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## IMPROVEMENT OF THE EXPRESS DIAGNOSTICS OF THE PRODUCTION ACTIVITY OF THE ENTERPRISE TAKING INTO ACCOUNT THE METHOD OF DETERMINING THE OPTIMAL PRODUCTION PROGRAMS IN THE OPERATIONAL MANAGEMENT SYSTEM

Об'єктом дослідження є особливості формування і використання системи експрес-діагностики виробничої діяльності (на засадах бізнес-індикаторів) та визначення оптимальних виробничих програм підприємства в системі операційного менеджменту. Однією із основних проблем побудови на підприємствах ефективних систем експрес-діагностики виробничої діяльності є вибір конкретного переліку і складу діагностичних бізнес-індикаторів та критеріїв їх оптимальності. Тут важливе значення має змістовна постановка та розв'язок задачі: визначення оптимальних виробничих програм за фінансовим критерієм розвитку підприємства в системі операційного менеджменту. Побудова та впровадження на підприємствах ефективних систем експрес-діагностики виробничої діяльності також супроводжується комплексом взаємозв'язаних проблем організаційного, кадрового, технічного, технологічного, часового та економічного характеру.

В ході дослідження використовувалися методи узагальнення, систематизації, системного аналізу та економіко-математичного моделювання, на основі яких:

- 1) сформовано систему бізнес-індикаторів експрес-діагностики виробничої діяльності підприємства;
- 2) визначено, з множини допустимих варіантів виробничої програми підприємства, той варіант, який задовольняє умови праці і виробництва та оптимізує функцію цілі для забезпечення максимального прибутку.

З'ясовано, що кінцевим результатом виробничої діяльності підприємства є одержання інтегрального ефекту (результату), основними структурними складовими якого є такі види ефектів: економічний, соціальний, бюджетний, екологічний, ресурсний ефект, інтелектуальний та науково-технічний.

На основі проведеного дослідження, виходячи із поставленої мети і задач, удосконалено систему експрес-діагностики виробничої діяльності підприємства, яка враховує економіко-математичний метод визначення оптимальних виробничих програм в системі операційного менеджменту. Ключовими діагностичними бізнес-індикаторами системи експрес-діагностики виробничої діяльності підприємства є: обсяг товарної продукції, обсяг валової продукції, обсяг незавершеного виробництва, частка браку у товарній продукції, оптимальна виробнича програма в системі операційного менеджменту.

Враховуючи представлений удосконалений економіко-математичний метод визначення оптимальних виробничих програм (в системі операційного менеджменту), необхідною умовою розвитку виробничого підприємства є оптимальне співвідношення обсягу виробництва (реалізації) продукції з витратами. А також з абсолютним фінансовим критерієм максимізації (розвитку) – чистим прибутком підприємства. Тут важливе місце займає відмінність бухгалтерського та економічного підходу до обчислення прибутку.

**Ключові слова:** виробнича діяльність підприємства, виробнича програма підприємства, операційний менеджмент, експрес-діагностика підприємства, управлінські рішення.

### 1. Introduction

To ensure the effective development of any enterprise, the following three requirements must be met: an effective management system, optimal competitiveness and high investment attractiveness of the enterprise. At the same time, the modern theory and practice of business proves that:

- 1) one of the main promising ways to effectively search for directions of enterprise development is the use of economic diagnostics (or activity diagnostics) of an enter-

prise, which is designed to form an information system to support management decision-making in the management system;

- 2) in accordance with the classification of types of diagnostic systems, the diagnostics of an enterprise's activity is divided into the fundamental (in-depth) diagnostics and express diagnostics according to the level of complexity;

- 3) the system of purposes for express-diagnostics of the enterprise's activity includes the following 3 groups of diagnostic purposes according to the level of detail:

- elemental diagnostic goals – goals that are aimed at narrow highly detailed express diagnostics of individual (specific) business indicators of industrial enterprises;
- partial diagnostic goals – goals that pursue the express diagnosis of certain (specific) areas, activities or business operations of a manufacturing enterprise;
- complex diagnostic goals – goals that cover complex integral express diagnostics of simultaneously various fields of activity (functioning) of a production enterprise;
- 4) express diagnostics of the production activity of an enterprise – a structural component of a group of private diagnostic goals (or a partial diagnostic goal) of a system of goals for express diagnostics of a production enterprise [1–3].

In the context of this, according to experts, it has been established that one of the main problems of building efficient systems for express diagnostics of production activities at enterprises is the selection of a specific list and composition of diagnostic business indicators and criteria for their optimality. Here, the task of optimizing the production program of the enterprise is important, based on the research of operations and the use of optimization problems in the economy and management of enterprises. Namely: the determination of optimal production programs according to the financial criterion of the development of a production enterprise in the operational management system, based on the ratio of features of the technological processes of the enterprise and the available production resources. All this determine the relevance of research and its topic.

## 2. The object of research and its technological audit

*The object of research* is the features of the formation and use of the system for express diagnostics of production activities (based on business indicators) and the determination of the optimal production programs of an enterprise in the operational management system.

The construction and implementation of effective systems for express diagnostics of production activities at enterprises is accompanied by a set of interrelated pressing problems of organizational, personnel, technical, technological, temporary and economic nature. According to the information base for express diagnostics of the production activity of an enterprise, it should be based on management accounting data, not accounting or tax, and also take into account the views and sources of information (formal, informal).

In modern conditions, taking into account the objective laws of production development, with the help of economic-mathematical methods and models it is possible to determine the main options for the development of the production system as a whole and its individual elements. The result of the selection of the optimal solution in this direction is the determination of the optimal production programs in the operational management system and the formation of economic strategies based on them. In turn, the development and implementation of effective economic strategies for the problem will provide the enterprise with the maximum return on all elements of its production potential.

## 3. The aim and objectives of research

*The aim of research* is the formation of theoretical positions and the development of practical recommendations for improving the system of express diagnostics of the

production activity of an enterprise based on the method of determining the optimal production programs (financial development criteria) in the operational management system.

To achieve the aim of research the following objectives are defined:

1. To clarify the essence of the category «production activity of an enterprise» and find out what is the end result of the production activity of an enterprise.
2. To offer tools (or an economic and mathematical apparatus) to determine the optimal production programs (financial criterion of development) in the system of express diagnostics of the production activity of an enterprise.

## 4. Research of existing solutions of the problem

The theory [4, 5] and practice unequivocally states the existence of a relationship between systems of economic diagnostics and the efficiency of enterprises. However, there is no unambiguity on a certain list of principles (general theoretical, special and interdisciplinary), the selection and composition of diagnostic business indicators (criteria, indicators, parameters) with their semantic content, specific assessment methods, and the like.

The authors of [3, 6] present the concepts and tools for diagnosing the efficiency of enterprises. However, in these works, the methodological and criteria-based provision of express diagnostics of the production activity of an enterprise based on business indicators is not fully disclosed.

In addition, in the works [7, 8], the essence and efficiency of diagnostics of the production activity of an enterprise in terms of complexity remains the object of sharp discussions. Based on the analysis of literary sources [3, 9], it is established that:

1) express diagnostics of the production activity of the enterprise – a system of probabilistic on-line diagnostics of the production activity of an enterprise, based on the study of key symptoms and business indicators, allows to form a preliminary understanding of the state of the object of diagnostics and the existence of certain threats;

2) in modern conditions, the system of express diagnostics of an enterprise's production activity (based on business indicators) can be effective only if there is adequate software and hardware, financial support and high-quality analytical material. Here, of particular importance, in addition to a specific list and composition of diagnostic business indicators, is the practical application of adequate methods, techniques and tools for determining the optimal production programs (financial development criteria) in the operational management system.

At the same time, it is established that the author's statement [9] remains important today: «When implementing polycriterion diagnostics, preference is given to simple analytical methods (dynamic, structural, comparative analysis), while ignoring complex economic, mathematical and statistical methods that make it possible to identify connections between business indicators, development trends, etc.».

It is worth noting here that in the works [10, 11], based on foreign experience, methods of determining (according to financial criteria of development) and the construction of optimal production programs of the enterprise are presented. However, taking into account the results of research [12] and based on the current state and directions of accounting development in Ukraine in the context of

international trends of harmonization of financial statements and current needs of business management, the presented economic and mathematical methods do not take into account the difference between the accounting and economic approach to calculating profits. This, supporting the opinion of the authors of works [13, 14], is a very important aspect when making management decisions to ensure the effectiveness and efficiency of the production activity of an enterprise in Ukraine.

Thus, the results of literary analysis of studies of existing solutions of the problem determine the direction of research in this direction towards the result.

## 5. Methods of research

In the process of research, the following general scientific and special methods were used:

1) methods of generalization and system analysis – for the formation (construction) of a system of business indicators for express diagnostics of the production activity of an enterprise;

2) methods of systematization and economic and mathematical modeling – to substantiate theoretical positions and develop practical recommendations for determining the optimal production programs (financial development criteria) in the system of express diagnostics of the enterprise's production activities.

## 6. Research results

Based on the results of the research [15, 16], it can be stated: the production activity of an enterprise is a set of targeted actions of its employees using the tools and objects of labor necessary to transform resources into finished products, providing services and satisfying social and economic needs. Here the production resources include [15]:

- 1) labor resources;
- 2) material resources;
- 3) financial resources;
- 4) energy resources.

At the same time, it was established that the end result of the production activity of an enterprise is obtaining an integral effect (result), the main structural components of which are the following types of effects [3, 4, 17]:

- 1) economic effect;
- 2) social effect;
- 3) budgetary effect;
- 4) environmental impact;
- 5) resource effect;
- 6) intellectual effect;
- 7) scientific and technical effect.

At the same time, the performed studies [3, 18, 19] allow to conclude:

1) express diagnostics of the production activity ( $E$ ) of an enterprise is recommended to be carried out according to specific diagnostic business indicators (components) according to an economic-mathematical model (1);

2) based on formula (1), the information source is a report on the production and sale of industrial products (in accordance with the Order of the State Statistics Service of Ukraine No. 131 of 06.07. 2018 [20]):

$$E = f(X_1, X_2, X_3, Z, N), \quad (1)$$

where  $X_1$  – the volume of marketable products (products of the enterprise, which is characterized by the completion of the level of readiness and delivered to the warehouse of finished products or immediately shipped to consumers);  $X_2$  – the volume of gross output (all products of the enterprise, regardless of its degree of readiness);  $X_3$  – the volume of unfinished production (preparation in the manufacture of products is in the production process at different stages) [3];  $Z$  – the share of rejection in marketable products (reflects the level of aggregate rejection in the volume of production):

$$Z = \frac{Z_1}{X_1}, \quad (2)$$

where  $Z_1$  – the volume of the detected rejection for various reasons (objective or subjective);  $N$  – production program (in the operational management system):

1) describes the degree of use of the production potential of the enterprise;

2) it is the composition and volume of products that an enterprise must produce for a certain period of time (day, week, month, quarter, year).  $N$ , which provides the greatest profit, is considered optimal [21]. It is worth noting here that in order to improve the performance of a production enterprise, it is important to establish and evaluate parameters at which the profit function will reach a maximum [22–24].

Taking this into account, according to the results of research [10, 11, 25], it is established that the basis of the process of determining the optimal production programs of an enterprise (taking into account the peculiarities of its technological processes and available production resources) is the calculation of these 2 financial criteria for maximization (or the effectiveness of the development of production capacity) as:

1) net profit (absolute value,  $P$ );

2) rate of return/product profitability (relative indicator,  $R$ ):

$$P = (1 - \alpha)[(1 - \beta)(X - Y) - (1 + \gamma)\omega L - \delta K], \quad (3)$$

$$R = \frac{P}{V} = \frac{P}{Y + \delta K + \omega L(1 + \gamma)}, \quad (4)$$

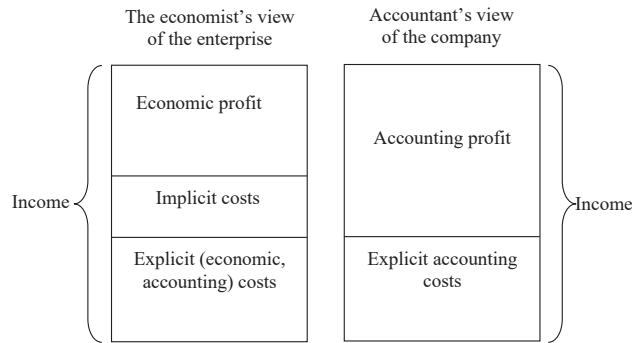
where  $X$  – the total volume of production in terms of value;  $Y$  – the total cost of raw materials and materials used in the process of manufacturing products;  $L$  – the total number of industrial production personnel of the enterprise;  $\omega$  – the average wage per employee;  $K$  – the average annual value of fixed assets;  $\delta$  – depreciation rate (in units of units);  $\alpha$  – income tax (in unit shares);  $\beta$  – value added tax (in unit shares);  $\gamma$  – payroll (in fractions of a unit);  $V$  – current production costs.

Here (at current production costs), based on the results of the analysis of literary sources [12, 26, 27], it is also advisable to take into account the economic approach to calculating profit taking into account all the opportunity costs of lost opportunities for the production of goods and services (Fig. 1).

The substantive statement of the problem is as follows: the main tasks of the unconditional optimization of the production program of an enterprise are [10, 13]:

$$P(X) \rightarrow \max, \quad (5)$$

$$R(X) \rightarrow \max. \quad (6)$$



**Fig. 1.** The difference between the accounting and economic approach to the calculation of profit [12]

The existing theory [10, 28, 29] and practice of business proves that the  $P(X) \rightarrow \max$  corresponds to the concept of process-structured management and reflects the economic strategy of the enterprise. From this it is obvious that at the basis of the implementation of an effective economic strategy is the desire to obtain the maximum profit (within clearly defined limits (conditions) for a specific period of time) expected from the sale of all produced (marketable, final) products.

At the same time, it is established that the result of the production process at an enterprise is ultimately determined by the action of various factors (organizational capabilities and the state of the environment of direct and indirect action), the effect of which in each specific case may be different in direction and with different complexity at the same time [10, 29, 30].

In the context of this, it is found out that when assessing the environmental factors of an enterprise, the manager should take into account the following key characteristics, namely [29]:

- 1) interdependence of all factors of the external environment of the enterprise (a change in one factor may lead to a change in other factors);
- 2) mobility, dynamism, uncertainty and versatility of the external environment (the rate of change of the environment of the enterprise, limited information, display of various events, situations and aspects);
- 3) interdependence of factors of the internal environment (or internal variables: goals, structure, tasks, technologies and workers [30]) and the external environment of the enterprise.

At the same time, on the basis of the results of the performed studies [10, 25], it is determined that it is possible to quantify, measure the nature and degree of influence of production factors in an enterprise's production process with the help of targeted production functions.

The financial and economic dictionary [21] presents the economic essence of the production function. It is found that production functions are:

1) the functions that characterize the possibility of one factor of production to replace others in the production process;

2) the functions by which it is possible to identify and mobilize production reserves to ensure a certain volume of production, improve its quality, and the like.

According to the results of studies [10, 11, 15], it is established that microeconomic production functions provide an opportunity to describe the relationship between parameters such as the amount of used resources ( $y$ )

during a certain (defined) period and the volume of products produced ( $x$ ) obtained by a specific economic subject during this period:

$$x = f(y_1, y_2, y_3, \dots, y_n). \quad (7)$$

To characterize the impact of each specific resource on production growth, coefficients (indicators) of the elasticity of costs of various types of production resources for output are used [11]. Coefficients (indicators) of elasticity [10]:

- 1) reflect the marginal ratio of the increase in the expenditures of each resource to the increase in production;
- 2) provide an opportunity to determine how much interest will increase the corresponding (explicit and implicit) costs with an increase in output by 1.0 %.

In the context of this, it is worth noting that economists in [10, 11, 25] recommend forming a comprehensive system of indicators (or coefficients) of elasticity in output, namely:

- elasticity indicator of the average number of industrial personnel:

$$\lambda = \left( \frac{X}{L} \right) \left( \frac{dL}{dX} \right); \quad (8)$$

- elasticity indicator of the costs of raw materials and materials in terms of value:

$$v = \left( \frac{X}{Y} \right) \left( \frac{dY}{dX} \right); \quad (9)$$

- elasticity index of the average annual value of fixed assets:

$$k = \left( \frac{X}{K} \right) \left( \frac{dK}{dX} \right). \quad (10)$$

Simultaneously from formulas (8)–(10), it is proposed to obtain single-factor production functions (power functional dependencies) for calculating the needs of a particular enterprise:

- in the workforce:

$$L = bX^\lambda; \quad (11)$$

- in raw materials:

$$Y = aX^v; \quad (12)$$

- in basic production assets:

$$K = mX^k, \quad (13)$$

to ensure the production of a given volume of products. The parameters  $a$ ,  $b$  and  $m$  in formulas (11)–(13) are the constants (constant values), which depend on the initial business parameters (volume and structure) of the production potential of the enterprise and the relationships between these business parameters. According to the presented constants ( $a$ ,  $b$  and  $m$ ) can be interpreted as indicators (business indicators) of the overall efficiency of the resources or elements of the production potential, align the units of measure of the used resources and the output products [10, 11].

It is worth noting that the diagnosis of the use of enterprise resources:

1) is used as a tool to monitor the use of labor, material, financial and energy resources of the enterprise;

2) it is advisable to carry out according to a certain (specific) list of criteria (parameters, indicators, business indicators, etc.), where the determining factors are objectives that are pursued by the subjects of evaluation (managers, owners, investors, etc.) [3, 15].

From this it is obvious that modeling (in practice) is a cyclical process, where there are certain principles and rules to be used.

So, supporting the opinion of the authors of [10, 11] that, if substituting (11), (12) and (13) in formula (3), then the economic-mathematical model for calculating the net profit of an enterprise will look like:

$$P = (1 - \alpha) [(1 - \beta)(X - aX^v) - (1 + \gamma)wbX^\lambda - \delta mX^k]. \quad (14)$$

The maximum profit ( $P$ ) is reached at some point  $X_{opt}$ , for which:

$$\frac{dP}{dX} = 0. \quad (15)$$

Equating the 1<sup>st</sup> derivative to zero, given the formula (14):

$$\frac{dP}{dX} = \frac{1-a}{X} \left[ \begin{array}{l} (1-\beta)X - (1-\beta)av^2X - \\ - (1+\gamma)wb\lambda^2X - \delta mk^2X - \\ - (1-\beta)(1-v)av - \\ - (1+\gamma)(1-\lambda)wb\lambda - (1-k)\delta mk \end{array} \right] = 0. \quad (16)$$

Thus, based on the conditions of the first order (5) and differentiating (14), an economic-mathematical model is obtained to determine the optimal production volume (16), at which the enterprise's profit will be maximal in terms of the existing volume and structure of its production potential [10, 11].

In further consideration let's assume that the condition of the 2<sup>nd</sup> order:

$$\frac{d^2P}{dX^2} < 0, \quad (17)$$

is executed, and the  $X_{opt}$  point is the *max* (maximum) point.

In this case, from the formula (16):

$$X_{opt} = \frac{B}{A} = \frac{\delta mk(1-\lambda) + wb\lambda(1-\lambda)(1+\gamma) + av(1-v)(1-\beta)}{-\delta mk^2 - (1+\gamma)wb\lambda^2 + (1-\beta)(X - av^2)}. \quad (18)$$

The theoretical concept of the presented research is based on the law of decline of the marginal utility of production factors (or marginal returns of production factors): an increase in the variable costs of an enterprise contributes to an increase in production, revenue from product sales and profits only up to a certain (specific) border. According to this feature, the economic effect of increasing production (as a component of the integral

effect (final result) of the production activity of an enterprise [17]) begins to decline due to the necessary expansion of the production potential. And, accordingly, the growth of fixed costs that accompany this expansion [10, 11, 31].

From this it is obvious that the company receives the greatest profit in the case when the difference between marginal revenue and marginal costs will be *max* (maximum). This difference determines the optimal production volume, which, in turn, provides the company max profit. Here it is also worth noting that if the law of recession is limiting, that is, if  $d^2y/dX^2 < 0$ ,  $d^2L/dX^2 < 0$ ,  $d^2K/dX^2 < 0$ , then  $v < 1$ ,  $\lambda < 1$ ,  $k < 1$ . From this let's obtain inequalities:

$$\frac{dX_{opt}}{d\beta} < 0, \quad (19)$$

$$\frac{dX_{opt}}{d\gamma} < 0, \quad (20)$$

indicating that the increase in the value-added tax rate and the decrease in payroll wage rates for workers exercise a stimulating effect on production [10, 11].

As for the corporate income tax, it should be noted that it (that is, the tax) directly affects the final financial results of the business [32–34] and also plays an active role in forming the basis for further building up (expanded reproduction) the production potential of the enterprise by reinvestment of profits, due to which the production accumulation occurs.

Here it is also necessary to agree with the opinion of scientists in the works [10, 11, 25] that in the study presented above, the neutrality of the income tax is due to the fundamental static nature of the economic-mathematical model (3). The presented model (3) actually reflects only the process of formation of the enterprise's profit, without at all affecting another stage of reproduction – the distribution of net profit.

Along with this, it is established [35–37]: during the express diagnostics of the production activity of an enterprise, the use of automated systems for the economic diagnostics of an enterprise is an effective and promising technological means of processing information, since these are:

1) significantly speeds up the accounting process and the process of analysis and evaluation of the use of enterprise resources (labor, material, financial and energy resources);

2) improves the quality of operational and ongoing monitoring of production activities, as well as a full audit. This allows, in the framework of optimizing the production program of the enterprise, taking into account the specifics of its activities, especially in conditions of uncertainty, to determine the optimal technological mode of production.

## 7. SWOT analysis of research results

*Strengths.* The strengths of research (the main ones) are that the improved system of express diagnostics of the production activity of an enterprise:

1) takes into account the economic and mathematical method of determining the optimal production programs in the system of operational management, which allows to identify the relationship between business indicators, development trends, and the like;

2) is based on management accounting data, and not accounting or tax. At the same time, using a systematic

approach in the study, taken into account the set of essential structural components of the system presented diagnostics, determines its character, type and development.

*Weaknesses.* According to experts, the weak side is that the formation of a production enterprise (small business and large business in accordance with article 55 of the Economic Code of Ukraine [38]), a streamlined and informative system of express diagnostics taking into account standard software takes from six months to a year.

*Opportunities.* Express diagnostics of the production activity of the enterprise is intended to form an information system to support management decisions (current operation, development), which are aimed at improving the efficiency and effectiveness of the production activity of the enterprise.

*Threats.* If an enterprise has separate business indicators of an express diagnostic system for its production activity, it is (or will be) criteria (parameters) for material incentives, that is, the threat of hiding real information and the presentation of incomplete true or false.

## 8. Conclusions

1. According to the research results, the essence of the category «production activity of the enterprise» is clarified. According to the authors of this work, the production activity of an enterprise is a set of targeted actions of its employees using the tools and objects of labor necessary to transform resources (labor, material, financial and energy) into finished products, provide services and meet socio-economic needs. Here, the end result of the production activity of an enterprise is obtaining an integral effect (result), the main structural components of which are the following types of effects: economic, social, budget, environmental, resource effect, intellectual and scientific and technical.

2. The scientific novelty of the research is improvement of:

1) the system of express diagnostics of the production activity of the enterprise, which, unlike the existing ones:

- takes into account such key diagnostic business indicators as: the volume of marketable products, the volume of gross output, the volume of work in progress, the share of defects in marketable products, the optimal production program in the operational management system;
- aimed at the formation of an information model to support management decisions in the system of organization of labor and production (or in the system of operational management);

2) an economic-mathematical method for determining the optimal production programs (in management), which, unlike the existing ones:

- takes into account the optimal ratio of the volume of production (sales) of products with costs and the absolute financial criterion of maximization (development) – the net profit of the enterprise;
- suggests a different accounting and economic approach to calculating profits.

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