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"Digital" Approach to Determining the Strategy of Innovative Production in the Enterprise

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***Abstract*—The digital economy is becoming a world reality, implying the transformation of all spheres of human activity and, of course, the production processes of enterprises of all industries. The article is devoted to the methods of optimal management of innovative development processes at enterprises. The concept of quality management and innovation management is delineated in the article. The indicators characterizing the economic efficiency of the enterprise innovation process are defined, the indicators allowing to determine the economic losses of the enterprise from the inconsistency of decisions on managing processes to the existing conditions of production activity, characteristic for the innovation process, are determined. Losses stem from the fact that often management decisions are made in conditions of uncertainty when it comes to innovation in the digital economy. Characteristic for innovation is the situation of uncertainty, for the adoption of management decisions in these conditions, the article proposes the use of the so-called "loss matrix", under the losses here the authors mean the costs arising from the inconsistency of decisions on managing the existing operating conditions characteristic of the innovation process. The example shows that, under uncertainty, the optimal management strategy is a "minimax" strategy, chosen according to the principle of "minimum possible losses".**

Keywords*—Digital economy. Losses of the production process. Innovative production.

I. INTRODUCTION

The digital economy, together with the "digitalization" of everyday life, is becoming a world reality. Of course, the digital economy implies the digitization of all spheres of human life. Doctor of Economic Sciences, A.M of the Russian Academy of Sciences - Vladimir Ivanov gives the broadest definition: "The digital economy is a virtual environment that complements our reality" [12]. Transition to the digital economy, its introduction into all leading sectors, including its scientific, fundamentally justified component, is the main trend of the state policy of the Russian Federation.

For example, Dobrynin AP in his work [1] points out the need for an integrated approach to the introduction of digital innovations, with the coordinated and simultaneous application of several key technologies. In this article the author offers his view on these key positions and steps to realize the advantages of the digital economy through the use of information technology

The book of Sh. Klaus [2], the founder and president of the World Economic Forum in Davos, raised the undoubted scientific interest and is dedicated to the fourth industrial revolution. The author believes that "...We are at the begining of the revolution, which will fundamentally change the way we live, work and communicate with each other. In terms of scale, volume and complexity, the fourth industrial revolution has no analogues in all previous experience of the mankind. We have to see stunning technological breakthroughs in the widest range of areas, including artificial intelligence, robotics, robot cars, 3D printing, nanotechnology, biotechnology and much more ... " The book essentially is a guide that is designed to help enterprise management orient themselves in the occurring changes and get the maximum economic effect from production activities.

Despite all the seeming "novelty" of digital trends, this problematic is being developed by the classics of world science for a long time. For example, Tapscott [3] in his 1996 paper describes the revolutionary phenomenon of digitalization, caused by the convergence of advances in human communication, computing and information content for the creation of interactive multimedia highways. The author points out the need in connection with this revision of the traditional paradigms of economic management. The book focuses on three main areas: the new economy and the factors shaping it, the interworking interaction and how it relates to enterprises and the state, and the need for strong progressive management, responsible for the transformation being the driver of the transition to the economy figures.

Later works by Tapscott [4] are devoted to the role of the Internet in the process of digitization, the Internet of things, the technology of machine learning and many other relevant

It is obvious that there is a need to adapt existing management practices, criteria for assessing the effectiveness of enterprises' activities to the innovative specifics of their activities.

II. PROBLEM STATEMENT AND RESEARCH OBJECTIVE

A lot of scientific research and publications are devoted to methods of optimal management of innovative development processes at enterprises. Here we are talking only about the processes of management or economic management. For the economic justification of the management methods used, the terminological aspects are important: in many cases, the boundaries of the controls of the innovation process, the links between the elements, are not clearly defined in space and time. As an example, two "related" processes can be cited: "innovation management - economic aspect" and "quality management". [8,10]

The process of innovation management can include both the production of new products and the use of new production technologies / processes. Quality management covers the improvement and quality assurance of products, as well as the quality of the production process. But improving product quality is a change / improvement in product / process properties, the result of quality improvement is always a new product / process with improved properties. If there is an improvement in the properties of the product, it is already a new product; in this part quality management coincides with the process of innovation management. At the same time, the role of quality assurance processes is narrowing-they include only questions of quality level assessment, metrology and control methods, including methods for optimizing the parameters of selective quality control (the latter is especially important for destructive testing) It can be seen from the example that there may be difficulties in assessing the economic efficiency of these processes: for quantitative determination of the efficiency index (the ratio of the result to the cost of achieving the result), information is needed both about the results and the costs, but they are difficult to obtain without knowing the exact boundaries process, composition of costs and the effects achieved. [7,9,11]

As a simplified model of the innovation process for the enterprise, it can be assumed that in the production process there is a combination of two elements: the product (P) and the production process – technology (T). For each element, two states should be allowed: "old (O)" and "new (N)". Assume the relative independence of the states of the elements and note a number of intermediate and final states of the innovation process:

(PN+TN); (PO+TN); (PN+TO); (PO+TO). (1)

Obviously, the state: 1) can be characterized as a full-fledged innovation process; state 2) and 3) as a partial / incomplete innovation process, in the state 4) the innovation process is absent.

We introduce indicators to characterize the economic efficiency of the innovation process (each indicator is marked with a digital index).

Costs and economic effect:

1. Investments in the development of new products (1);

2. Investments in the development of new production processes (2);

3. Investment costs for the "harmonization" of the product and production process ((3/1) for the situation (PO + TN), (3/2) for the situation (PN + TO));

4. Economic effect from the development of new products (4);

5. The economic effect of the development of new production processes (5).

Indicators of economic efficiency:

1) Effectiveness of the innovation process as a whole (in the above classification (PN + TN)):

$$\frac{PN\ effect + TN\ effect}{Production\ costs + Tecnology\ costs} = \frac{4+5}{1+2}$$

2) Efficiency of the new process: $\frac{5}{2+(3/1)}$

3) Efficiency of the new product: $\frac{4}{2+(3/2)}$

It is assumed that in the case of an "incomplete innovation process," additional investment costs may be required to refine the product or process in order to eliminate possible inconsistencies (the cost of harmonizing the product and the process). Obviously, these costs will be different for performance indicators 2 and 3. Among the performance indicators, obviously, there is the following quantitative ratio: the overall process efficiency (PN + TN) -parameter 1 is greater than the efficiency of the new process (PO + TN) - indicator 2 and the efficiency of the new product (PN + TO) is indicator 3, but the value of the ratio between the "partial" efficiency indicators is uncertainty

In the absence of innovative components (PS + TO), the effect of innovation is absent, the effectiveness of the innovation process is zero.

III. Key Results

For the analysis of economic efficiency, it is also expedient to determine the indicators characterizing the economic losses of the enterprise from the inconsistency of decisions on managing the processes of the existing conditions of production activity. Losses come from the fact that management decisions are often made in conditions of uncertainty, if it comes to innovation. [5]

TABLE I. «Loss Matrix»

	Process (uncertainty)			**Maximum loss**
		TO	TN	
Product	PN	Π_1=3/1+additional production costs	-	Π_1
	PO	-	Π_2=3/2- savings in production costs	Π_2

The "loss matrix" table is used when making managerial decisions in conditions of uncertainty. In this simplest situation, two areas of production activity are distinguished (the production of new products of PN and the production of old products of substations), which is carried out under conditions of uncertainty regarding the applied production process - tecnology (T), for which two states are allowed: "old (TO)" and "new (TN). " In the cells of the table, the losses are borne by the enterprise from the discrepancy of the administrative decision taken with the state of the production process. Losses are expressed directly in value form (monetary units, if possible). For example, in the table cell corresponding to the variant of production of new products in the old production process (PN / TO), the composition of losses will be the following

The cost of "harmonizing" the product and the production process (3/2) for the situation (PN / TO). Other losses are not taken into account - in this situation, a new product is still produced using the old technology, although, possibly, with higher production costs, which should also be taken into account, if possible. Therefore, the cost of product development cannot be regarded as a loss.

When new products are released on a new production process (PS / TN), losses will not be due to full compliance, as in the case of (PS / TO).

When using a new production process for the production of old products (PS / VT), the costs for "harmonizing" the product and the production process (3/1) for the situation (PS / TN) should be considered losses. These losses should be reduced by the amount of savings obtained when old products are produced using the new technology, assuming that such savings can be obtained

As can be seen from the "loss matrix," each cell in the table shows the loss values corresponding to the product / process combinations. In the last column of the table, the maximum value of the loss value is given for each managerial decision. Under uncertainty, the optimal management strategy is the "minimax" strategy, chosen on the principle of "minimum possible losses". In the case under consideration, the criterion is as follows: min max $(\Pi_1; \Pi_2)$. [6]

It is also possible to use another criterion to determine the specific weight of each product in the general release: it is assumed that each variant of the PN / SS strategy is applied at a frequency of "p", (here $0 \leq p \leq 1$). The criterion answers the question, at what specific weight of PN /PO is the mathematical expectation of losses regardless of the process used (TO or TN), i.e. will not depend on the technology used, or will have the same value for any technology (TO or TN):

$$p \times \Pi_1 = (1 - p) \times \Pi_2 \quad (2)$$

From this expression, you can find "p", which will determine the production strategy, in particular the distribution of output of products between PN and PS. That is, the criterion given will allow optimal way from the point of view of minimization of losses that the enterprise incurs from the discrepancy of the accepted management decision to the state of the production process, to distribute the output volume between a new, innovative product and a product manufactured by the old technology.

IV. CONCLUSIONS

Thus, the concept of quality management and innovation management is delineated; the latter can include both the production of new products and the use of new production technologies / processes. Quality management, in turn, encompasses improving and ensuring the quality of products, as well as the quality of the production process, but improving the quality of the product is changing / improving the product / process properties, the result of quality improvement is always a new product / process with improved properties.

The indicators for characterizing the economic efficiency of the enterprise's innovation process are determined, and, in the opinion of the authors, it is expedient to determine the indicators characterizing the economic losses of the enterprise from the inconsistency of decisions on managing the processes of the existing production conditions characteristic of the innovation process for the analysis of economic efficiency. Losses come from the fact that often management decisions are made in conditions of uncertainty when it comes to innovation in the digital economy.

For the adoption of managerial decisions in conditions of uncertainty, the use of the so-called "loss matrix" is proposed. It is shown that, under uncertainty, the optimal management strategy is a "minimax" strategy, chosen on the basis of the "minimum possible loss" principle.

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