Special features of digitalization of technological development management of production enterprises

Zharov V.S.

Branch of the Murmansk Arctic State University in Apatity, G.P. Luzin Institute of Economic Problems of Kola Science Center of the RAS,
Apatity, Russia
zharov_vs@mail.ru

Abstract — **To digitalize the process of managing the technological modernization of production enterprises, it is important to formulate target indicators and set their achievable values, as well as an algorithm for achieving them.**
It is proposed to solve these problems using the methodology of a new type of economic analysis: investment and innovation, the basis of which is the calculation and analysis of the values of the coefficient of the production processability level and the matrix of possible directions of technological development of production enterprises and the corresponding values of indicators of resource efficiency-material and capital productivity. The developing of actions algorithm is determined by the sequence of steps in obtaining answers to four basic questions: whether or not technological upgrade of production is needed; what to do - to improve existing technology or to introduce a new one; when to introduce a new technology; whether its introduction into production will ensure the financial stability of the enterprise.

Keywords — digitalization, management process algorithmization, technological update, production enterprise, technological development targets, investment and innovative analysis, coefficient of production processability level.

I. Introduction

It is obvious that the future development of the world economy, including the Russian economy, will be associated with its gradual digitalization, with the most important section being the digitalization of economic development management. However, first of all, it is important to develop an appropriate algorithm of actions, that is, an algorithmization of the management process. In this case, firstly, the most important task in ensuring the effectiveness of management is the goal-setting, that is, setting development goals for a certain period of time in the form of values of the corresponding target indicators. Unfortunately, as we noted in [1], in the field of technological development so far, both in theory and in practice, this problem has not been solved at all levels of the hierarchy of economic systems management: macro, meso and micro levels. Accordingly, there is no theoretical and methodological approach to such goal-setting that is uniform for all levels; therefore, each production enterprise will have to solve this problem in its own way, that is, based on its own ideas about the development prospects.

Secondly, the development of actions algorithm for managing economic development should be based on some methodological base, which, in turn, depends on the type of target orientation of the economic systems development. At present, and in the near future, the development of production enterprises will be based on the Industry 4.0 conception implementation, which for Russian enterprises means primarily technological modernization of production with its transition to the sixth technological paradigm, that is, the technological innovations introduction. However, it is obvious that these innovations should increase the economic efficiency of production and allow to reduce the material intensity of production, including to reduce emissions of polluting waste into the environment. Moreover, they should substantially improve labor productivity in Russia, the level of which is much lower than in developed countries. Thus, technological update of production enterprises should lead to an increase in the resource efficiency of production, but how to ensure this in the process of development management? Accordingly, the goal of the study is to disclose a methodological approach determining the analytical relationship between the technological and economic aspects of the production enterprises development, and formation of target indicators on this basis with the algorithm development for enterprises of production technological update to achieve the corresponding target values of these indicators.

II. Research methodology

Since last century, in Russia, an analysis of economic activity has been actively used to analyze the effectiveness of production systems [2]. Over the past decades, the methodology of this analysis has not changed much [3]. Its common drawback is that the used methods do not allow a systematic assessment of the impact on the production activity efficiency by changing the technology used, that is, improving the existing technology or using a new one, since the effectiveness of resources used in production is estimated separately for their main types of material resources, labor resources and fixed assets in the form of indicators of material productivity, labor productivity and capital productivity. However, apparently, it is impossible to significantly increase labor productivity and reduce the material intensity of production, that is, increase its material output without introduction of technological innovations and raising the level of capital productivity. Resource efficiency indicators are interconnected, therefore, a change in the value of one of them affects the change in the values of the other two, which cannot be reflected by current practices and methods used in them. This aspect is very important in predicting the production

systems efficiency and, above all, in substantiating the prospects for their technological modernization.

The idea of expanding its types (directions) depending on the analysis subject is being actively promoted in the scientific literature on economic analysis [4]. It is believed that the main task of economic analysis is to identify reserves in the use of production resources throughout the life cycle of organizations [5]. Accordingly, to solve it, it is proposed to develop a methodology for factor-driven economic analysis [6,7], which, in our opinion, is completely fair, but a change in methodology should involve not only a change in the subject of analysis, but also its methods. Unfortunately, in such an analysis methodology presented to the scientific community, the relationship between the efficiency of using different types of production resources noted above is not considered in any way. Moreover, the assessment of impact on the efficiency of production resources use, changes in production technology over the life cycle of production organizations is not considered. In addition, the methodology used to evaluate the effectiveness of investment projects used abroad and in Russia [8, 9], including when substantiating the introduction of technological innovations, determines the economic feasibility of their implementation, regardless of the level of resource productivity at a particular enterprise, which may reduce, and not increase the future profitability of its activities.

In recent years, the concept of business analysis has been actively developing in Russia and abroad in the field of economic analysis [10, 11]. However, its use to assess the impact of technological innovations on the efficiency of production resources use is almost impossible, since, firstly, the relationship between the indicators of resource productivity (material productivity, capital productivity and labor productivity) is not defined. Secondly, it is not proposed to use one or several interrelated indicators as targets for analyzing the attainability of their values when changing production technology [12-14]. As a result, many indicators are used to assess the effectiveness of using innovations at enterprises both in Russia and abroad, that are not interconnected, and sometimes contradict each other [15]. So according to the data mentioned in the study of German scientists [16], for the period of 1980-2015, foreign organizations used 82 indicators for these purposes abroad. Accordingly, this situation does not allow us to consider various options and strategies for technological upgrade of production enterprises in the future and optimize their use of limited production resources, which is one of the most important tasks that industrial business analytics is designed to solve [17].

There is a functional relationship between the technological and economic aspects of the production systems development, that is, a change in production technology (improving an existing one or introducing a new one) has a direct impact on the change in material intensity and capital intensity of production, and hence labor productivity. In our opinion, such a relationship reflects the proportionality coefficient, calculated as the ratio of capital intensity to material intensity or as the ratio of material productivity to capital productivity [18]. Fundamentally, it corresponds to the "knowledge and skills" indicator proposed in the 80s of the last century by academician V.A. Trapeznikov to reflect the impact of scientific and technological progress on production systems [19].

We have shown that a change in the value of this coefficient in one direction or another depends on the degree of fixed assets renewal and thus determines the level of economic efficiency of the resources used by production enterprises - material, labor and physical capital in the form of fixed assets through indicators of material intensity or material productivity, capital intensity or capital productivity and labor productivity. Accordingly, we named this coefficient as the *coefficient of production processability level* (k).

Based on the analysis of dynamics of the main economic indicators of the development of the North regions and leading enterprises, we have developed a matrix of possible directions and options for development directions depending on the effectiveness of the economic resources used. It identifies four possible directions and two options in two directions. Their interconnection allowed us to develop a graphic model of the life cycle of the enterprises technological development, which includes six stages that reflect possible directions and options for development directions [20]. At the same time, the increase of coefficient of production processability level is ensured only at three interconnected stages, however, a simultaneous increase in the efficiency of all three the above types of economic resources is possible only at one these stages. It corresponds to the first variant of the enterprise development direction, which we named an innovative and effective direction. With the enterprise transition to the second development option in this direction (the next stage), the value of coefficient of technological development level begins to decrease, which is a sign of efficiency decrease of the production technology used

III. RESULTS OF THE RESEARCH

Thus, the life cycle of technological development in relation to a particular enterprise allows to determine the stage of its development in an appropriate period of time and to formulate ideas about its possible future development on this basis. As a result, it becomes possible to form a new type of economic analysis: investment and innovation. At the same time, the main analyzed indicator is the coefficient of technological development level, since its value determines the level of technological updating of production and therefore it can be a target guideline for the enterprise development. However, it must be borne in mind that the value of this coefficient can be high at relatively low values of material and capital productivity, which is typical for most Russian production enterprises, therefore, the level of production material intensity should be the second target indicator.

To develop an algorithm for controlling the process of technological updating of production enterprises, it is necessary to find answers to four basic questions. Firstly, it is important to determine the need for technological updating of production, since generally, an enterprise can be new and working using modern technology.
 Then the production modernization is premature. Secondly, if such modernization is necessary, the answer to the "what to do?" question is very important. DO we have to improve the existing production technology or introduce a new one?

Thirdly, when introducing a new technology, it is necessary to calculate the required amount of investment and determine the implementation timelines. Fourthly, it will be important to determine the real sources of investment and the future level of financial stability of the enterprise.

IV. Discussion of Results

To answer the first question, we have to analyze the dynamics of the values of production processability level coefficient, material productivity and capital productivity for several years in a retrospective period (at least three years) with the calculation of the number and option for the direction of enterprise technological development, and then compare the values of the coefficient of technological development and material productivity for the last year of enterprise's activity with the same indicators of the best enterprises in the relevant industry.

If the enterprise is the best in the industry or the deviation from the values of the best enterprises is insignificant (5-10%) and it develops in the best direction and development option, when the coefficient of technological development level, material productivity and capital productivity increase at the same time, then it is obvious that there is no need in technological update of the enterprise.

Otherwise, to answer the "what to do?" question, one has to consider three possible situations and the corresponding options for the enterprise's actions based on the stage of technological development in accordance with the life cycle model of technological development.

In the first situation, the enterprise may be the best in the industry or among the best, but if the material productivity in the last year of activity already begins to decrease, then a transition to a new technology is necessary, since all the possibilities for improving the technology have already been exhausted. However, if material productivity continues to increase, then it is necessary to support the improvement of existing technology. In the second situation, the enterprise is not among the best, but the dynamics of its development shows an increase in the values of the technological development level coefficient and material productivity, therefore, this trend must be maintained by improving the technology. In the third and worst situation, the enterprise has a dynamic decrease in the coefficient of technological development level and the rate of material productivity, therefore, the urgent need to solve the issue of introducing a new production technology.

To find the answer to the third question, the enterprise first needs to determine the values of the target indicators, the coefficient of production processability level and material productivity, that are desirable to achieve in a certain period of time. Accordingly, the target value of the capital productivity target value is determined, and then based on the estimated volume of products sales and the necessary increase in the volume of fixed assets, the required volume of investment in fixed assets is calculated. It should be borne in mind that until the new technology is introduced, the enterprise will reduce material productivity, that is, the material intensity of products will increase, which means that the cost of sales will increase (other things equal) and the profit of the enterprise will decrease. Therefore, when determining the time period for introducing a new technology, this factor must also be taken into account, that is, the total annual loss of profit must be added to the required volume of investment in fixed assets taking into account the time factor.

The answer to the last, fourth question allows to determine the real attainability of the initially set values of the two target indicators, that is, the coefficient of technological development level and material productivity, so when introducing new technology, the enterprise should not violate its financial stability. Accordingly, if as a result of an investment project implementation with borrowed capital, the value of the financial leverage coefficient of the enterprise will exceed one, then it is obvious that the set values of the two target indicators will be unattainable and will have to be adjusted downwards.

V. Conclusions (Inference)

1. To digitalize the process of managing technological upgrade of production at enterprises, it is necessary to formulate target indicators and set their achievable values, as well as subsequent algorithmization of the control process.

2. The development of an action algorithm requires an answer to four basic questions that can only be obtained using the methodology of a new type of economic analysis: investment and innovation.

3. The sequence of actions is shown when answering the questions posed, on the basis of which the corresponding algorithm is formed.

References

[1] Zharov V.S. Digitalization of the technological development management process of the Russian economy // 1st International Scientific Conference "Modern Management Trends and the Digital Economy: from Regional Development to Global Economic Growth" (MTDE 2019). Published by Atlantis Press. Advances in Economics, Business and Management Research, 2019, vol. 81, pp.273-276.

[2] Endovitskiy D.A., Lyubushin N.P., Babicheva N.E. Dialektika teoretiko-metodologicheskikh osnov ekonomicheskogo analiza // Ekonomicheskiy analiz: teoriya i praktika,2015, № 20(419). S 2-15.

[3] Barngol'ts S.B., Mel'nik M.V. Metodologiya ekonomicheskogo analiza deyatel'nosti khozyaystvennogo sub"ekta. M.: Finansy i statistika, 2003. 240 s.

[4] Endovitskiy D.A., Lyubushin N.P., Babicheva N.E. Resursnoorientirovannyy ekonomicheskiy analiz: teoriya, metodologiya i praktika // Ekonomicheskiy analiz: teoriya i praktika,2013, № 38(341). S 2-8.

[5] Endovitskiy D.A., Babicheva N.E. Metodologicheskie osnovy ekonomicheskogo analiza razvitiya organizatsiy // Ekonomicheskiy analiz: teoriya i praktika,2012, №14. S.2-7.

[6] Babicheva N.E. Teoretiko-metodologicheskie osnovy ekonomicheskogo analiza razvitiya organizatsiy na osnove resursnogo podkhoda: monografiya. M.: ID «Finansy i kredit», 2012. 256 s.

[7] Lyubushin N.P., Lylov A.I., Babicheva N.E. Ispol'zovanie resursno-orientirovannogo ekonomicheskogo analiza v otsenke ustoychivogo razvitiya khozyaystvuyushchikh sub"ektov // Vestnik TGU, №2(142), 2015. S.32-45.

[8] Sharpe W.F., Alexander G.J. Investments, 4-th ed. Prentice-Hall International, Inc., 1990.

[9] Vilenskiy P.L., Livshits V.N., Smolyak S.A. Otsenka effektivnosti investitsionnykh proektov. Teoriya i praktika. M.: Delo, 2002. 888 s.

[10] BABOK v.3.0 -IIBA -A Guide to the Business Analysis Body of Knowledge-International Institute of Business Analysis (2015).

[11] Zrozhevskaya Yu.A. Klyuchevye ponyatiya VAVOK: ikh kratkaya kharakteristika // V sbornike: INTERNATIONAL INNOVATION RESEARCH. Sbornik statey XII Mezhdunarodnoy nauchno-prakticheskoy konferentsii : v 3 ch.. 2018. S. 189-191.

[12] Barilenko V.I. Biznes-analiz kak instrument obespecheniya ustoychivogo razvitiya khozyaystvuyushchikh sub"ektov // Uchet. Analiz.Audit, 2014, №1. S.25-31.

[13] Barilenko V.I. Biznes-analiz i preodolenie "novoy normal'nosti" otechestvennoy ekonomiki // Menedzhment i biznes-administrirovanie, 2016, № 4. S. 44-50.

[14] Barilenko V.I. Analiticheskoe obespechenie upravleniya innovatsionnym razvitiem khozyaystvuyushchikh sub"ektov // RISK: Resursy, Informatsiya, Snabzhenie, Konkurentsiya. 2017. № 3. S. 38-43.

[15] Hittmar S., Varmusa M., Lendela V. Proposal of Evaluation System for a Successful Strategy for a Prospectus // Procedures Economics and Finance. 2015 No. 26, pp. 17 - 22

[16] Dziallas M., Blind K. Innovation indicators throughout the innovation process: An extensive literature analisis // Technovation, 2018, vol.80-81, pp.3-29.

[17] Kogdenko V.G. Prognosticheskiy (prediktivnyy) i predpisyvayushchiy (preskriptivnyy) analiz: teoreticheskie aspekty // Ekonomicheskiy analiz: teoriya i praktika.2019.T.18.№7(490). S.1243-1255.

[18] Zharov V.S. Vzaimosvyaz' tekhnologicheskogo i ekonomicheskogo razvitiya proizvodstvennykh sistem // Nauchno-tekhnicheskie vedomosti SPbGPU. Ekonomicheskie nauki. 2018. V. 11. № 3. S. 32—44. DOI: 10.18721/JE.11303.

[19] Trapeznikov V.A. Upravlenie i nauchno-tekhnicheskiy progress .-M.: Nauka, 1983.

[20] Zharov VS, Kozlov A. Management of Technological Development of Enterprises on the Basis of a Life Cycle Model. Proceedings of the 2018 IEEE International Conference "Quality Management,Transport and Information Security, Information Technologies"(IT&QM&IS) (g. Sankt-Peterburg, 24-28 sentyabrya 2018 g.). pp. 181-184. doi: 10.1109 ITMQIS.2018.8525109