Assessment of the synergetic efficiency of industrial companies reengineering processes

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Abstract. The relevance of the research topic is due to the fact that in the conditions of increasing global hypercompetition, it is necessary to modernize production processes on the basis of synergetic reengineering of business processes, production, technological and organizational systems. The purpose of the research is to develop practical recommendations for evaluating the effectiveness of project-synergetic reengineering processes in the system of industrial transformation of industrial companies. In this regard, the author puts forward the concept of development of industrial companies on the basis of project-synergetic reengineering of production and technological systems and business processes, and also offers a methodological assessment of the synergetic efficiency of reengineering projects, taking into account the receipt of synergetic effects. The information and empirical basis of the research is based on legislative and regulatory acts of the Russian Federation, materials of Rosstat, regional statistical services, as well as the results of the author's original research. The practical significance of the results of this study is that the proposed program-target methodology for designing reengineering processes will cover all the links of creating innovations from generating ideas to their implementation in mass production, eliminate gaps and institutional traps, overcome barriers and reduce transaction costs in industry.

1. Introduction

Analysis of industrial companies shows a low rate of renewal of fixed assets (their active part-equipment at the best Russian enterprises is updated annually by only 0.1-2.0%). The level of R & d expenditures is unacceptably low, and there are gaps in the chain "basic research – applied research – industry development – factory innovative technologies". In fact, the activities of many industry institutes, problem laboratories, and factory pilot plants have been stopped. As an alternative to the current situation, we consider the processes of industrial modernization based on synergetic reengineering of business processes, production, technological and organizational systems.

As competition and inefficiency of the production apparatus increased, the theory of reengineering and business processes (Business Process Reengineering) of production systems was developed by foreign and domestic specialists. Among foreign researchers, the most notable contributions were made by I. Ansoff, D. Akoff, P. Drucker, R.S. Kaplan, N. Lemert, D.P. Norton, M. Porter, C.K. Prahalad, J. Ridge, B. Steiner, M. Hammer, J. Champy et al. The work of K.A. Bagrinsky, S.V. Ildemenov, A.D. Kiselyov, S.N. Kolesnikova, J.I. Kuzminova, B.S. Milner, V.G. Medynsky, I.I. Mazur, I. Matveev, S.P. Nikanorov, R.M. Nureyev, E.G. Oykhman, A.N. Porshnev, E.V. Popov, Y.F. Tlnova, Y.F. Tlnova, E.F.
Telman [1-8]. The new approach to the problems of reengineering production systems is connected with the concept of self-organization and the theory of synergies.

Attention to self-organization, synergies, emergence is due to the complexity of business processes and production systems, increasing the level of uncertainty, imbalance, non-linear dynamics of the development of production systems. Programs and projects of modernization, reengineering, transition to innovative development strategies run into an insufficient level of theoretical research of self-organization, synergies and emergence in production systems. The manifestation of the factors of globalization and hyper-competition requires the development of new approaches to ensure socio-economic and technological development through the formation of new concepts of project - synergistic reengineering of production systems in industry.

Theoretic and methodical provisions of design-synergistic reengineering of production and technological systems are a scientific-organizational concept of overcoming organizational, technological and management backlog by translating the production system from the trajectory of small increments "from achieved" to the trajectory of continuous transformations through the implementation of synergistic projects with the inclusion of synergistic development factors and the formation of synergistic effects.

The model includes four blocks of functional structural changes (reengineering) in production systems:

- The "organizational- synergistic integration" unit consists of vertical, horizontal, network integration subsystems and implements organizational-administrative, functional and autowave resources to produce economies of scale, animation and network diffusion of innovation.
- The "Synergetic interactions" block consists of subsystems for the development of transaction links, price transfers, and strategic partnerships and implements the resources of cooperation, cost resource, and potential for mergers and acquisitions to produce phase, cumulative, and resonant effects. Phase effects are associated with an increase in transaction costs as a result of the complexity of production systems; cumulative effects are due to an increase in the number of management levels in complex production systems; resonant effects are caused by synchronization of all processing processes in complex production systems.
- The "Synergetic orientation and clusterization" block implements the clusterization effect, when enterprises coordinate actions, focusing on the "anchor" enterprise of the region. The effect of mobilization can be obtained by coordinating the missions, goals and objectives for the strategic future, based on the interests of the "anchor company". The effect of autocatalysis can be obtained by coordinating the marketing strategies of dealers, distributors, and franchisors, based on the strategy of the "anchor" enterprise.
- The block "synergy of innovative development" implements the "threshold effect", which is formed by overcoming the critical threshold of intellectual and information potential in large corporations that are able to create powerful innovation and technological and scientific and technical centers to compete with the world market leaders, when enterprises coordinate actions, focusing on the "anchor" enterprise of the region.

2. Research methodology and data
Synergistic efficiency - the classification of the synergistic effect derived from reengineering to a specific scale of measurements, in the most general form can be presented:

\[ \text{Es} = \frac{\Delta R}{\Delta C}, \]

where \(\Delta R\) - increments of the production system's performance through reengineering;
\(\Delta C\) - the cost of implementing reengineering of the production system.

In the most universal form, the result of reengineering (synergetic effect) can be used to evaluate the result of the Cobb – Douglas production function in the interpretation of J. Tinbergen, taking into
account the non-linearity of production factors and the impact of scientific and technological progress (basic innovations):

$$\Delta E_{L,K} = A \times L^\alpha \times K^\beta,$$

(2)

where L and K – factors of production (labor and capital);

$\alpha, \beta$ - elasticity of factors of production, or scaling normative constants;

$A$ – coefficient, which is a function of time and technological progress $A = f(t, \lambda, t)$, where

$\lambda, t$ - coefficient that takes into account the non-linearity of the innovation effect (synergetic effect), i.e., the rate of technological progress:

$$A = Me^{\lambda t},$$

(3)

where e - the base of natural logarithm; M - the target function of management decisions (management aim), i.e. in this case, reengineering projects.

As a target function M can be: 1) value added resulting from reengineering $\Delta EVA$, 2) net profit before tax $\Delta EBITDA$, 3) increment of capitalization $\Delta WACC$, etc. Thus, the synergetic effectiveness of reengineering projects can be expressed depending on the goals to be solved in the projects, such as

$$E_{s1} = \frac{\Delta EVA \times e^{\lambda t}}{\Delta (L^\alpha + K^\beta + M^\phi)}$$

(4)

$$E_{s2} = \frac{\Delta WACC \times e^{\lambda t}}{\Delta (L^\alpha + K^\beta + M^\phi)}$$

(5)

$$E_{s3} = \frac{\Delta EBITDA \times e^{\lambda t}}{\Delta (L^\alpha + K^\beta + M^\phi)}$$

(6)

or in general form:

$$E_{s} = R \times e^{\lambda t} / \Delta (L^\alpha + K^\beta + M^\phi)$$

(7)

where $R$ - the result of a synergistic re-engineering project, and the denominator is the material, labor and financial costs of achieving it.

In reengineering projects implemented at the expense of investment, material, labor and financial costs can be attributed to the amount of investment necessary to obtain a synergistic effect. Then the synergetic efficiency of the reengineering project in the most universal form will be:

$$E_{s} = (R \times e^{\lambda t}) / \text{Investments}.$$  

(8)

In this formula, $\lambda$ (the coefficient that reflects the rate of technological progress according to J. Tinbergen) roughly corresponds to the tangent of the angle between the linear (routine) trajectory and the trajectory of transition to the exponential curve that characterizes the synergetic effect.

Based on the proposed concept and model of synergistic reengineering using the reviewed organizational-economic mechanism for the implementation of the reengineering project, the synergetic effectiveness of which, calculated on the above methodical development is estimated as doubling the sales volume of industrial companies.

The target function of synergetic reengineering of the production system of PJSC “Surgutneftegaz” is the growth rate of value added $\Delta EVA$, as an indicator that best meets the requirements of national economic efficiency of the economy. Calculation formula for evaluating the synergetic efficiency of reengineering a production system:

$$E_{s} = E_{s1} + E_{s2} + E_{s3} + E_{s4} + E_{s5},$$

(9)

where $E_{s}$ - the synergetic effectiveness of the reengineering of the production system;

$E_{s1}$ - efficiency of transition to a new technology platform (technological reengineering);

$E_{s2}$ - efficiency of economic reengineering of the production system;

$E_{s3}$ - efficiency of organizational reengineering of the production system;

$E_{s4}$ - efficiency of financial reengineering of the production system;

$E_{s5}$ - efficiency of social reengineering.

The formula is used to assess private performance:
\[ E_i = \Delta EVA \times e^{\lambda t}/I \] (10)

where \( E_i \) - effectiveness of a private reengineering subroutine;

\( \Delta EVA \) – Increment during \( t \) of value added in a private reengineering sub-program; \( \lambda \) - the set rate of increase of the intellectual component in the cost of production;

\( I \) - the amount of investment in rubles for the implementation of a particular program.

To perform calculations related to the evaluation of the synergetic efficiency of the "program of reengineering of the production system of PJSC "Surgutneftegaz", based on the project-synergetic approach, the information system "Project Synergetic Reengineering System" was developed, which includes the assessment of \( \Delta EVA \) depending on the annual volume of investments, the annual increase in labor productivity (\( \lambda \)) due to reengineering (total for all subsystems for 1 year). The volume of investment, the growth of \( \Delta EVA \) and the growth of labor and the annual values of synergetic efficiency are presented in table 1.

| Years | The amount of investment under the program, billion rub. | The growth of \( \Delta EVA \) through the implementation of the program, billion rub. | Increase in labor productivity (\( \lambda \)) | Synergistic efficiency, rub. \( \Delta EVA \) per 1 rub. of investment |
|-------|--------------------------------------------------------|----------------------------------------------------------------------------------|---------------------------------------------|-------------------------------------------------------------|
| 2015  | 0.8                                                    | 0.85                                                                             | 1.00                                        | 1.06                                                         |
| 2016  | 2.35                                                   | 1.25                                                                             | 1.11                                        | 1.67                                                         |
| 2017  | 2.67                                                   | 1.43                                                                             | 1.14                                        | 1.71                                                         |
| 2018  | 2.74                                                   | 1.56                                                                             | 1.18                                        | 1.86                                                         |
| 2019  | 2.86                                                   | 1.75                                                                             | 1.24                                        | 1.92                                                         |

The proposed method of assessing the synergistic effectiveness of the reengineering processes of industrial companies will allow to develop a program of reengineering of the production system and, as a result, allows to increase the amount of added value in comparison with the situation "before the project" almost twice (from 0.85 to 1.75 billion rubles), increase the volume of production by 2 times, increase productivity by 25%. The synergistic efficiency will increase by 1.92 times.

3. Conclusions and recommendations on the results of the case-stage

The concept of project – synergetic reengineering of complex production systems and business processes is Proposed, combining project, process and synergetic approaches and a model of project-synergetic reengineering, taking into account the specific features of industry, to make the transition to a new technological level of development through the development and implementation of breakthrough synergetic projects, including positive feedback, and new mechanisms.

We propose an organizational and economic mechanism for generating synergetic effects in the process of reengineering complex production systems using the reengineering model, which includes, along with negative feedback, positive feedback consisting of development institutions, institutional relations that affect the formation of synergetic effects as a system set of private efficiencies, mechanisms coordinated in space and time, resources and the effects created by them.

A methodological assessment of the synergetic efficiency of reengineering projects is Proposed, taking into account their mission, system of goals (target function), non – linearity of development dynamics, elasticity of production factors, and qualitative structural and phase transformations in the process of reengineering complex production systems and business processes.

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