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THE SYSTEM AND SITUATIONAL MODELS OF BUSINESS ACTIVITY

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The article adapts the cybernetic concept of management in the space of boundary resources and states of the object of development (CURSOR +) to the business activities of the enterprise. The system-situational model of development of the modeling object is a cross-shaped four-pole shell, and the space limited by the poles is a space of development of the modeling object. The vertical of this imaginary cross, bounded at the top by an extremely positive pole and at the bottom by an extremely negative pole, reflects the process of development of the modeling object. The horizontal of the cross, which on the one hand is limited by an unrenewable resource, and on the other, an extremely inexhaustible resource, which corresponds to the resources used for development. The systematization of methods of mathematical, informational and logical modeling allowed developing a mathematical apparatus for the system-situational model of business activity (MODUZ).

***Key words:** system-situational model of modeling object development*

В статті адаптовано кібернетичну концепцію управління в просторі граничних ресурсів та станів об'єкту розвитку (КУРСОР+) до бізнес-діяльності підприємства. Сучасні соціально-економічні відносини формують нові вимоги до підприємств, що диктуються як високими стандартами і вимогами до якості товарів, так і існуючою конкуренцією між підприємствами (виробниками продукції). Дані вимоги змушують підприємства доволі гнучко і досить вчасно реагувати на зміни, що відбуваються як у ринковій, так і виробничій ситуації. На сучасних підприємствах виникає комплекс проблем, пов'язаних з цілеспрямованою переорієнтацією випуску продукції нової номенклатури й асортименту, впровадженням новітніх технологій, проведенням реконструкції, розвитком маркетингу, удосконаленням структури управління підприємством, здійсненням підготовки і перепідготовки кадрів. В результаті перед кожним підприємством виникає ряд глобальних задач: аналіз існуючої ситуації і стану фірми; обґрунтування постановки мети фірми;

вибір найбільш ефективних варіантів рішень виявлених проблем. Реалізація системного підходу потребує корінного змінення методологічного арсеналу досліджень і управління, яке дозволяє погоджувати складність проблем і простоту їх рішення, кількість і якість, надійність і економічність. Відсутність такого арсеналу вимагає здійснення на кожному кроці натурних експериментів, які призводять до непередбачуваних, іноді необоротних або згубних, наслідків для підприємства. Концепція КУРСОР+ має такі складові: системно-ситуаційна модель розвитку, проблемно-діагностична модель, модель універсаму станів об'єкта, модель універсаму знань про стані об'єкта. Системно-ситуаційної моделі розвитку об'єкта моделювання є хрестоподібна чотирьохполюсна оболонка, а простір обмежений полюсами є простором розвитку об'єкта моделювання. Вертикаль цього уявного хреста, обмежена зверху гранично позитивним, а знизу гранично негативним полюсом і відображає процес розвитку об'єкта моделювання. Горизонталь хреста, яка з одного боку, обмежена гранично не відновлювальним, а з другого – гранично невичерпним ресурсом, що відповідає використовуваним для розвитку ресурсам. Систематизація методів математичного, інформаційного і логічного моделювання дозволили розробити математичний апарат для системно-ситуаційної моделі бізнес-діяльності (МОДУЗ).

***Ключові слова:** системно-ситуаційна модель розвитку об'єкта моделювання.*

В статье адаптировано кибернетической концепции управления в пространстве предельных ресурсов и состояний объекта развития (КУРСОР +) к бизнес-деятельности предприятия. Системно-ситуационной модели развития объекта моделирования является крестообразная четырехполюсная оболочка, а пространство ограничено полюсами есть пространством развития объекта моделирования. Вертикаль этого воображаемого креста, ограниченная сверху предельно положительным, а снизу предельно отрицательным полюсом и отражает процесс развития объекта моделирования. Горизонталь креста, которая с одной стороны, ограничена предельно невозобновимым, а с другой-предельно неисчерпаемым ресурсом, соответствует используемым для развития ресурсам. Систематизация методов математического, информационного и логического моделирования позволили разработать математический аппарат для системно-ситуационной модели бизнес-деятельности (МОДУЗ).

***Ключевые слов:** системно-ситуационная модель развития объекта моделирования.*

Problem statement. Modern socio-economic relations form new requirements for enterprises. These requirements are stipulated by both high standards and requirements for the quality of goods, and the existing competition between enterprises (product manufacturers). These requirements force enterprises to be flexible and timely enough to respond to changes in both the market and production situation.

The success of an enterprise largely depends on the ability of a decision maker to anticipate possible situations and, based on correctly made decisions, effectively plan the range and volume of products, investments and profits.

At modern enterprises, a set of available problems concerns the purposeful reorientation of the production output of new nomenclature and assortment, the introduction of new technologies, reconstruction, marketing development, improvement of the enterprise management structure, training and retraining of personnel. As a result, each enterprise faces some global tasks: analysis of the existing situation and the state of the company; rationale for setting the goal of the firm; selection of the most effective solutions to the identified problems.

At the present stage of development, any progressive solution associated with the system outside distant phenomena activates various processes in the technological, socio-economic and other areas of the enterprise. Therefore, when identifying both the immediate and the most distant consequences of a decision made under conditions of limited all types of resources, and especially the time factor, it is necessary to apply a systematic approach [1].

The implementation of a systematic approach requires a radical change in the methodological framework of research and management, which allows one to meet the complexity of problems and the simplicity of their solution, quantity and quality, reliability and economy. The lack of such an framework requires the implementation of natural experiments at the each step, which lead to unpredictable, sometimes irreversible or harmful, consequences for the enterprise.

Analysis of recent research and publications. A significant contribution to the development of theoretical and methodological aspects of modeling the system-situational approach to business activities of enterprises was made by the following well-known domestic and foreign scientists: Ruban V.Ya., Dubrova T.A., Chubukova O.Yu., Akoff R.L., Braverman E.M., Gurevich T.F., Anfilatov V.S., Emelyanov A.A., Kukushkin A.A, et al.

Unaddressed points of the overall problem. At the present stage of the development of science, there is a significant variety of types of economic and mathematical models for managing economic objects: analytical and applied, deterministic and stochastic. Economic and mathematical models are divided into: macro- and microeconomic, depending on the level of the object of modeling; dynamic, characterizing the change in control objects over time; static, describing the relations between various parameters, object indicators at a certain moment of time; discrete, reflecting the state of the control object at separate, fixed moments of time; continuous, characterizing the continuous change in the performance indicators of the object over time; simulation, which are used to simulate management objects using computer technology.

Following the type of mathematical apparatus used in the models, it is possible to distinguish economic and statistical correlation and regression models, linear (nonlinear) programming models, matrix, network, etc.

Goal setting. The accumulated experience and theoretical improvement of knowledge, methods of mathematical, informational and logical modeling make it possible to develop a mathematical apparatus for the systematic and situational model of business activity (MODUZ) [1].

Statement of the basic research material. The system-situational approach is the basis of the cybernetic concept of management in the space of boundary resources and states of the object of development (CURSOR +). This concept was proposed by V.Y. Ruban.

The simplest and clearest presentation of the system-situational model of the development of the modeling object looks like a cross-shaped four-pole shell. The vertical of this imaginary cross, bounded at the top by the extremely positive (preferable) and the extremely negative (dangerous) pole at the bottom, is adequate to such a fundamental concept as the process of development of the modeling object (MO). The horizontal of the cross, which on the one hand is limited by an urenewable resource, and by an extremely inexhaustible resource on the other hand, is adequate to the resources used for development. The space is limited by the given poles; it can be imagined as the space of development of the modeling object. The introduced concepts of the space of boundary resources and states of development objects became the basis for the title: "The concept of management in the space of boundary resources and states of development objects" (CURSOR +).

A meaningful interpretation of each of the poles of the vertical and horizontal of the four-pole shell is as follows. The extremely positive pole of the development vertical should be considered as the highly preferable limit of perfection of the modeling object, i.e., some of its ideals. The concept states that the ideal is an unattainable pole, but it can be approached indefinitely. The process of development of any object is regarded progressive if its essential properties monotonically approach the limit of perfection – "ideal". The unattainability of the "ideal" and, at the same time, the ability to get as close as possible to it, makes the process of progressive development potentially infinite, i.e., eternal. Sustainable development is progressive potentially infinite development. The real attainability of an ideal is limited to a positively arbitrarily small distance from the ideal.

The extremely negative pole of development of any object of reality in the concept means its extremely dangerous state, which causes significantly premature, contrary to the purpose of creation or life, cessation of functioning or even existence of the object under study. This condition is called a "catastrophe." And the concept (CURSOR +) is also called "ideals" and "catastrophes".

From a systemic standpoint, the boundaries of the ideal and catastrophes should be considered as system-forming invariants – constant in the life cycle of the object of modeling classes of its states. It is important to emphasize that any real-world object has a systemic-situational nature. The systemic nature of an object makes it possible to distinguish it from the environment and identify it as reality, and situationalism allows one to observe or control the space of its situational states within the systemic poles of development of this object. These poles, i.e., boundary states, set the boundaries of the progressive or regressive life cycle of the object of modeling, and situational poles reproduce the process of functioning and purposeful development, i.e., the change of states of this object. Situational states include a target (planned) state, adequate to the direct connection of the subject and the object of management, an actual (current), adequate to their feedback, an expected (forecast). Thus, the process of functioning and development of any object of reality can be featured by a space of states of five types of states – two boundary and three situational ones. In CURSOR + this space of states is called the "universe" of states.

The horizontal of resources is limited, on the one hand, by extremely unrenewable resource, in the role of which in the CURSOR + is a fundamental category of time (past, current (present, modern), future); on the other, the horizontal of resources is limited by an extremely inexhaustible resource, which progressively grows under the influence of its consumption. The role of this resource in CURSOR + is such a fundamental category as knowledge, i.e., true reflection of reality (past, present, future) in human thinking.

The article proposes MODUZ as one of the components of CURSOR +, which is adapted to the modeling of business activities of the studied object [1].

In a more detailed consideration of MODUZ [1; 2], the output arguments are: limiting types of resource – time (absolutely unrenewable resources); knowledge (absolutely non-versatile resources), limiting levels of development – "ideal" and "catastrophe".

The boundaries of time change in discrete form can be set by stationary time intervals (STI): T^p –STI of the past; T^{pr} – STI of the present; T^f – STI of the future. It is clear that $T^p < T^{pr} < T^f$.

Under the state of the object (enterprise) $P_s(t_i)$ at the moment of time t_i, it is necessary to determine P_s at the moment. The specific value of P_s is interpreted as a factor of objective reality, which can be expressed as a quantitative or qualitative measure that enables to distinguish between states over time. The set of properties of an object (enterprise) will be denoted by Q, and each individual property is correspondingly $q \in Q$. For an enterprise, such properties can be, for example, management, marketing, supply and sales, legal support, personnel, finance, technological process [3; 4].

The introduction of properties allows studying the development of an enterprise as a whole, its individual properties or their combinations. The values of the properties $P_{sq}(t_i)$ at the moment t_i are factors of reality; chain of these factors

$$P_{sq}(t_i);P_{sq}(t_{i+1});\ldots;P_{sq}(t_{i+k});\ldots$$

ordered by time, forms a factual model (FM) of the development of the object.

During the time at each next moment t_{i+1}, the values of the properties (all or individual) can either change or remain constant. The mapping of the set of values of the object $s \in S$ at the moment t_i into the set of its property values at the moment t_{i+1} is a development on the interval $\omega \in [t_i;t_{i+1}]$, or in symbolic form:

$$P_{sq}(t): P_{sq}(t_i) \to P_{sq}(t_{i+1}).$$

If the values of the properties P_{sq} do not change on the interval ω, then such a development is considered degenerate: $P_{sq}(\tau): P_{sq}(t_i)$.

Obviously, when the moments of time t_i belong to the stationary interval of the past time $t_i \in T^p$, then the corresponding FM is retrospective and reflects the history of enterprise development; if $t_i \in T^{pr}$, then FM corresponds to the trajectory of the present development; in the case when $t_i \in T^f$, FM corresponds to the trajectory of the prospective development of the enterprise.

In the study, and especially in the management of enterprise development process, the issue of the direction and speed of this process is important. The selected limiting classes of states allow us to determine two mutually opposite directions of enterprise development: development (movement) towards the ideal – ρ^i and movement towards catastrophe – ρ^k. These directions correspond to the process of progressive development, in which the values of essential properties are monotonously directed towards the vicinity of the ideal, and regressive, in which the values of essential properties are monotonously removed from the ideal and end up in the vicinity of catastrophe [5].

The complete variety of states in studying or making managerial decisions on the development of an enterprise can be represented by the matrix model of the set of states (Table 1), where the following levels of knowledge reification (LKR) are indicated in rows: P_{sq}^i – ideal; P_{sq}^k – catastrophe; P_{sq}^t – target; P_{sq}^f – forecast; P_{sq}^a – achieved; the columns indicate STI; the elements are LKR with the moments of STI.

One of the highlighted properties of the enterprise is the sale of products. Obviously, employees of an enterprise that manufactures some products receive wages when their products are sold, that is, under the state of the object $P_{sq}(t_i)$ it is suggested to consider the volume of sale of some products at the moment $t_i - P_{sn}(t_i)$.

The state of the ideal $P_{sq}^i(t_i)$ is a state that does not require any expenses for its existence. It is clear that such a state cannot be achieved, but one can head to it without limit (perpetual motion machine) [1; 2]. Therefore, determining the state of the ideal for sales it should be assumed that it is equal to some value N, which tends to infinity:

$$P_{sn}^i(t_i) = N, if\ N \to \infty.$$

From an economic point of view, this means that the market demand for the products of this enterprise is constantly growing.

The use of a quantitative measure to determine states allows us to assume that the state of catastrophe $P_{sq}^k(t_i)$ for sales is some value ε, which tends to zero:

$$P_{sn}^{\kappa}(t_i) = \varepsilon, if\ \varepsilon \to 0.$$

From an economic point of view, this means that the company's products are not in demand among consumers.

The achieved state P_{sn}^a is obviously specified as statistics of sales volumes over the past years.

To construct FM and assess development, it is necessary to use the main dynamics indicators [3]: absolute growth characterizes the change in the indicator after a certain period of time; growth rate characterizes the intensity of changes in

Table 1

The model of possible states of business objects

State \ time	**Past T^p**	**Present T^{pr}**	**Future T^f**
Ideal P_{sq}^i	Ideal $P_{sq}^i(T^{м})$	Ideal $P_{sq}^i(T^{pr})$	Ideal $P_{sq}^i(T^f)$
Catastrophe P_{sq}^k	Catastrophe $P_{sq}^{\kappa}(T^p)$	Catastrophe $P_{sq}^{\kappa}(T^{pr})$	Catastrophe $P_{sq}^{\kappa}(T^f)$
Target P_{sq}^t	Target ^{past} $P_{sq}^t(t_i^p)$	Target^{present} $P_{sq}^t(t_i^{pr})$	Target^{future} $P_{sq}^t(t_i^f)$
Forecast P_{sq}^f	Forecast^{past} $P_{sq}^t(t_i^p)$	Forecast^{present} $P_{sq}^f(t_i^{pr})$	Forecast$_{future}$ $P_{sq}^f(t_i^f)$
Achieved P_{sq}^a	Achieved^{past} $P_{sq}^t(t_i^p)$	Achieved^{present} $P_{sq}^a(t_i^{pr})$	Achieved^{future} $P_{sq}^a(t_i^f)$

Table 2

The main indicators of dynamics

Indicator	Absolute increase	Growth rate, %	Increase rate,%
Average	$\bar{y} = \frac{y_n - y_1}{n-1}$	$\bar{T} = \sqrt[n-1]{\frac{y_n}{y_1}}100$	$\bar{K} = \bar{T} - 100$

the levels of the series and shows the difference between levels; increase rate shows the difference between the comparative level comparated to the basic one.

Moreover, each of the above indicators can be of three types: chain, basic, average. The greatest interest for statistical analysis is average absolute increase, average growth rate, average increase rate, because these indicators are generalizing characteristics of the dynamics (table 2) [6].

The description of the dynamics of the series using the average absolute increase also allows us to get a forecast for L steps ahead:

$$\bar{y}_{n+L} = y_n + L\bar{y}\ .$$

This value is used to determine $P^a_{sn}\left(t^f_i\right)$. An example of using the described methodology will serve as data on the volume of sales of products of a certain enterprise (tab. 3).

Table 3

The volume of sales of enterprise's products

Quarter	The volume of sales			
	2017	2018	2019	2020
I	56.0	57.2	58.4	59.3
II	54.5	55.6	56.9	58.2
III	55.2	56.2	57.1	58.3
IV	59.3	60.4	61.5	-

Absolute increase:

$$P^a_{\bar{y}_n}\left(t^f_i\right) = \frac{61.50 - 56.00}{12-1} = 0.50;$$

$$P^a_{\bar{y}_n}\left(t^{pr}_i\right) = \frac{58.30 - 56.00}{15-1} = 0.16;$$

$$\bar{y}_{16} = 58.3 + 1 * 0.16 = 58.46;$$

$$P^a_{\bar{y}_n}\left(t^f_i\right) = \frac{61.50 - 58.46}{16-1} = 0.20.$$

Average sales of products to 2019 grew monthly by 0.5 thousand pieces. In 2020, this value decreased to 0.16 thousand units. Having predicted the data for the IV quarter 2020, the volume of sales will increase by only 0.2 thousand units at the end of 2020.

Growth rate:

$$P^a_{\bar{T}_n}\left(t^p_i\right) = \sqrt[11]{\frac{61.50}{56.00}} * 100 = 100.8\%;$$

$$P^a_{\bar{T}_n}\left(t^{pr}_i\right) = \sqrt[14]{\frac{58.30}{56.00}} * 100 = 100.3\%;$$

$$P^a_{\bar{T}_n}\left(t^f_i\right) = \sqrt[15]{\frac{58.46}{56.00}} * 100 = 100.3\%.$$

On average, product sales were 100.8% of the level of previous quarter until 2020; 100.3% – in the III quarter of 2019; 100.3% – taking into account the forecast data of the IV quarter.

Increase rate:

$$P^a_{\bar{K}_n}\left(t^p_i\right) = 100.8\% - 100\% = 0.8\%;$$

$$P^a_{\bar{K}_n}\left(t^{pr}_i\right) = 100.3\% - 100\% = 0.3\%;$$

$$P^a_{\bar{K}_n}\left(t^f_i\right) = 100.3\% - 100\% = 0.3\%.$$

On average, monthly sales grew by 0.8% until 2019. In 2020, this value decreased and amounted to 0.3% in the first three quarters. Taking into account the forecast data of the IV quarter, the sales of 2020 will also increase by 0.3%.

Let us construct FM:

$$P^a_{\bar{y}_n}\left(t^p_i\right) > P^a_{\bar{y}_n}\left(t^{pr}_i\right) > P^a_{\bar{y}_n}\left(t^f_i\right) > 0;$$

$$P^a_{\bar{T}_n}\left(t^p_i\right) > P^a_{\bar{T}_n}\left(t^{pr}_i\right) \approx P^a_{\bar{T}_n}\left(t^f_i\right);$$

$$P^a_{\bar{K}_n}\left(t^p_i\right) > P^a_{\bar{K}_n}\left(t^{pr}_i\right) \approx P^a_{\bar{K}_n}\left(t^f_i\right).$$

Therefore, at each of the time intervals: past, present and future, there should be a positive development of the enterprise. The analysis also shows that, although the volume of product sales continues to grow in 2020, but the rate of this growth has decreased, that is, the enterprise needs to analyze the products it manufactures: its quality, variety, market saturation, etc. [7].

Conclusions. The proposed economic and mathematical methods for describing the achieved state of MODUZ make it possible to analyze and evaluate the achieved state of all elements that fill the space of business administration. Such assessments, firstly, allow avoiding a catastrophe when making management decisions, since they reveal implicit tendencies; secondly, they will make it possible to determine the goals of the enterprise's future development correctly.

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