climate to preserve the premises from the elements. The costs of such unpredictable expenses came up to 20% of all the company's expenses, according to our analysis. It is also essential to keep in mind the direction of the technological process of the main production which depends on the correct modeling of the reconstruction process of the existing industrial facility. A few reconstruction features should be considered while developing the managerial and technological models of reconstruction by using network diagrams [1,8]. The regularities of failure distribution have been properly researched by now [20]. By now, we have studied quite properly the regulations of failure distribution. Construction provides for an equal distribution of the rhythms of oncoming events, where an occasional event is studied against a certain time gap, while the equally probable factor of an event oncoming gets determined in the process of a rhythmic production cycle [19]. Currently, there exist a few approaches to forecasting the malfunctioning of the working cycle due to uncertainty factors, such as using standards oriented at territorial and corporate evaluation. The operational design process remains rather vital, because the minimal sum of resources enables creation of highly efficient managerial and technological sustainability of building production [13]. In figure 1, provides an assessment of production losses in the core activities. The dependence of the losses in only one sector - energy management.

The methods of dealing with the causes of failures include logistic methods, introduction of the system of quality control (quality management system) basing on international standards, reasonable control of power and material resources, risk management [9,10]. The key tasks of logistics are the establishment of an integrated efficient system of regulating and controlling material and data streams to ensure the high quality of material supply, achievement of maximal benefits in the changing marketing environment, and winning competitive advantages at minimal logistic expenses [14].

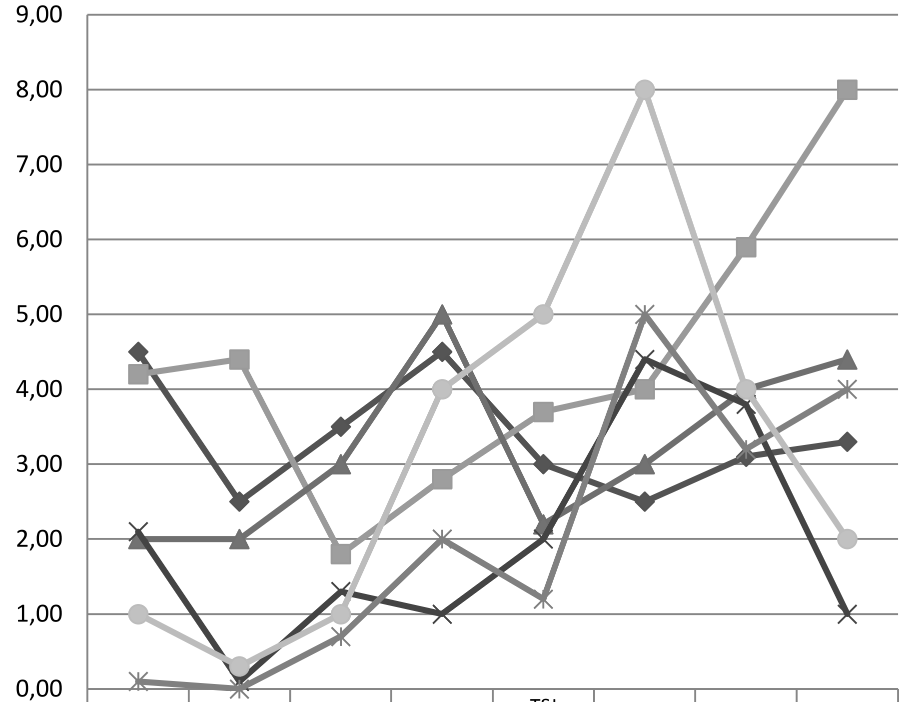
The research shows that contractor's operations, resource management, including optimal consumption of power, material and other resources, are still suffering from certain weaknesses, even where mathematical modeling is applied. To adapt to the existing standards, the contractor should utilize new effective thermal insulation materials and structures, otherwise the thickness and monetary value of the outside enclosing structures would grow enormously.

Effective thermal insulation materials, due to saving on heat resources, fully compensate for nonrecurrent expenses for newly built civil and social structures in 7-8 years, and 12-14 years for already existing structures.

In practice, expenses may not grow proportionally due to some inadequate estimates by contractors in terms of the choice of technological and structural solutions about thermal insulation. Our study shows that in a few cases the heat insulation scheme and materials have not been properly selected or assembled, thus serving as one of the examples of evident errors in company management.

The welcome outcome of developing and implementing a program of risk management should be such management where the main activity of contractors is accompanied with high sustainability and resistance against inner and outer risks. Insurance is a universal means of compensating for material risks in contractor's operations, however the current state of insurance hardly covers the risks due to a faulty usage of resources or overpricing of operations caused by ineffective patterns and models of design, erection, reconstruction, and maintenance of facilities. The high efficiency of project maintenance may result from a complex approach that includes risk minimization due to the dynamic mathematical modeling, which, up till now

has never been used in the industry, even though the need in such approaches, including the suggested mathematical model, is quite ripe.



	DonStrojTech (Construction of residential buildings)	Don-2(Construction of residential buildings)	RSK StrojTrest(Construction of residential buildings)	JEU-7 (Management and operation of a residential building)	TSJ "ARCHIMED"+(Management and operation of a residential building)	StrojServis (Management and operation of a residential building)	TSJ 27/14 (Management and operation of a residential building)	DonServis Tech (Management and operation of a residential building)
Planning errors	4,50	2,5	3,5	4,5	3	2,5	3,1	3,3
Appreciation of resources	4,20	4,4	1,8	2,8	3,7	4	5,9	8
Overspending	2	2	3	5	2,2	3	4	4,4
Incorrect selection of equipment	2,1	0,1	1,3	1	2	4,4	3,8	1
Crash	0,1	0	0,7	2	1,2	5	3,2	4
Misappropriation	1	0,3	1	4	5	8	4	2

Figure 1. Assessment of production losses in the region of an incorrect management of energy resources in the construction

5. Conclusions

Considering the above, we are ready to arrive at the following conclusions. When performing mathematical modeling of a decision-making process, it is possible to make use of the method of specific risks for a variety of functional subsystems. This method utilizes the function, earlier known as the Neuman-Morgenstern Method, but it is only applicable to explaining event risks, which are classified as "lottery". Extrapolation of the method to the sphere of events caused by the practical use of production and resource management at every multilevel stage may increase reliability. This reliability boosting factor is possible as a result of classifying the processes according to the principle of affiliation to those functional subsystems that determine the relationship of controlled processes and risk.

When applying mathematical modeling to the process of decision making, we can use the method of specific risks applicable to a variety of functional subsystems. This method utilizes the function known as the Neumann-Morgenstern functional background, but only used to explain event risks classified as "lottery". The application of this model in the process of operative management and risk modeling by using software may help effectively manage the company in view of a variety of factors accepted as a single synthetic system housing a multitude of subsystems. Here, power efficiency of the company and the facility maintained may act as a private controlled subsystem that depends on other subsystems, whose uncertainties and risks may be treated as a complex against dynamically developing situation.

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