Economic-mathematical simulation modeling of management and innovative activities of the industrial enterprises

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Abstract. The essence of transformational processes which happen in the Russian economic system now consists in "diffusion" of innovative business in the system of the economic factors causing changes in the market relations. These transformations, first of all, are shown in acquisition by production and the market of social orientation. Respectively more and more relevant are socially oriented innovative enterprises (SOIE) which are developed and introduce in production the new technologies and products making long-term positive impact on level of quality of life and welfare of the population. When carrying out imitating modeling processes of economic-mathematical modeling can be divided into a number of stages: identification of an object, the specification of model, identification and assessment of specific signs of model, definition and check of interrelations between them, and their configuration, the mathematical description. At the same time all cycle is usually repeated several times, and in each cycle the mathematical model is specified, in particular, if it is about the model important for practical calculations. In this case additional requirements for implementation of algorithmic technology and programming are imposed to it. For achievement of goals in a research the mathematical description on the basis of the device of matrixes is used. In the course of carrying out economic-mathematical modeling the matrix device at creation of mathematical matrixes was used, for the description of type socially oriented business of structure of holistic management.

1. Introduction
Socially oriented innovation business belongs to a practical combination of innovations, creativity and opportunities for a solution of the major social and ecological tasks. Social business is concentrated on conversion of market economy which business purposes are basic reasons of poverty, marginalization, an unsatisfactory status of an ecological system and the accompanying loss of human dignity. Socially oriented innovation business can provide the innovative development on the basis of creation of the non-profit or commercial organizations which as basic function have achievement of steady positive changes in economy. At creation of models at each their stage certain and major rules of their implementation, check are followed. At the same time, flaws come to light and eliminated, it is possible to carry four types of defects to the most typical: inclusion in model insignificant (for this task) variables, not inclusion in model of essential variables, insufficiently exact assessment of model parameters, shortcomings of structure of model, i.e. the wrong determination of dependences between variables, and
in case of optimization — dependence of the accepted criterion on the managed and uncontrollable variables [1,2].

Complicating model to make it more exact and detailed, it is necessary to know whether the received accuracy of results compensates application of highly productive computer facilities. To the contrary, deciding to exclude some element from model to make it simpler, it is necessary to estimate losses in its reliability i.e. whether they will be more expensive, than a prize from simplification of calculations [3].

2. Materials and method

In the course of the mathematical description the matrix device is used, it is connected with the fact that a descriptive part of model is presented in a tabular style. The matrix type of fixing of basic data and interpretation according to the discharged results, first, can be seen in very evident way, secondly, it is represented very convenient for application in computing software, and, thirdly, representation of material in the form of matrixes allows to accumulate the available massif of the received empirical results.

Because management of innovative activity passes through various subsystems of the organization, the specified matrixes has to be created a little (D, C, etc.), at the same time the description of the integrated system is executed with use of the device of addition of matrixes (1) [4,5]:

\[
D_{mn} + C_{mn} = H_{mn} = \begin{pmatrix}
d_{11} + c_{11}d_{12} + c_{12} \cdots d_{1n} + c_{1n} \\
\cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \\
\end{pmatrix}.
\]

Rather widespread departments of rather large business of firm, it is necessary to consider such: human resources departments; sales; information technologies (analytical); marketing; supply. Also we consider it expedient to allocate still the main and auxiliary production, accounting service and the director of the company.

The specification of divisions depends on features of functioning of SOIP. In the specified matrixes departments which theoretically are available, from our point of view, in the most part of the socially oriented companies are shown [6].

For assessment of a contribution of each division by means of ranging, establishment of priority criteria, allocation of the most significant purposes and tasks, it is possible to use transposing and multiplication of matrixes. Multiplication initial transposed matrixes leads to receiving a new square matrix which reflects lines (i.e. elements of a matrix are the purposes and tasks) both down, and across [7,8]:

\[
D_{mn} \times C_{mn} = H_{mn},
\]

in which \( C_{mn} = D_{mn} \times T \)
i.e.

\[
D_{mn} \times D_{mn} \times T = H_{mn}.
\]

The received matrix allows to estimate the importance of each purpose and problem of innovative activity of the companies, gives the chance to establish their priority, to determine the level of social orientation of the company, innovative orientation of various subsystems of its activity.

Or, because lines and columns of matrixes participate in work DC unequally, and, and at multiplication of the transposed matrix on initial, we receive [9]:

\[
D_{mn} T \times D_{mn} = H_{mn}.
\]

Thus, we will receive the new square matrix reflecting divisions of the company which carry out innovative activity, both down, and across. Such matrix shows a contribution of each structural division to holistic development of the company.
3. Results and Discussion

The mechanism of holistic management to the socially oriented innovative enterprises consists in the choice of holistic management decisions on each sphere of activity of the enterprise depending on the SOIP model. The choice of solutions of administrative character (or scenarios of actions) is made depending on importance of the concrete direction for achievement of the defining purposes of each model of the socially oriented innovative enterprise [10].

The choice of scenarios needs to be established from priority of the certain areas on the SOIP models which are defined in the expert way in each direct company. At the same time the general vision of set of areas and their interrelations is considered.

Options of the created interrelations which are received by authors of the project for a number of the socially oriented innovative organizations are presented in table 1.

| Table 1. Priority of certain areas depending on the SOIP model |
|---------------------------------------------------------------|
| Area of SOIP type | Built-in model | The integrated model No. 1 | The integrated model No. 2 | External model No. 1 | External model No. 2 | External model No. 3 |
| Marketing        | 4              | 4                           | 2                           | 3                   | 2                   | 3                   |
| Personnel        | 3              | 2                           | 4                           | 5                   | 3                   | 5                   |
| Social activity  | 1              | 1                           | 1                           | 1                   | 1                   | 1                   |
| Innovations      | 1              | 1                           | 1                           | 1                   | 1                   | 1                   |
| Finance          | 5              | 3                           | 5                           | 4                   | 4                   | 2                   |
| Information      | 2              | 5                           | 3                           | 2                   | 5                   | 4                   |

According to table 1 it is visible that, the created square matrix reflects all divisions business of structure, participating in innovative activity, as on vertical, and on the horizontal plane. The presented square matrix allows to define structure of innovative activity in a section of divisions business of structure for holistic development of the organization [11].

In figure 1 the example of visual interpretation of an innovative matrix and a social matrix of the built-in type of the socially oriented innovative enterprise is given.

| Creation of innovative products / services | 0 | 0 | 2 | 0 | 2 | 1 | 1 |
| The use of innovative approaches in technological processes | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Mastering of innovative product / service by consumer | 0 | 2 | 1 | 2 | 1 | 0 | 0 |
| Commercialization of an innovative product | 0 | 2 | 1 | 1 | 1 | 0 | 0 |
| Investing in the latest production technologies / automation tools | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Creation of innovative products / services | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| The use of innovative approaches in technological processes | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Mastering of innovative product / service by consumer | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| Commercialization of an innovative product | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Investing in the latest production technologies / automation tools | 2 | 1 | 1 | 1 | 1 | 1 | 1 |

**Figure 1.** Approximate type of an innovative matrix (below) than a social matrix at identification of the SOIP built-in type.
During the research of the socially oriented innovative organization within the holistic concept we created innovative (type A) and social (type B) matrixes of the companies. They characterize a contribution of each division to realization of goals of firm. For an overload exception unnecessary information, by us excluded other purposes of the organization, are left only social and innovative.

It should be noted that a set of target parameters and extent of their realization on divisions is specific to each model of the socially oriented innovative company.

In matrix cages in the drawing 1 figures specified the level of realization of target indicators of the company by structural units of SOIP. It is necessary to tell what "0" - means, absence, not achievement by the relevant division of the socially oriented innovative organization of noted purpose; "1" means that the objectives are achieved fragmentary; "2" specifies that the purpose is basic for the specified division. Level size in points is appropriated to each division or the director, or it becomes in the expert way, with the purpose to increase in the future effectiveness of work of SOIP [12].

Considering creation of innovative products in SOIP with the built-in model, it is possible to note that the biggest contribution is made by such divisions as the department of information technologies and services connected with production (assessment - 2 points), but estimates can change depending on a type of the realized innovations. The accounts department and the management are connected with the innovative purpose is mediated, the director – making management decisions on acceptance of innovative goods or service in production, and the accounts department estimates financial and material resources necessary for this purpose (as a result, they got 1 point according to their contribution).

Consumption by the client of a new product / service made by the organization with the SOIP built-in model is carried out by means of department of sales/sale (there is a contact with the real/potential client) and department of marketing (through the system of advertizing campaigns and advance of goods/service). Therefore, about 2 points in a matrix of innovative type when determining SOIP are appropriated to these divisions.

The feature of matrixes of the SOIP built-in models can be characterized through their obvious social orientation. Work of all departments of the company is aimed at growth of satisfaction of personnel with the activity that it is necessary to consider one of the main directions of development of the organizations of this SOIP type (such situation is confirmed by the highest points on the presented social purpose).

Important activity of the organization with the SOIP built-in model by definition includes social programs of the company which are supported directly by the director and human resources department (respectively in figure 1 about two points are appropriated to them). Other structural units only suffer consequences of these decisions (receive on one point).

When determining value of each purpose for the studied SOIP type it is necessary to execute summation of points on productive vectors of matrixes of A and B (5) [13, 14].

\[
A_1 = \begin{pmatrix}
0 & 0 & 2 & 0 & 0 & 2 & 1 & 1 \\
2 & 2 & 2 & 2 & 2 & 2 & 2 & 2 \\
0 & 2 & 1 & 2 & 1 & 0 & 0 & 1 \\
0 & 2 & 1 & 1 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{pmatrix}
\] (5)

It is possible to note that as the most significant innovative purpose in business to structure with the integrated SOIP model, approach on realization of an innovative vector in production and innovative activity acts (receive 16 points from 16).

In the course of assessment of structure of innovative activity for achievement of the goals of a matrix of group A, taking into account identification of the SOIP built-in type, there are received values of priority vectors on vertical plane (6).
Thus, the crucial importance in development of innovative activity is played by the structural divisions business of structure which are engaged in selling of innovative products since these divisions realize directly innovations, on the basis of developments of department of IT (this directions have on 6 points) providing uninterrupted operation of activities for formation and commercialization of innovative activity.

In the same way it is necessary to conduct a research of an innovative matrix of group B having the SOIP (7) built-in model [15].

In the presented innovative matrix the customer satisfaction of the made innovative products (16 points), taking into account the directions of safety of production and application of social programs in business to structure acts as the most significant social priority (To each direction – 10 points).

The most powerful contribution at achievement of specific goals is made by the head (nine points from 10, down) and also HR department and production divisions (get six points respectively). It should be noted that in bigger quantity of cases in the organizations with the SOIP built-in type the involvement of management into social work of firm is very significant and fluctuates from "1" to "2" depending on loading of the director and the sizes of firm.

4. Conclusion
It is obvious that the built-in model is in essence characterized by high complex innovative and social orientation therefore has the greatest total number of points in both directions.

In the course of the research, we did similar calculations with the remained SOIP models, the overall innovative and social effectiveness of departments of all types is shown in table 2.

| Table 2. Total social and innovative effectiveness of the SOIP basic types |
|-----------------------------------------------|
| SOIP model                  | Total on all SOIP models | Personnel division | Sales division | IT division | Marketing division | Assets | Logistics | Production | Account section | Chief executive |
| Built-in model              | 81                      | 8                 | 10             | 10          | 12             | 8     | 8         | 10         | 8           | 13            |
| The integrated model No. 1  | 57                      | 7                 | 7              | 7           | 7              | 7     | 7         | 7          | 7           | 8            |
| The integrated model No. 2  | 79                      | 7                 | 11             | 9           | 13             | 9     | 8         | 8          | 8           | 14           |
| External model No. 1        | 59                      | 5                 | 7              | 9           | 8              | 7     | 8         | 6          | 9           | 9            |
| External model No. 2        | 62                      | 7                 | 5              | 6           | 8              | 9     | 7         | 8          | 7           | 12           |
| External model No. 3        | 39                      | 4                 | 4              | 4           | 5              | 7     | 5         | 5          | 8           | 8            |
| Total on all models to divisions | 39                      | 44                | 45             | 51          | 45             | 51    | 51        | 42         | 71           |               |
Total values of the importance of all analyzed purposes of the socially oriented innovation company are specified in table 2.

Application of matrix methodology when carrying out modeling of the innovation socially oriented business of structure allows to evaluate the objects set business more effectively. Matrix approach needs to be used, applying the statistical and research information added with set of independent variables.

Having carried out economic-mathematical modeling on the basis of computer data analysis, on calculation results, presented in table 2, it is possible to draw a conclusion that the developed SOIP models are characterized by necessary effectiveness taking into account specifics within social and innovative development. The most powerful estimated values are observed at the integrated model No. 2 (79 points) and the built-in innovation model (81 points). As the most productive links it is possible to note divisions of managing top management (71 points), marketing division (59 points), division of IT, on an equal basis with production structures show estimated values on 51 points respectively.

According to the conducted research it is possible to draw a conclusion that in all variety of the applied methods necessary for achievement of a goal, statistical processing of data arrays, in total with some other (more unified) basic methods is applied. Application of this methodological approach on the basis of modeling and computer data analysis allows to create necessary models by means of which there will be an opportunity to structure necessary algorithms.

It should be taken into account that the matrix parameters given above and calculated defining the direction of the innovative development of SOIP can be presented as in the form of production and statistical innovation characteristics, and independent variables i.e. which in the general statistical researches are not observed, but which, in turn, are created on the basis of original statistical data.

In the conclusion it is possible to note the fact that in a long-term perspective for improvement of approaches on use of effective technologies of management of the innovative development on the basis of holistic methodology, it is reasonable to use the approaches which are carrying out measurements of independent variables provided that the complex assessment directly not of the observed parameters defining the innovative development of SOIP, but created on the basis of original statistical data is carried out.

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