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MANAGEMENT OF DEVELOPMENT OF MANUFACTURING ENTERPRISES IN DECENTRALIZATION CONDITIONS

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Abstract
This article summarizes the arguments and counterarguments within the scientific discussion on identifying the enterprise's state to evaluate its effectiveness and optimize the target functions in solving enterprise development problems. The proposed scientific and methodological approach to modeling the enterprise development management system under decentralization conditions and its practical implementation makes it possible to determine the dominant development parameters of manufacturing enterprises that influence the United Territorial Community and to timely track the impulses and space of the United Territorial Community state, taking into account the PS state as parameters for its development. The proposed analysis of the Production System state within the United Territorial Community framework and evaluating its development dynamics shows the necessity of forming a system of generalized vector-scalar, situationally oriented indicators.

Keywords
Development, manufacturing enterprise, system modeling, production system, strategic planning.

Introduction

Formulation of the problem

Administrative-territorial reform and decentralization, which is defined as an essential prerequisite for the significant social and economic development of Ukrainian territorial communities, impacts the formation and development of manufacturing enterprises in the territory of the United Territorial Community (UTC). Today, it is becoming increasingly apparent that the synergistic interaction of manufacturing enterprises and their territories of basing and justifying priority areas of development are of great importance in the application plan.

Managing enterprise development under decentralization is classified as a poorly structured processes because it is characteristic of it [1–4]:

- high dynamism and speed of change of the external environment of the UTC in which the enterprise exists [5];
- the emergence and intensification of the impact of processes of globalization of the world economy on an individual enterprise [6];
- strengthening the impact of the linkage of complex socio-economic systems, both domestically and through integration into a single world economy [7].

On the one hand, the process of enterprise development is becoming increasingly poorly structured and random. On the other, there is a need to manage this process to survive and develop an aggressive market environment.

Analysis of recent research and publications

Many scientists are researching the issues of enterprise development management. Purposeful change of parameters, structure, and properties of the system in response to perturbation of the external and internal environment of the enterprise – so determine the adaptive approach to managing the development of the enterprise [8, 9]. The evolutionary approach to development management has been well expressed by American researchers Aslim and Nevapti [10]: "the imbalance and irreversibility of the evolutionary processes taking place in the world require the emergence of new models of management in the enterprise, and each new model must be better than that which is being replaced". An innovative approach involves managing the development of an industrial enterprise based on the activation of innovative activity, analysis, and implementation of innovative achievements in all spheres of economic activity of the organization. British researcher Barton [11] in a 2003 study, showed that a comprehensive approach to managing enterprise development aims to simultaneously develop many aspects of management in their relationship – technical, environmental, economic, organizational, psychological, and so on [12]. When implementing a marketing approach to enterprise development management, its internal aspects are not given sufficient attention. For example, the needs of production and personnel are ignored, the dynamics of environmental changes are not taken into account, new challenges of globalized markets, etc. [13]. Under the process approach to industrial enterprise development management, offer to understand a series of consistent, continuous, interdependent actions achieving the goals of the enterprise. In [14] offered to understand a systematic approach to managing an enterprise's development by studying the object as a system where each economic phenomenon is considered and evaluated in interaction with others. On the contrary, all other elements of the object and the processes that occur in it are interconnected, taking into account both internal and external factors [15].

Constructive analysis of the enterprise's state and evaluation of its development dynamics shows the need for the formation of a system of generalized vector-scalar, situation-oriented indicators [16–18]. Each level of analysis and the problematic situation is answered by an aggregate set of estimates that consider both individual indicators and their different groups.

Many indicators essential for identifying an enterprise's state are used to evaluate the effectiveness of its operation and optimize the target functions in solving the problems of managing the enterprise's development [18].

To implement the management of the costs of heterogeneous resources – input vector $V = (V_1, V_2, ..., V_n)$ – owned by the enterprise over time t, based on the current state of the enterprise and retrospective analysis of its activities:

$$V(t) = V_{ro}(t) + V_{rm}(t), \tag{1}$$

where V_{ro} – resources of operation; V_{rm} – management (development) resources.

Because of the above, it is forming a control system $V(t)$ for enterprise development under decentralization conditions is to determine the time-ordered state of the enterprise, which is estimated by the vector $X(t) = (x_1(t), x_2(t), ..., x_r(t))$ and its change $\dfrac{dX}{dt}$ when performing functional properties.

Problem statement

The purpose of the article is to develop a scientific and methodological approach to modeling the control system of a manufacturing enterprise's dynamic state in the conditions of decentralization and the formation of indicators of its development.

Research methodology and methods

During the development of an enterprise, its elements and the structure of all its properties change, including integrative ones, i.e., the $Y(t)$ vector that determines the initial characteristics. As a generalized mathematical model for managing the dynamic development of the enterprise can use a model of the following form:

$$\frac{dx}{dt} = f(t, x, v, y), \tag{2}$$

where $x(t)$ – an n-dimensional phase vector; $v(t)$ – the vector of dynamic enterprise development management; $y(t)$ – the vector of a functioning enterprise's output indicators.

The task of managing the enterprise's performance should be considered a kind of optimal management tasks, offering the optimal use at each stage of operation of all resources possessed by the Production System (PS) (labor, energy, information). To achieve the main at this stage of the goal subject to many restrictions. The tasks of conditional PS control optimization can be written as:

$$X^0 = \mathrm{argextr} P(x), \tag{3}$$

where $P(x)$ – a utility function.

The set of admissible solutions tau is given based on meaningful analysis of PS with the restrictions in the form of inequalities:

$$h_i(x, q_i) \leq 0, \quad i = \overline{1, n} \tag{4}$$

and equality:

$$g_i(x, q_j) = 0, \quad j = \overline{1, n}, \tag{5}$$

where $X(t)$ – the controlled state-space variable of PS; h_i, g_i – operators that determine the structure of a mathematical model of the corresponding constraint; q_i, q_j – tuples of quantitative parameters of corresponding restrictions.

Outline of the main material

Starting from 2015, based on the concept of reforming local self-government and territorial organization of government in Ukraine approved by the Cabinet of Ministers of Ukraine (resolution of the Cabinet of Ministers of Ukraine No 333-r of 01.04.2014), practical implementation of measures related to the tasks of reforming the administrative-territorial system has begun. Ukraine, particularly with changes in the system of administrative-territorial units, which, by definition of the Constitutional Court of Ukraine, is considered a compact part of Ukraine's single territory, which is the spatial basis for the organ State local self-government bodies [19].

United communities have a broader range of responsibilities, first and foremost – community planning and economic development, attracting investment, business development, and budgeting, land management, building permits, development of local infrastructure, the provision of housing and communal services, the maintenance of streets and roads in the community, the organization of passenger transportation and public safety by municipal police, fire protection. Therefore, administrative-territorial reform and decentralization, which is defined as an essential prerequisite for the significant social and economic development of territorial communities, impact industrial enterprises' formation and development in the communities' territory [20].

The process of forming United Territorial Communities (UTC) can be called dynamic: 159 UTCs were formed in Ukraine in 2015; as of 2016 – 366; as of 2017 – 665; as of 2018 – 806; and as of August 10, 2019, 936 United Territorial Communities (UTC) have been formed in Ukraine, 55 of which await the CEC's decision to appoint the first local elections in their territories. The total number of UTCs includes those formed with centers in regional cities – 75 territorial communities joined 34 cities of regional importance. The 936 UTC, as mentioned above, brought together 4330 local councils. As of August 2019, the UTC territory formed more than a third (40.3%) of Ukraine's total area. Such communities are home to over 10.1 million people (representing 28.6% of Ukraine's total population). The average number of territorial communities united in one UTC is 4.5, and the average population of one UTC is 13313. The largest number of UTCs were created in Dnipropetrovsk (62), Zhytomyr (55), and Cherkasy (57) regions. In the Transcarpathian (6), Lugansk (17), Donetsk (11), and Kharkiv (19) regions, however, the consolidation of territorial communities continues at a much slower pace [20].

According to the analysis conducted by the experts of the financial monitoring group of the Central Reform Office of the Ministry of Regional Development of Ukraine (based on the U-LEAD with Europe program and SKL International), which are made for the situation in the country the lowest financial capacity indicators are usually characteristic of most small communities. The exception is the small communities where large real-sector enterprises and budget-forming enterprises are located. A relationship between population size and financial capacity can be explained because these relatively large communities are more actively developing small and medium-sized businesses that focus on sufficient labor resources, a more capacious local market for goods and services, and better prospects for sustainable development.

One of the best options for further development for communities with low financial capacity and demographics is joining them to other territorial communities and creating a larger UTC in size and size. Even if there are no clear economic prospects for development at such a UTC, such an association will enable the optimization of the territorial structure of local councils, increase the efficiency of territorial management, improve the investment attractiveness and increase the level of expediency of investments into the territory [21].

A community with a diversified economy is deprived of monofunctional dependence on one enterprise and has a greater chance of sustainable development. The presence of extensive, incredibly strategic enterprises of multinational companies contributes to the development of small and medium-sized businesses that serve them or perform intermediary or contracting work (supply, packaging, design, design, sales, logistics, transport, food, advertising, trade, support, security). Therefore, the more high-yielding businesses with high productivity and high value-added work in the community, the higher the quality of life.

The decision to optimize the functioning of the production system in the context of decentralization is related to the definition of a metric in which the quality of solutions is compared with the utility function.

The identification of the state of the enterprise based on a comprehensive assessment of the state of the enterprise takes into account the financial and economic activity of the enterprise, the production component of the enterprise, innovation, investment and social aspects of functioning, and the impact of the enterprise's activity on the environment.

Developing a production system is sufficient if it ensures the system's development towards achieving strategic goals. It means that the system's integrative property's quantitative or qualitative characteristics change toward improvement. Appropriate performance indicators should be introduced as criteria for the optimization of development management in the form of maximum functional:

$$J(y) = \int_0^T F(x,y)dt, \tag{6}$$

where $x(t)$, $y(t)$ – managed and output state variables of the production system.

The function $y(t)$ is constrained:

$$0 \le y \le x. \tag{7}$$

Solving PS development management problems requires information support provided by ACS. However, they are focused on maintaining the functioning of the enterprise and not on managing development processes. It became a prerequisite for creating a development management subsystem and a development strategy system as part of the ACS enterprise [22].

The formation of management for each group of processes consists of the sequential implementation of the stages: control, diagnosis, prediction of states, the formation of control effects, the relationship of which is shown Fig. 1.

Analysis of existing enterprise management systems [23] shows that they have several disadvantages:

- no functional development subsystem is allocated;
- interaction with the environment is not fully taken into account.

The current topic of research on management effectiveness is the assessment of the activities of a single territorial community, on the territory of which there are several enterprises, including the city-forming ones in terms of indicators: the volume of own resources in the community budget per inhabitant; economic self-sufficiency of the community; community expenditures on management and capital expenditures per capita [24].

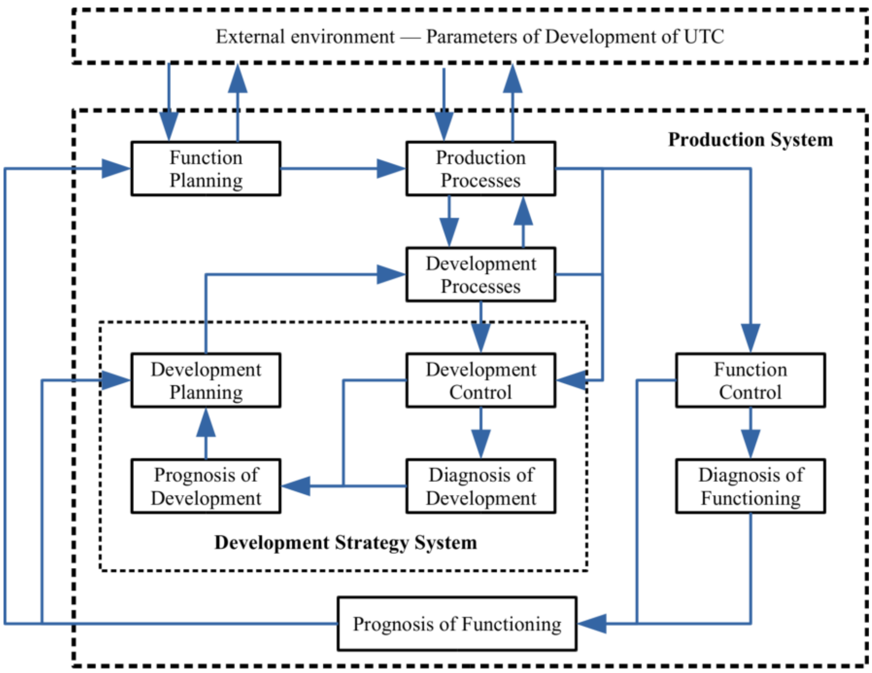

Fig. 1. Connection of development and functioning of production system.

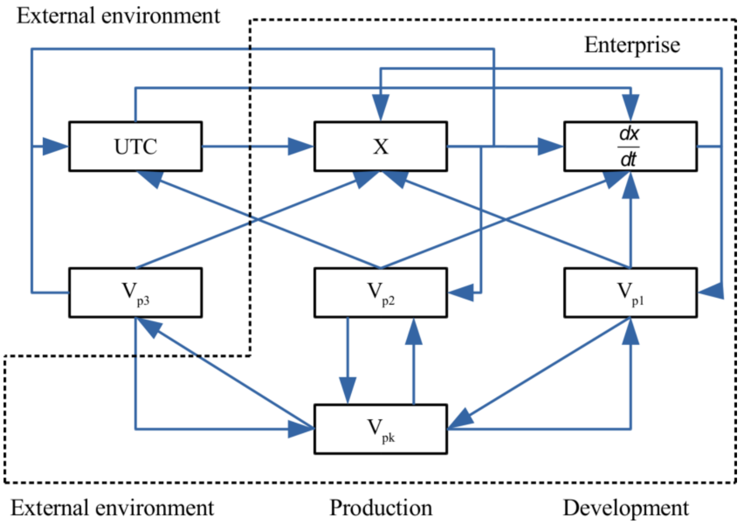

Fig. 2. Structural diagram of a developing enterprise model in interaction with the external environment.

United territorial communities and businesses share a common goal of development – to increase revenue, which is achieved by increasing competitiveness and attracting innovative high-performance investments that will provide a high level of added value.

Therefore, by presenting UTC as an external environment, a developing enterprise model can be represented as the following block diagram (Fig. 2).

Here, UTC is a unified territorial community; X – vector-function of production and technological process of the enterprise; $\frac{dx}{dt}$ – PS functioning; V_{p2} – production management system; V_{p1} – development management system; V_{p3} – UTC interaction management system; V_{pk} – a matching system that provides the UTC – $x(t)\frac{dx}{dt}$ interaction.

UTC restructures its state $q(t)$ following the vector V_{p1} acting in the form of initiating control. The transformation of resources determines PS activity into a final product. Resources and products are considered, for example, finance, material values, intellectual and professional qualities of PS employees.

PS activities include various processes to get the final product or result and cover all production functions – planning, development, design, logistics, production technology, verification, quality assurance, and implementation. It uses the technologies of the necessary process of activity and the corresponding technological processes.

For different businesses in the territory of UTC, their business process technologies are in place.

Besides, the enterprise's fundamental processes are implemented processes of management, communication, organization of production, and ensuring interaction with the external environment (UTC).

Enterprises use in their work:
- basic processes – P_{1i};
- technology changes in staff quality and quantity – P_{2i};
- organizational technologies (management, communications, decision-making and implementation technologies – P_{3i};
- interaction with the environment – P_{4i};
- Information Technology – P_{5i}.

The development of enterprises to improve the efficiency and competitiveness possible through innovation, products, and technologies.

Suppose that UTC contains n enterprises. Each enterprise's economic condition is characterized by an m-dimensional vector: $x_i = (x_{i1}, x_{i2}, ..., x_{im})$ variables that determine the i-th enterprise's functioning.

It is assumed that the random effects on the PS are small enough and can be neglected. Each UTC enterprise has complete information on macroeconomic parameters. Interactions between different enterprises can be neglected.

Then there is a relationship between time and the rate of change in economic indicators in the form of a system [25]:

$$\frac{dx_{ij}}{dt} = qf_{ij}(x_i, y), \tag{8}$$

where y – output variables of PS; q – the rate of establishment of microeconomic variables.

Thus, the enterprise as a dynamic system is mainly determined by the change in microeconomic variables.

For UTC, within which a city-forming enterprise is located, it is essential to know how to manage sustainable development to increase its efficient production.

We consider the enterprise as a PS with variables that characterize its functional activity. All variables acting on or related to PS should be divided into three sets:

- input variables $v_1, v_2, ..., v_m$ that characterize the external influences on the system inputs;
- state variables $x_1, x_2, ..., x_n$ – internal variables, the totality of which fully characterizes the properties of the system;
- output variables $y_1, y_2, ..., y_r$, representing those reactions to external influences and those states of the system that relate to the system performance indicators.

For example, input variables $v_1, v_2, ..., v_m$ of PS can be all kinds of resources consumed by the system, investments, innovations, advanced technologies, and the updating of actual production means.

The state variables x_i includes the depreciation of fixed assets, the enterprise's profitability, the efficiency of using fixed assets, production capacity, and their implementation efficiency.

The initial variables y_i include financial coefficients PS such as product profitability, turnover indicators, fund return, market stability indicators, competitiveness, social, budgetary, and environmental efficiency.

The PS itself in the UTC structure can be represented as a "black box" with m inputs and r outputs, each associated with a corresponding variable.

Consider the set of inputs as one generalized input influenced by the vector $v(v_1, v_2, ..., v_m)$, and the set of outputs – as a generalized output, characterized by the output vector $y(y_1, y_2, ..., y_r)$. State variables are related to the $x(x_1, x_2, ..., x_n)$ vector system's intrinsic properties and their $\frac{dx}{dt}$ changes during production.

PS, its inputs and outputs are three interrelated objects determined in each case according to the system's description (structure and properties of components or mathematical model of PS) and specifying sets of input and output variables. Depending on which object needs to be identified (including the other two), the research goals may differ (Table 1).

Table 1
The tasks of research of the state of the production system.

Task	Inputs	System	Outputs
Analysis	+	+	?
Synthesis	+	?	+
Diagnosis	?	+	+

The solution to any of these problems is related to the PS status study.

Assuming the state PS is continuous at each time t, we write the matrix equations that characterize the operation of this system:

$$\begin{aligned} \frac{dx(t)}{dt} &= F\left[x(t)\right], \\ y(t) &= U\left[x(t), v(t)\right]. \end{aligned} \tag{9}$$

The first of expressions (9) is the equation-of-state PS whose solution satisfying the condition $x_0 = x(t_0)$ gives the vector of PS development:

$$x(t) = \psi\left[x\left(t_0\right), v(t)\right]. \tag{10}$$

The second equation determines the output variables depending on $x(t)$ and $v(t)$, and so it is called the output equation.

Under UTC conditions, the production system is additive, so equation (9) takes the form:

$$\begin{aligned} \frac{dx(t)}{dt} &= A(t)x(t) + B(t)v(t), \\ Y(t) &= C(t)x(t) + D(t)v(t), \end{aligned} \tag{11}$$

where $A(t)$ – the system's matrix (square n-th order); $B(t)$ – the size of control matrix $(n \times m)$; $C(t)$ – the size of output matrix $(r \times n)$; $D(t)$ – the input matrix of size $(r \times m)$.

For stationary production systems, the elements of the matrices A, B, C, D are expressed by constant numbers, which are functions of the parameters of the components of PS. A – the main matrix of the system that determines the nature of production; B – communication matrix; the structure of this matrix determines the nature of the PS login relationship to the various production system variables; C – the matrix of the relation of PS variables to the output variables of the vector function $Y(t)$; D – the coupling matrix that directly connects the input vector $v(t)$ PS with the output vector $Y(t)$. The structure of this matrix determines how compelling input features (e. g., increasing PS innovation performance) affect different outputs $Y(t)$ (e. g., the profitability of output) (Fig. 3).

The most complex structure are PSs with nonlinear dependencies between variables at their inputs and outputs. The equation of state of such PS can be represented in the form (11) [26]:

$$\begin{aligned} \frac{dx(t)}{dt} &= Ax(t) + Bv(t) + Fz(t), \\ f\left[x(t), z(t), v(t)\right] &= 0, \end{aligned} \tag{12}$$

where A, B, F – constant matrices; $f(x, z, v)$ – a nonlinear algebraic equation whose solution regarding the vector $z(t)$ allows us to exclude this vector from the differential equation.

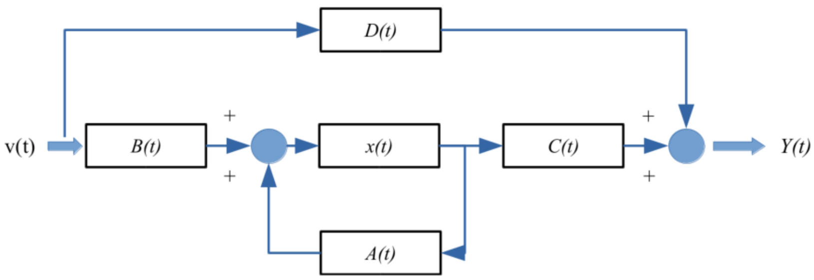

Fig. 3. Functional diagram of the production system.

Let PS be described by the equation-of-state $x(t) = Ax + Bv$, a matrix entry of a differential equations system with constant coefficients in the standard form. Its solution, which satisfies the initial conditions $x_0 = x(0)$ for the state vector $x(t)$ and the output vector $Y(t)$, has the form:

$$x(t) = \phi(t)x(0) + \int_0^t \phi(t - r)Bv(r)d\tau,$$

$$Y(t) = C\phi(t)x(0) + \int_0^t C\phi(t - \tau)Bv(\tau)d\tau + Dv(t). \tag{13}$$

The first additive in (13) corresponds to the reaction of PS, depending on the initial conditions (production operates in the regular mode), and the other additives – the reaction to the input influences (for example, introducing investments in fixed capital, the number of advanced technologies used).

The fundamental matrix $\phi(t) = e^{At} = \exp At$ is called the transition matrix of the PS state. It reflects the initial state of enterprise $x(0)$ to some state for the time t (at zero inputs), i.e., $x(t) = \phi(t)x(0)$.

When PS is started, when $x(0) = 0$ and the input vector $v(t)$ are not connected to the output vector $Y(t), D = 0$, the relation describes the relationship between the output and input response:

$$Y(t) = \int_0^t C\phi\,(t - \tau)\,Bv(\tau)d\tau = \int_0^t g(t - \tau)v(\tau)d\tau. \tag{14}$$

The matrix $g(t) = C\phi(t)B$ is a generalized characteristic of PS regarding its input and output variables. The reaction to the i-th output of the enterprise can be written in the form:

$$y_i(t) = \int_0^t \left[g_{i1}(t - \tau)v_1(\tau) + g_{i2}(t - \tau)v_2(\tau) + \ldots \right.$$
$$\left. + g_{1m}(t - \tau)v_m(\tau)\right] d\tau, \tag{15}$$

where $g_{ij}(t)$ is the ij-elements of the matrix $g(t)$, which describes the effect of the corresponding input parameter and is equal to the reaction $y_{ij}(t)$ at the i-output relative to the j-input, provided that all other inputs zero, that is:

$$y_{ij}(t) = \int_0^t g_{ij}(t - \tau)v_j(\tau)d\tau, \qquad i = \overline{1, r}, \quad j = \overline{1, m}. \tag{16}$$

The right side of equality (15) is a convolution of functions $g(t) \times v(t)$ [26]. Given the properties of the convolution of functions [26], the expression for $y_{ij}(t)$ can be written in four different ways, given the simplification of the notation of scalar functions $y_{ij}(t) - y(t)$ and $v_j(t) - v(t)$:

$$y(t) = g(t) \times v(t) = \int_0^t g(t - \tau)v(\tau)d\tau$$
$$= \int_0^t g(\tau)v(t - \tau)d\tau = \int_0^t h(t - \tau)v'(\tau)d\tau \tag{17}$$
$$= \int_0^t h(\tau)v'(t - \tau)d\tau,$$

where $h(t)$ is a function whose derivative defines $g(t)$ by its argument, i.e.:

$$g(t) = \frac{dh(t)}{dt}, \qquad g(t - \tau) = \frac{d}{d(t - \tau)}h(t - \tau).$$

The scalar functions $g(t)$ and $h(t)$ are called, respectively, the impulse and transient characteristics of PS. The economic interpretation of these functions can be given by $g(t)$ – an innovative short-term component; $h(t)$ – the PS state's reaction and its initial characteristic from the short-term use of an innovative component.

Suppose the input $v_p(t)$ of the development resource at time τ is input to PS. Then, by the mean property [26], the output response will be represented as:

$$Y(t)=\int_0^t g(t-\tau)v_p(\tau)d\tau = g(t-\Theta)\int_0^t v_p(\tau)d\tau$$
$$= g(t-\Theta)\times Su, \tag{18}$$

where $0<\Theta<t$, Su – the value of the component $v_p(t)$ of the development resource.

Therefore, $g(t-\tau)$ can be considered as a reaction of PS to the component $v_p(t)=\delta(t-\tau)$ function applied at the input at time τ. If the D-matrix of the relation of the input vector $v(t)$ of PS with the output vector $Y(t)$ is not zero, ie $D\neq 0$, then the characteristic $g(t-\tau)$ is $v_p(t)$ is determined by the expression:

$$g(t)=Ce^{At}B+D\delta(t),$$
$$h(t)=C(e^{At}-E)A^{-1}B+D,$$

where $\delta(t)$ – a function of short-term input to the PS input component $v_p(t)$ of the enterprise development management resource; $h(t)$ – the reaction to the function $\delta(t)$ applied at the initial time $t=0$.

This model allows estimating UTC impulses for PS development while assessing enterprises' performance and their impact on UTC indicators.

Depending on the development goals of the enterprise, compromise criteria can be used in the UTC structure. For example, in the initial stages of system development, it is necessary to achieve the targets in each development period and ensure the highest outputs.

The choice and the relative hierarchy of one or another criterion are related not only to the specifics of development and operation, the enterprise but also to the general structure of its economic and mathematical models. The main groups of restrictions within which the development and operation of the enterprise are:

- resource constraints (resources, development fund) and capacity constraints;
- balance constraints that link the individual elements and subsystems;
- restrictions on the value of technical and economic indicators characterizing various aspects of the system's development and functioning.

An essential step in the development of PS is the assessment of sustainability. The problem of managing the sustainable development of business entities is complex and diverse. According to Lyapunov, the theoretical apparatus of stability analysis can not be fully applied to the class of organizational and technical systems to which PS belongs. The concept of sustainable development of the enterprise contains components of efficiency of functioning and development. However, there is some benefit to analyzing the results of enterprise development modeling in terms of controllability and observation of this process. To do this, to the equation of a linear system describing the state of PS:

$$\frac{dx(t)}{dt}=Ax(t)+Bv(t),$$
$$y(t)=Cx(t)+Dv(t),$$

we apply the Laplace transform [26]. In the operator form, the PS state looks like:

$$\begin{aligned} PX(p)-X(0)&=AX(p)+BV(p),\\ Y(p)&=CX(p)+DV(p). \end{aligned} \tag{19}$$

From here, we obtain the solution for the state vector $X(p)$ and the source vector $Y(p)$ in the images:

$$X(p)=(PE-A)^{-1}\left[X(0)+BV(p)\right],$$
$$Y(p)=C\,(PE-A)^{-1}X(0) \tag{20}$$
$$+\left[C\,(PE-A)^{-1}B+D\right]V(p).$$

Here, the matrix $\phi(p)=(PE-A)^{-1}$ is an image of the transition matrix of the state $\phi(t)$.

Thus, the transition matrix PS $\phi(t)=\exp(At)$ can be calculated by converting the matrix $F(p)=PE-A$ and the subsequent transition from $(PE-A)^{-1}$ to its original.

Provided that the state PS in the operator form in the initial state $x(0)=0$, the original vector takes the form:

$$Y(p)=\left[C\phi(p)B+D\right]V(p)=F(p)V(p). \tag{21}$$

The matrix $F(p)=C\phi(p)B+D$ is called the transfer function. This matrix's economic meaning forms the link between converting raw materials into a product and the output variable – the profit from the sale of finished products.

The image of the i-th source variable contains:

$$Y_i(p)=\sum_{j=0}^{m}F_{ij}(p)V_j(p). \tag{22}$$

The elements $F_{ij}(p)$ of the transfer matrix $F(p)$, which can be scalar transfer functions from the i-th input to the j-th output. Knowing:

$$F_{ij}(p)=\frac{Y_i(p)}{V_j(p)}. \tag{23}$$

$F_{ij}(p)$ can be correlated between the V values of investment costs and the transition characteristic Y of the component $v_p(t)$ of the enterprise development management resource and the response of the output vector $Y(t)$. It could be a change in production profitability, an increase in fixed assets' value, and PS's profitability. It allows us to estimate the impact of each production system on the development indicators of UTC.

Thus, the transfer function $F_{ij}(p)$ is the image of $g_{ij}(t)$, and the image of the transition characteristic

$$h_{ij}(t) = \frac{F_{ij}(p)}{p}.$$

To obtain $g_{ij}(t)$ and $h_{ij}(t)$, it is enough to go from the image to the original using the Laplace inverse transform [26] $g(t)$ and $h(t)$.

PS will be managed if all variables

$$x(t) = x\left(x_1(t), x_2(t), ..., x_n(t)\right)$$

depend on the input effects

$$v(t) = v\left(v_1(t), v_2(t), ..., v_v(t)\right).$$

A PS is called observable if $x_i(t)$ is associated with at least one output $y_j(t)$. The full observation of PS means that there is such an influence $v(t)$ that the reactions at the outputs $y(t)$ at a time interval $0 \leq t \leq T$ can determine the initial state $x(0)$ of the system.

Conclusions

The proposed scientific and methodological approach to modeling the enterprise development management system under decentralization conditions and its practical implementation will allow determining the dominant development parameters of manufacturing enterprises that impact UTC and to timely track the impulses and space of the UTC states taking into account the PS state as parameters for its development. The proposed analysis of the PS state in UTC's framework and evaluation of its development dynamics shows the need to form a system of generalized vector-scalar, situationally oriented indicators. The presented PS indicators in the form of state vector $x(t)$, input $v(t)$ and output vector $y(t)$ can be essential for identifying the enterprise's state and evaluating its functioning, and optimizing target functions in solving problems. Strategic enterprise development. Identification of the enterprise's state based on a comprehensive assessment of its state vector-functional components $v(t)$, $x(t)$, $y(t)$ allows taking into account the financial activity, production, and investment-innovation activity of PS. It will contribute to the development of both UTC and manufacturing enterprises in their territories and obtain the corresponding economic benefits: the rise of economically backward enterprises and territories; the diffusion of new technologies, new products, and the development of the innovation sector; increasing employment and increasing demand for skilled labor, a qualitative change in modern life; high cost-effectiveness and profitability; stimulating new business.

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