# Modeling operation of mechanism of holistic management of technological processes at enterprise

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**Abstract.** Enterprises applying modeling and technological process management approaches represent a sector of a new innovative economic system. First of all, they are innovators using innovative proposals and various resources to solve practical problems. Their work leads to balanced positive technological changes. In other words, they constitute industrial entrepreneurship with innovative goals and vice versa - innovative entrepreneurship with industrial objectives. It should be noted that the mechanism of holistic management of technological processes at the enterprise combines a traditional industrial organization of production, an innovative and technological enterprise. The enterprise borrows industrial targets from the latter one, an innovative component - from innovative activity and entrepreneurial approaches to holistic management - from a commercial firm.

## 1. Introduction

The aim of the research is to build and simulate the mechanism of holistic control of technological processes necessary for industrial enterprises and entrepreneurial structures to create or improve production technologies based on the direction aimed to achieve positive changes in the production of goods. The results of approbation of this mechanism and modeling of technological processes are given in the article.

When constructing and modeling the mechanism of holistic control of technological processes at the enterprise, based on the constructed models for improving production technologies, the basic models of technological processes have been developed, taking into account the distinctive properties of the proposed mechanism.

## 2. Materials and methods

In the mathematical description and modeling of technological processes or objects, it is advisable to use the matrix apparatus. This is due to the fact that the matrix is a table, and this form of recording data and results is, firstly, very clear, secondly - convenient for introduction into PC and, thirdly, operations on matrices work well for obtaining empirical results [5].

The multiplication of the original transposed matrix results in a new square matrix that reflects the rows (i-th elements of the matrix - goals and tasks) both vertically and horizontally [4]:

$$D_{mn} \times C_{nm} = H_{mm}, \qquad (1)$$

in which $C_{nm} = D_{mn}^{T}$, i.e.:

$$D_{mn} \times D_{mn}{}^{T} = H_{mn}. \tag{2}$$

The resulting matrix makes it possible to assess the significance of each goal and objective of the innovation activity of companies, provides an opportunity to establish their priority, determines the level of social orientation of the company, the innovative focus of various subsystems of its activities.

Due to the fact that the rows and columns of the matrices are involved in the DC product in an unequal way, and $DC \neq CD$, then when multiplying the transposed matrix by the original one, one obtains:

$$D_{mn}{}^{T} \times D_{mn} = H_{mn}, \tag{3}$$

The transposed matrix is denoted by $D^{T}$ or D':

$$\text{If D} = \begin{pmatrix} dep_{11} & dep_{12} & \cdots & dep_{1n} \\ dep_{21} & dep_{22} & \cdots & dep_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ dep_{m1} & dep_{m2} & \cdots & dep_{mn} \end{pmatrix}, \tag{4}$$

$$\text{then D}^{T} = \text{D'} = \begin{pmatrix} dep_{11} & dep_{21} & \cdots & dep_{m1} \\ dep_{12} & dep_{22} & \cdots & dep_{m2} \\ \cdots & \cdots & \cdots & \cdots \\ dep_{1n} & dep_{2n} & \cdots & dep_{mn} \end{pmatrix}. \tag{5}$$

In this case, a matrix method is used to determine the type of process control at the enterprise.

To compare the contribution of each production technology or ranking, prioritizing, revealing the most significant goals and objectives, conjugation and multiplication of matrices is used.

The matrix constructed according to the principle - (i-th element) - goals are located horizontally, vertically (j-th element) - the production technology of the organization - can be transposed into a matrix in which a production technology organization (j-th element ) will be located horizontally, and goals and / or tasks (i-th element) will be located vertically.

$$\text{D} = \begin{pmatrix} dep_{11} & dep_{12} & \cdots & dep_{1n} \\ dep_{21} & dep_{22} & \cdots & dep_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ dep_{m1} & dep_{m2} & \cdots & dep_{mn} \end{pmatrix}, \tag{6}$$

where $dep_{ij}$ – real numbers (i = 1, 2,..., m, j = 1, 2, ..., n), called elements of the matrix, which reflect the contribution of production technology to the achievement of the goal (solution of the planned task);

i and j – respectively, the indices of the row (goal, task) and the column (production technology). In this case, product m x n of the number of rows by the number of columns is called the size of matrix D. Often matrix (1) is written in a short form:

$$\text{D} = \|dep_{ij}\|, \text{ i} = 1, 2,..., \text{m}, \text{j} = 1, 2, ..., \text{n} \tag{7}$$

Multiplying the original matrix by the transposed one allows us to obtain a new square matrix reflecting the rows (i-th elements of the matrix - goals and tasks), both vertically and horizontally.

Goals of holistic management of technological processes at the enterprise for this research include: satisfaction of executive management with the technology of production management; labor safety/technological package (equipment); ecological compatibility of the technological process/economical resource consumption; development of technologies within the industrial cluster; technological equipment within the organization.

It should be noted that the authors have chosen specially an equal number of goals for the holistic management of technological processes at the enterprise for the simpler addition of matrices, as well as for the most understandable definition of the contribution of each production technology to

achieving the goals of building and modeling the mechanism of holistic control of technological processes at the enterprise.

## 3. Results
Approbation of research results has been carried out at enterprises in the Russian Federation; let us call them enterprises A and B, respectively.

Thus, the main qualitative indicators, which can describe the "portrait" of enterprises of the Russian Federation using innovative technological processes, are presented in Table 1.

**Table 1.** The main holistic indicators of the effectiveness of application of technological processes at the enterprise

| Field of activity | Qualitative holistic indicator of effectiveness |
|---|---|
| Technological package (equipment) | Coefficient of holistic of technological activity ($H_{ta}$) |
| Innovative activity | Coefficient of holistic of innovation activity ($H_{ia}$) |
| Technology development within industrial cluster | Holistic indicator of technology development efficiency within an industrial cluster ($H_{man}$) |
| Financial activities | Coefficient of day-to-day liquidity and asset coverage ($Hea = f(Cdl; \text{К}C_{ac})$ |
| Effective resource use | Holistic indicator of efficiency of resource consumption ($H_{wc}$) |
| Management satisfaction with the technology | Holistic indicator of satisfaction of executive management with the technology of production management ($H_{sat}$) |
| Holistic efficiency of management of technological processes at the enterprise $HE_y = f(H_{ta}; H_{ia}; H_{man}; H_{fa}; H_{wc}; H_{sat})$ | |

Thus, analyzing Table 1, it should be noted that the holistic indicator of satisfaction of executive management with production technology in the organization ($H_{sat}$) could be represented as a product of the information transfer speed ($S_i$), its availability ($A_i$) and quality ($Q_i$). All this will allow achieving the least distortion of information flows in the organization and the holistic management of them.

Thus, the formula for holistic efficiency as a whole ($HE_y$) is as follows (formula 8):

$$HE_m = \sqrt[6]{H_{sa} \times H_{in} \times H_{hr} \times H_{ftn} H_{mm} H_{im}}, \qquad (8)$$

where $H_{ta}$ – holistic indicator of technological activity;

$H_{man}$ – holistic indicator of the effectiveness of human resource management at a socially oriented innovation enterprise;

$H_{wc}$ – holistic indicator of technology development efficiency within an industrial cluster;

$H_{sat}$ – holistic indicator of satisfaction of executive management with the technology of production management;

$H_{ia}$ – holistic indicator of innovation activity;

$H_{fa}$ – holistic indicator of finance activity.

## 4. Conclusion
Thus, holistic management of technological processes of the enterprise in the Russian Federation will be defined as the product of all qualimetric indicators of the holistic performance of certain areas of production technology. At the same time, the above-mentioned methodological approaches to modeling and efficiency of functioning of technological processes have important theoretical and practical significance both for understanding the most important areas of their functioning and for practical research at the

level of cluster development by technological processes at the enterprise. Let us carry out directly modeling of technological processes on the basis of the holistic approach.

Table 2 shows the modeled innovation matrix of the technological process of Enterprises A and B.

**Table 2**. Modeled innovation matrix of technological process of Enterprises A and B.

| | Personnel division | Sales division | IT division | Marketing division | Assets Logistics | Production | Account section | Chief executive |
|---|---|---|---|---|---|---|---|---|
| **Enterprise A** | | | | | | | | |
| Creation of innovative products / services | 0 | 1 | 2 | 1 | 0 | 2 | 1 | 1 |
| Use of innovative approaches in technological processes | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Mastering of innovative product / service by consumer | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 0 |
| Commercialization of innovative product | 0 | 2 | 1 | 2 | 2 | 0 | 0 | 0 |
| Investing in latest production technologies / automation tools | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Enterprise B** | | | | | | | | |
| Creation of innovative products / services | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 2 |
| Use of innovative approaches in technological processes | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 |
| Mastering of innovative product / service by consumer | 0 | 2 | 1 | 2 | 2 | 0 | 0 | 1 |
| Commercialization of innovative product | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 |
| Investing in latest production technologies / automation tools | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 |

Analyzing the innovative matrix, it is worth noting that Enterprise A is an innovative holding using innovative production technologies; in this connection, innovations play a decisive role in its activity. The entire production process of the enterprise is built on innovative technological approaches; therefore, according to the data of the holistic approach, the target values for all subdivisions of Enterprise A are 2 points.

"Creation of innovative products / services" engages many divisions of the enterprise. For example, the main development of innovations occurs in production, and programmers of the information technology department code new programs for each specific order in order to optimize production technology; so in Figure 1 they are assigned 2 points each.

The remaining departments are connected with the technological direction indirectly: sales and marketing department - through studying the needs of the market; through accounts department – pass the means allocated for manufacture; the director determines the general directions of innovation development (1 point each).

Analyzing figure 2, one can note the following: the goal of "satisfaction with technology of production management" is implemented by the director and the department of innovation (2 points). The other units are indirectly connected, since people work everywhere, for satisfaction with the work of which the activities of these units are directed.

To this end, various innovative programs within the organization aimed at technological improvement implemented at Enterprise A are closely related. Several times a year, meetings are held at this enterprise where the management of Enterprise A is considering the technological state of production: from upgrading the technical systems to implementation means of automation. Also, the

usual practice at the analyzed enterprise is to pay employees who offer new innovative ways of using production technologies. Production technologies at Enterprise A are constantly being paid attention to by management, so the level of commercialization of the innovative product is high enough.

It is necessary to note a sufficiently high level of development by consumers of an innovative product at Enterprise B, in which there is a complete package of an innovative component of production technology, as well as the use of innovative approaches in technological processes. In the main, this direction is dealt with by the department of innovation; therefore in the matrix of Figure 2, it has 2 points.

Thus, the holistic efficiency of management of technological processes control is $H_{manX}$=49.8% at Enterprise A and $H_{manY}$=86.6% at Enterprise B.

Therefore, one can conclude that Enterprise B does not need additional actions for the holistic management of technological processes at the enterprise despite the fact that some areas of functioning are not developing enough (for example, innovation and production).

Analyzing the holistic management of Enterprise A based on the results of the simulation, it is worth noting its low level (49.8%). Consequently, at this production enterprise, to increase the level of functioning of technological processes, it is necessary to apply the modeled mechanism of holistic management.

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## References

[1]   Parahina V N, Boris O A, Bezrukova T L, Shanin I I 2014 State support for creation and development of socially oriented innovative enterprises *Asian Social Science* **10 (23)** 215-222

[2]   Bezrukova T L, Morkovkina S S, Russia B B, Shanin I I, Popkova E G 2013 Methodological approach to the identification of predictive models of socio-economic processes for investment and innovative development of enterprises *World Applied Sciences Journal* **27(11)** 1443-1449

[3]   Radievskii M V 2009 *Organizatsiya proizvodstva: innovatsionnaya strategiya ustoichivogo razvitiya predpriyatiya: Uchebnik* (Moscow: INFRA-M)

[4]   Baldin K V 2012 *Upravlenie riskami v innovatsionno-investitsionnoi deyatel'nosti predpriyatiya: uchebnoe posobie* (Moscow: Dashkov i K)

[5]   Shemyakina T Yu 2012 *Sistema upravleniya innovatsionnoi deyatel'nost'yu predpriyatiya: ucheb. posobie* (Moscow: FLINTA: Nauka)

[6]   Prigozhin A I 2003 *Methods of development of the organizations (*MTsFER)

[7]   Parakhina V N 2012 *Strategic management: textbook* (Moscow: Knorus)

[8]   Parakhina V N 2014 *Bases of the theory of management of the organization: Manual for higher education institutions* (Stavropol).

[9]   Morozov Yu P 2007 *Innovations at the enterprises and their introduction* (N. Novgorod)

[10]  Popkova E G, Shevchenko A N, Kirillova S S 2013 Procedure of formation of the small innovative enterprises with allocation of organizational, economic and social and psychological components *Polythematic network electronic scientific magazine of the Kuban state agricultural university* **89** 1242-1252

[11]  Kalyugina S N 2011 Strategic social alliances of the industrial enterprises and their influence on development of social responsibility of the Russian business. *Russian business* **2**

[12]  Vorontsova O G 2008 Role and value of image in formation of competitiveness of the modern organization. *Social and economic and technical systems: research, design, optimization* **9**

[13]  Ansoff I Kh 1989 *Strategic management* (Moscow: Ekonomika)

[14]  Abrameshin A E, Aksenov S N, Voronina T P, Kornyukhin S V, Molchanova O P, Tikhonov A N, Ushakov M A 2003 *Management of the innovative organization: Manual* (Moscow:

Evropeiskii tsentr po kachestvu)

[15] Vasil'eva E V 2011 Problems of management of innovative development of the enterprise. *Scientific messages* **15**

[16] Parakhina V N, Novlkova E N 2013 The features of innovation in the stavropol region *Theory and practice of management of the organization as a social and economic system: the identification, analysis and resolution of problems formation. Proceedings of the International Conference ed. P.G. Isaeva* (Finland, Helsinki: IsaevaKhel'sinki)

[17] Vasiltsova V M, Dyatlov S A, Vasiltsov V S, Bezrukova T L, Bezrukov B A 2015 Methodology of management innovation hypercompetition *Asian Social Science.* **11(20)** 165-169

[18] Parakhina V N 2012 Multiplicative effect of application of an innovative form of the organization of economic systems. *Innovative Messenger Region.* **3** 1-6

[19] de Melo F, Maslennikov V V, Popova E V, Bezrukova T L, Kyksova I V 2015 Quantitative analysis in economics based on wavelet transform: a new approach. *Asian Social Science* **11 (20)** 66-73

[20] Parakhina V N, Boris O A 2012 Interrelation of management of the industrial company with problems and sources of innovations. *Social and economic phenomena and processes* **3** 74-79