https://doi.org/10.15407/scine22.03.080

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MATHEMATICAL MODELLING OF THE IMPACT OF GENERAL INDICATORS OF THE BASIC ADMINISTRATIVE MANAGEMENT SYSTEM ON THE PERFORMANCE OF AN ENTERPRISE (ORGANIZATION, INSTITUTION)

Introduction. *Contemporary management faces the challenge of determining which managerial innovations should be systematically integrated into administrative decision-making in order to ensure the sustainable development of a legal entity and to secure stable competitive and reputational advantages.*

Problem Statement. *There is a need to develop a scientifically grounded approach to assessing the overall performance of the Basic Administrative Management System (BAMS), considered as a type of information and communication system that facilitates the rational achievement of expected results, while taking into account organizational performance outcomes, administrative documentation practices, environmental factors, and the implementation of managerial innovations.*

Purpose. *The purpose of this study is to provide the scientific substantiation of a mathematical model that captures the impact of the general indicators of the Basic Administrative Management System on the performance of an enterprise (organization, institution), while identifying the characteristic functional interrelationships among its constituent elements.*

Materials and Methods. *The research draws upon a comprehensive review of relevant scholarly sources and applies mathematical modelling, analytical and synthetic methods, graphical modelling techniques, economic modelling approaches, and systems-based analytical frameworks.*

Citation: Minenko, M. A., Husak, Yu. A., Mashtalir, V. V., Shovkoshytnyi, I. I., Minenko, L. M., and Marchenko, A. O. (2026). Mathematical Modelling of the Impact of General Indicators of the Basic Administrative Management System on the Performance of an Enterprise (Organization, Institution). *Sci. innov.*, 22(3), 80—94. https://doi.org/10.15407/scine22.03.080

Results. *The study has demonstrated, through the use of formulas, diagrams, and formalized models, the influence of the system's general indicators on organizational performance outcomes. The conditions required for the effective implementation of this managerial innovation have been identified and conceptually justified. Furthermore, the management process of a legal entity has been formally represented and analytically structured in order to evaluate the administrative significance of the identified indicators within the operational environment.*

Conclusions. *The findings have confirmed the substantive significance of the general indicators of labor organization and of the Basic Administrative Management System as determinants of organizational performance. The proposed approach enables the adaptation of mathematical models to the institutional and operational conditions of a specific legal entity and supports the development of a methodological framework for their practical application as an analytical instrument for achieving sustainable competitive and reputational advantages.*

Keywords: basic administrative management system, information and communication system, general indicators of administrative performance, managerial innovations, mathematical modelling, administrative decision-making, sustainable development, competitive and reputational advantages.

Any enterprise (organization or institution) constitutes a systemic entity in which numerous informational, technological, technical, social, and humanitarian processes operate relatively autonomously while simultaneously interacting with one another. These processes also encompass the administration of organizational development and growth. Managers are therefore required to regularly analyze organizational performance outcomes, systematically evaluate and account for the behavior of environmental factors influencing their activities, and consider existing constraints and recommendations that have been agreed upon with stakeholders and formally approved through internal organizational regulatory (administrative) documents.

At the same time, it is important to recognize that these formal regulations define and institutionalize the substantive and methodological potential of the general indicators (elements and subsystems) of the Basic System of Administrative Management (hereinafter referred to as BSAM). This system establishes the foundational framework for the effective functioning of the overall organizational management system of a particular legal entity [1, 2].

Given the above, whenever an operational or production problem arises, administration becomes an integrated task within the process of preparing, adopting, and implementing an administrative decision. Such integration is necessary to ensure the rational resolution of the problem under the prevailing conditions and to facilitate the most effective coordination and direction of synergistic influences, whether through mechanisms of enforcement or motivation.

In this context, the authors have analyzed scientific studies devoted to issues of mathematical modeling, which has made it possible to clarify the functional potential of the general indicators of BSAM (hereinafter referred to as general indicators of activity administration) [3, 4]. In particular, study [5] presents the principles of the theory of multi-level hierarchical systems and proposes specific classes of hierarchical structures, including strata, layers, and echelons. These structures differ in the principles governing the relationships among elements within the same level and in the degree of intervention that higher hierarchical levels may exert in organizing interactions and relationships among elements at lower levels.

However, the provisions of this theory allow only the description of the process of constructing abstract mathematical models of complex hierarchical systems. Therefore, they require a certain degree of methodological adaptation in order to adequately represent the BSAM model. A similar conclusion can be drawn regarding [6].

In addition, studies conducted by researchers who have explored the application of mathematical modeling within the theory of enterprise management have also been systematically examined [7, 8]. At the same time, the contemporary foundations of management theory and practice,

as well as the theoretical principles and applied aspects of administrative management, have been carefully taken into account [9—11].

Study [12] investigates mathematical models and methods of personnel management which, within the management cycle, operationalize administrative management decisions through processes of staff selection, placement, and professional development. The theory of Markov processes constitutes the basis of the mathematical apparatus, allowing a complex management system to be represented as a queuing system. However, the system of administrative management cannot be adequately represented by such a model without introducing a number of simplifying assumptions and substantial analytical constraints.

Furthermore, the work of M. A. Kukhar deserves particular attention. Based on the methodological framework of category theory, the researcher has proposed conceptual models for the implementation of decision-support systems within multi-level administrative governance structures. These models make it possible to formally represent domain-specific knowledge within decision-support systems designed to address specific managerial tasks and decision-making scenarios [13].

Among foreign studies available in open access, there are also contributions in which mathematical modeling is characterized as a professional and analytical task within administrative management. In particular, C. Telles has proposed a mathematical heuristic model for analyzing information flows within administrative workflow systems [14]. In turn, J. Tick and A. Tick have investigated simulation modeling approaches for workflow processes that reflect administrative governance activities. The purpose of such simulations is defined as conducting dynamic analysis of workflow models, identifying operational bottlenecks, and optimizing the allocation and utilization of organizational resources [15].

At present, the theory and practice of administrative management continue to evolve and expand. Within this context, the BSAM concept has been introduced and conceptually articulated [16]. The tasks of administration have been specified, their interrelationships with the functional responsibilities of staff members have been theoretically substantiated, and the structure and scope of internal organizational regulatory (administrative) documents have been systematically characterized [1]. Some studies have been devoted to improving the indicators of administrative enforcement and motivational influence, identifying the positive applied potential of these mechanisms, and analyzing the impact of comprehensive digitalization on existing management systems, particularly within the defense sector [2].

In summary, it should be emphasized that only a limited number of researchers have focused specifically on the development of mathematical models in the field of administrative management. The application of mathematical modeling for assessing the influence of the general indicators (elements and subsystems) of the BSAM on the effectiveness of the overall organizational management system of an enterprise (organization or institution), as well as on the performance outcomes of the organization as a whole, has not yet been sufficiently investigated. This circumstance further confirms the relevance, scientific significance, and timeliness of the research objectives pursued by the authors of this article.

The purpose of this study is to provide a scientific substantiation of a mathematical model that reflects the influence of the general indicators of the BSAM on the performance results of an enterprise (organization or institution), while identifying the characteristic functional relationships that emerge among its constituent elements.

One of the key methodological approaches applied in this study is mathematical modeling. At the outset, it should be emphasized that in order to ensure a reliable and analytically grounded assessment of the consequences of administrative influence — whether exercised through enforcement mechanisms or motivational incentives — implemented through the general indicators of activity administration and through the BSAM as an integrated system, on the effectiveness of the performance of a particular enterprise (organization or institution), its structural units, or individual staff

members, it is necessary to employ the mathematical methods of management theory [7].

To accomplish this objective, the management system must initially be conceptualized as a set consisting of two components:

- the subject of management, that is, the head, administration (management apparatus), a collegial or collective statutory body, or a manager (hereinafter referred to as the controlling subject (CS));
- the object of management, that is, a staff member, a structural unit, or an enterprise (organization or institution) (hereinafter referred to as the controlled object (CO)).

Under these conditions, the management process, which includes feedback, can be represented as a set of actions, operations, and procedures involving direct or indirect influence of the controlling subject (CS) on the controlled object (CO). This process is carried out in order to achieve the desired performance outcomes within clearly defined timeframes, with the rational use of resources, given previous achievements as well as internal and external circumstances that may exert direct or indirect influence.

In addition, particular importance is attributed to the general indicators of activity administration, which are duly agreed upon with stakeholders and approved by internal organizational regulatory (administrative) documents. The official significance of such documents characterizes the substantive and methodological foundational potential of labor administration within a specific legal entity and objectively defines the duties, rights, and responsibilities of each participant involved in the corresponding process [1] (Fig. 1).

During the implementation of the management process, the state of the controlled object (CO) changes continuously over time. Therefore, the general expression for the vector of its state $\vec{x}(t)$, after the implementation of an administrative decision, can be represented as follows [7, 8]:

$$\frac{d\vec{x}(t)}{dt} = f\left(\vec{x}(t), \vec{u}(t)\right), \qquad (1)$$

where: $\vec{x}(t)$ is the state vector of the controlled object (CO) based on previously obtained performance results; $\vec{u}(t)$ is the vector of administrative decisions adopted by the controlling system (CS).

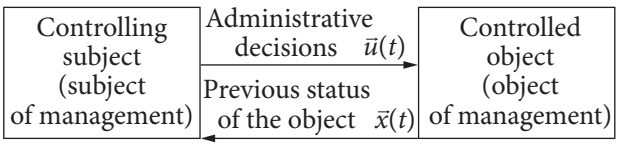

Fig. 1. General flowchart of the management process
Source: compiled by the authors based on the results of the study using [7].

Further, the authors have conducted a step-by-step analysis of the influence of the general indicators of activity administration and BSAM as a whole, as well as the factors that objectively determine the real state of the controlled object (CO) following the implementation of an administrative decision.

Thus, the influence of CS on CO relates to the processes of organizing purposeful work to achieve a defined Goal. This Goal must necessarily correspond to the Values, Vision, Mission, Outlook, and Policy of a particular legal entity. However, the Goal may change over time and may be adjusted depending on previous achievements, internal conditions (including actual capabilities), the external situation, and the formal guidelines of current regulations.

In this context, it should be understood that goals, structure, tasks, technology, personnel, and resources constitute a group of internal environment factors (hereinafter — IE). At the same time, the following elements — consumers, suppliers, competitors, government authorities, infrastructure, legislative acts, trade unions (parties and other public organizations), the system of economic relations within the state, and neighboring organizations — are factors of the external environment of direct effect (hereinafter — EEDE). Meanwhile, international events, the international environment, scientific and technological progress, political circumstances, socio-cultural conditions, the level of technology and equipment, the specifics of international economic relations, and the state of the economy form the list of fac-

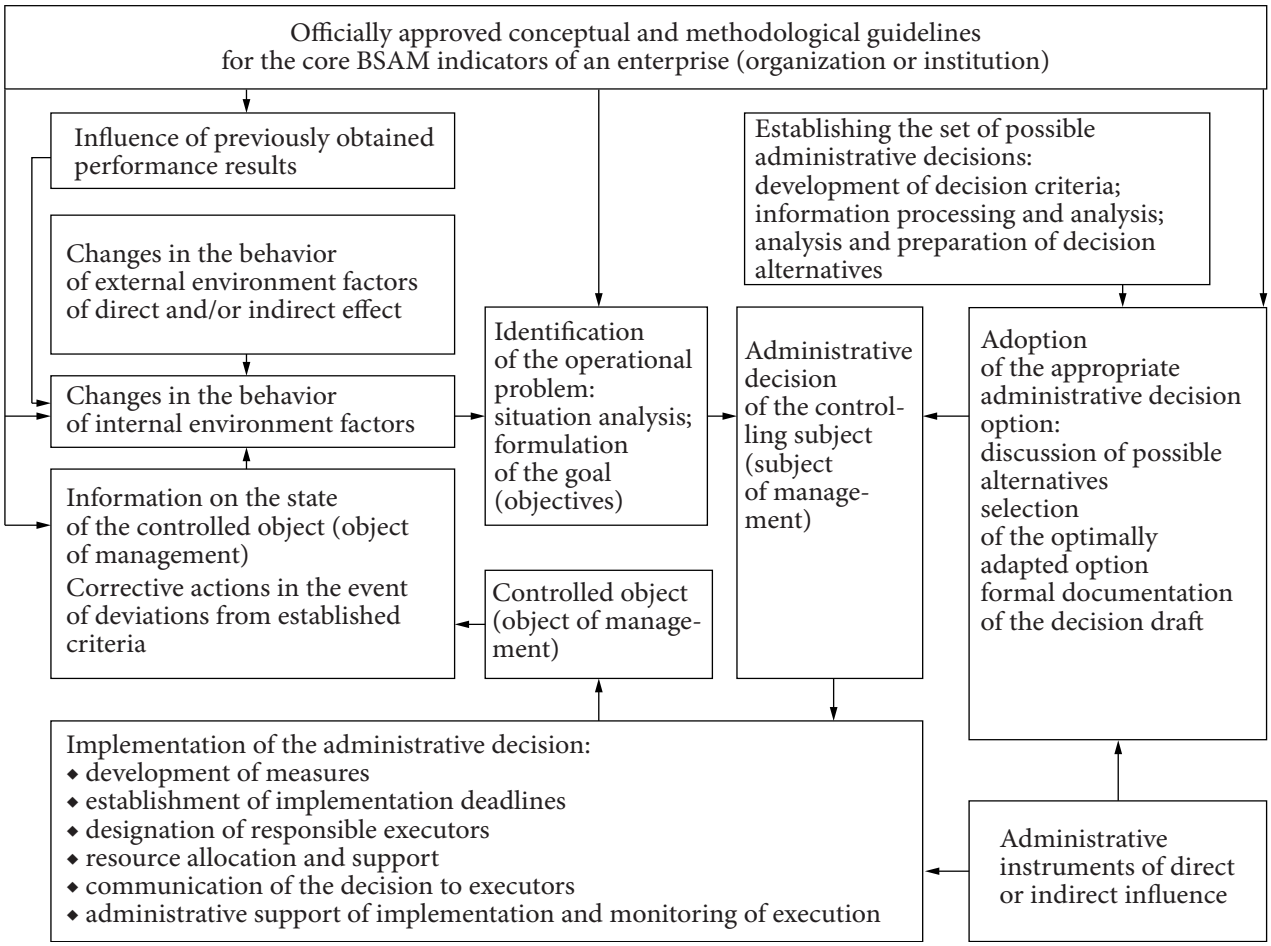

Fig. 2. Visualized scheme of the process of preparation, adoption, and implementation of administrative decisions
Source: compiled by the authors based on research results using [9—11].

tors of the external environment of indirect effect (hereinafter — EEIE) [9].

In addition, it should be emphasized that each CS, while performing the official duties delegated to them, carries out a continuous function of administrative management, namely the preparation, adoption, and implementation of administrative decisions [8]. An appropriate administrative decision, according to established criteria, is selected from a set of possible administrative decisions, which represents a certain collection of alternatives regarding the influence of the CS on the CO. Such a set may contain either a limited or an unlimited number of alternatives. From this set, taking into account the objective and subjective circumstances of the production problem, including previously obtained performance results, the possible behavior of factors of the external environment of direct and/or indirect effect (EEDE and/or EEIE) and internal factors, and — most importantly — the standardized guidelines of the general indicators of the BSAM, a rational decision is chosen. This choice aims to ensure the best operational mode, enabling the effective, timely, and successful achievement of the established Goal [developed by the authors based on research results using sources [3 and 8].

To evaluate potential options for solving a production problem and to select the optimal one,

not a single criterion but several criteria are used, which help to perform a rational selection. In this case, a multicriteria problem is solved.

In this way, the selected criteria make it possible to realistically assess the content-methodological potential of the restrictions and recommendations of the general indicators of the BSAM, as well as the influence of the controlling subject and the possibilities for productive and effective performance of the controlled object.

A visualized scheme of the process of preparation, adoption, and implementation of administrative decisions is presented in Fig. 2.

The actions, operations, and procedures (Fig. 2) are regulated by internal guidelines. In addition, their effectiveness depends on previously obtained performance results, the behavior of factors of the external environment of direct and/or indirect effect, and changes in factors that determine the state of the internal environment. However, it is precisely the official guidelines that characterize the actual general indicators of the BSAM of a particular legal entity.

In practice, such a system is considered a guarantee of the stable effectiveness of the general organizational management system and a foundation for the implementation of organizational innovations, including certification for compliance with Technical Regulations and/or Standards and the requirements of one of the Business Excellence models, for example: Australian, American, European, Ibero-American, Indian, Singaporean, or Japanese [16].

This is explained by the fact that, from a practical and legal perspective, the BSAM — as a type of information and communication systems — represents an officially structured set of relatively separate but interdependent general content-methodological indicators (elements and subsystems) of activity administration. Through professionally organized cross-cutting subsystems of Communication with Stakeholders and Record-Keeping and Documentation of Activities, and through formally legalized documents — such as the Charter; File Classification System (Records Schedule); Staffing Schedule; Organizational Management Structure; Regulation *On Remuneration*; Internal Labor Regulations; Instructions, including those on *Occupational Safety*, *Fire Safety*, and *Occupational Hygiene and Industrial Sanitation*, etc.; Regulations *On Information Policy* and *On Structural Units*; Job descriptions and, based on them, signed Contracts and Employment agreements — these elements, through the professional implementation of sequential and continuous functions of the administration (management apparatus) and the use of appropriate resource potential (including digitalization and, especially, innovative digital technologies and means of information and communication security), serve the effective and timely achievement of the established Goal(s).

These goals correspond to the adopted Values, Vision, Mission, Outlook, and Policy, as well as to the situationally selected development strategy(ies) and the organizational and legal form of economic activity. They do not contradict the norms of the approved Collective Agreement and Corporate Ethics Code, the chosen laws, principles, and management methods, and they also facilitate certification processes for compliance with Technical Regulation(s) and/or Standards, or the appropriate implementation of one of the internationally recognized Business Excellence models.

As a result, they ensure a regime of reliable, high-quality, rational, productive, and effective activity within the environment of the global economy and total digitalization. When necessary, they also form the basis for a profitable level of practical excellence and, above all, act as a guarantee of the effectiveness of the general organizational management system of a particular legal entity and, consequently, its sustainable development and ability to achieve the desired level of competitive and reputational advantages [developed by the authors based on research results using sources [1, 16].

Thus, it can be stated that the proper approval of the general indicators of the BSAM, which occurs through the official development of internal organizational administrative documents, plays

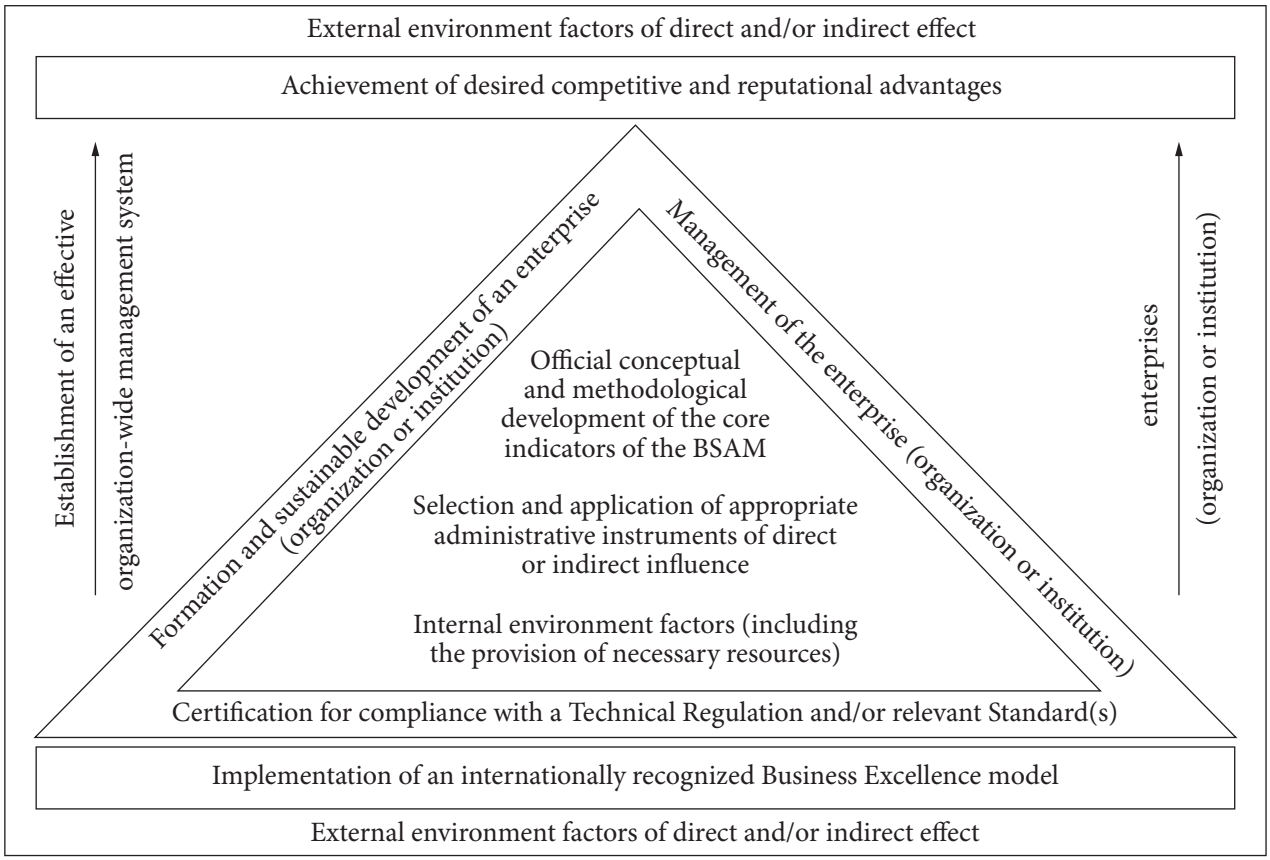

Fig. 3. Visualized model for ensuring sustainable development and achieving desired competitive and reputational advantages by an enterprise (organization, institution)
Source: compiled by the authors based on the results of the study using [1].

a key role in the regulated influence of the controlling subject on the controlled object. These documents are associated with the optimally adapted selection and effective application of appropriate administrative instruments of direct or indirect action for resolving a specific production situation.

The above-mentioned approach enables the governing body of a particular enterprise (organization or institution) — by using the available resource potential and applying modern management innovations, especially one of the internationally recognized models of business excellence — to ensure effective goal-setting aimed at the sustainable, rational, timely, and effective achievement of the defined Goal(s).

At the same time, this allows the organization to become a real leader in a particular field of activity, taking into account the possible behavior of factors of the external environment of direct and/or indirect effect, as well as objective changes in the factors influencing the state of the internal environment [2, 16] (Fig. 3).

For a more detailed representation of the general scheme of the management process (Fig. 1), it is presented taking into account the analysis of the specific features of the process of preparation, adoption, and implementation of administrative decisions (Fig. 2), as well as the model for ensuring sustainable development and achieving the desired advantages of a leader (Fig. 3) in the relevant field of activity (Fig. 4). Here: *B* is the module ge-

nerating the appropriate parameters of influence of the controlling system on the controlled object in response to changes in the behavior of internal environment factors (IEFs), which are formed under the influence of the factors illustrated in Figs. 2 and 3; A is the module accounting for the transformation parameters of the CO state after the implementation of an administrative decision produced by the CS, aimed at resolving the operational or production problem, while taking into account the factors shown in Figs. 2 and 3; $\vec{\nu}(t)$ is the vector of influence of the internal environment factors (IEFs) of the enterprise (organization or institution), whose state is determined, among other things, by the factors presented in Figs. 2 and 3; $\vec{\delta}(t)$ is the vector of influence of external system and operational environment factors (see Figs. 2 and 3).

Considering the analysis of factors presented in Figs. 2 and 3, it can be concluded that any administrative decision adopted by the CS (Figs. 1 and 4) is determined by the following expression:

$$\vec{u}(t) = A(t)\,\vec{x}(t) + B(t)\,\vec{\nu}(t), \qquad (2)$$

where: $A(t) = ||a_{kj}||$ is the transformation matrix of the BSAM that converts one state vector of the controlled object (CO) into another by multiplying its coordinates with the values of the previous coordinates. This matrix represents the transition of the CO state, based on the influence of previously obtained performance results $\vec{x}(t)$, to the subsequent moment in time after the implementation of an administrative decision, given the factors illustrated in Figs. 2 and 3; a_{kj} are the elements of the transformation matrix (coordinates characterizing rotation, translation, scaling, and inclination of the CO state vector based on previously obtained results) of the BSAM; $B(t) = ||b_{kj}||$ is the decision-generation matrix of the controlling system (CS), which determines the administrative decision, taking into account the influence of the factors depicted in Figs. 2 and 3; b_{kj} are the elements of the decision-generation matrix (coordinates characterizing rotation, translation, scaling, and inclination of the vector $\vec{\nu}(t)$ representing the CS administrative decision); $k = (1, \ldots, n)$, $j = (1, \ldots, m)$

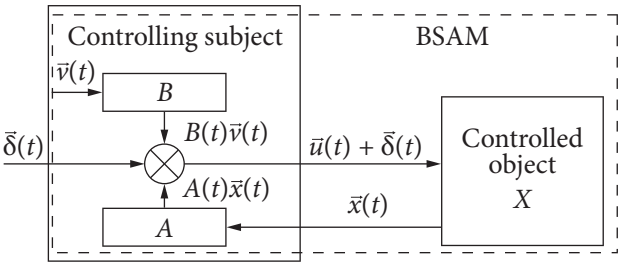

Fig. 4. Structural scheme of the management process over time *t*, taking into account the processes of preparation, adoption, and implementation of administrative decisions, as well as ensuring sustainable development and achieving the desired competitive and reputational advantages by an enterprise (organization, institution)
Source: compiled by the authors based on the results of the study using [3, 4, 7, 8, 15].

is the number of elements in the rows and columns, respectively, of the matrixes $||a_{kj}||$ and $||b_{kj}||$.

Given expressions (1) and (2), the vector $\vec{x}(t)$ at the subsequent moment in time is calculated using a differential equation that characterizes the administrative management process of the legal entity, effectively incorporating the previously analyzed processes depicted in Figs. 2 and 3:

$$\frac{d\vec{x}(t)}{dt} = A(t)\,\vec{x}(t) + B(t)\,\vec{\nu}(t) + \vec{\delta}(t). \qquad (3)$$

Reproducing the complete set and precise sequence of the general indicators of the BSAM, as well as assessing their role, significance, and the specifics of their interdependence, increases the demands on its functional-mathematical consistency. To ensure the reliability of results, it is necessary to strive for a balance between two rather complex tasks:

1. Accurately reflecting the general indicators of the established BSAM, which determine the vector of the primary purposeful influence of the CS on the CO, are considered during the implementation of administrative decisions (Fig. 2), facilitate the timely and rational achievement of Goals, and form the basis for the ongoing development of the legal entity (Fig. 3);

2. The complexity of the functional-mathematical construction of its analogue.

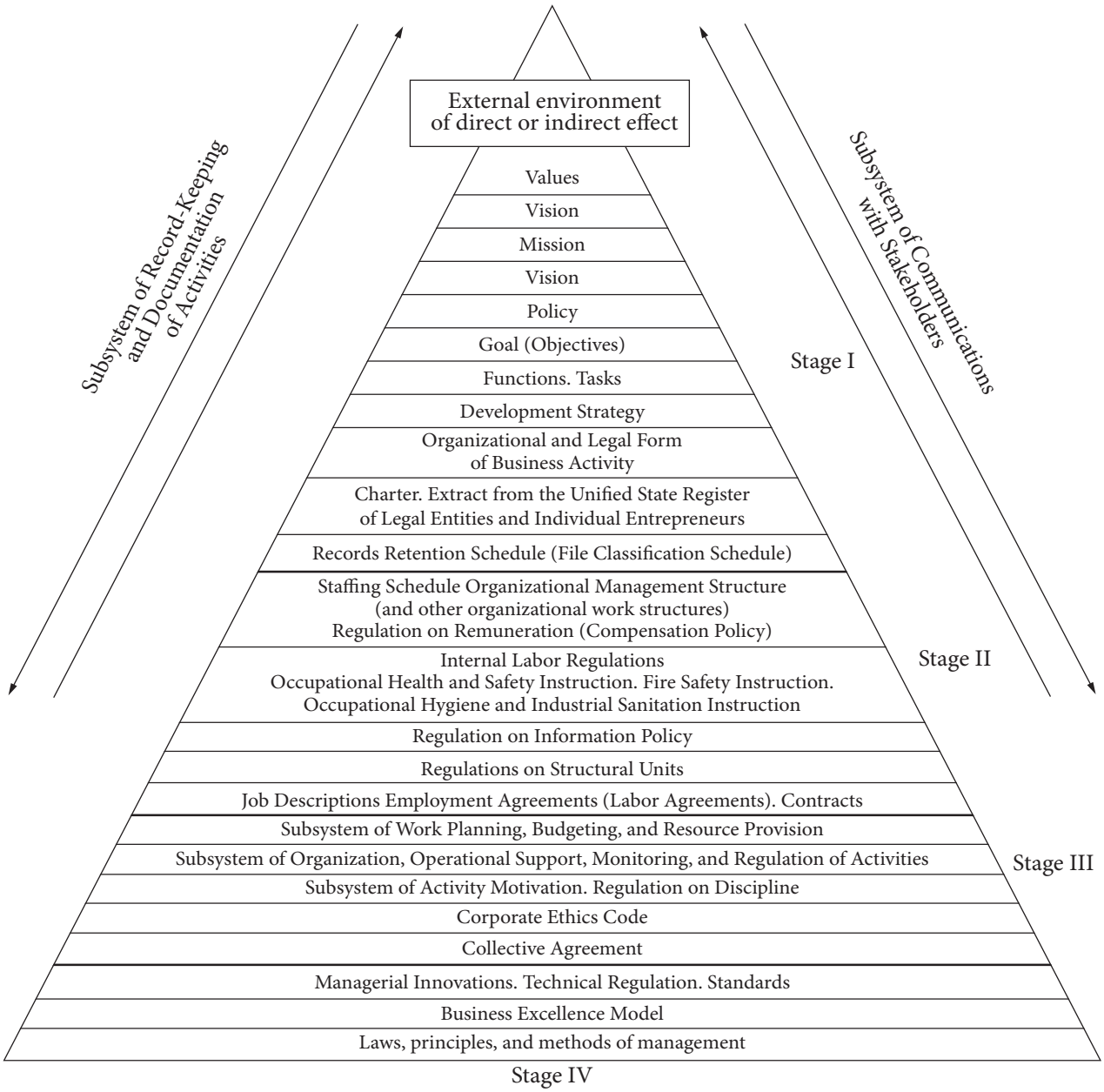

Fig. 5. Visualized model of the basic administrative management system of the enterprise (organization, institution)
Source: compiled by the authors based on research results using [1, 16].

Successfully addressing these tasks allows claiming that the set problem (hereafter referred to as the "task") has been solved. Modeling is advisable to carry out in three stages [3, 4, 8]:

- Stage I: The process of organizing work is recommended to be assessed from the perspective of systems analysis. At this stage, we immediately present a model of the legal entity's BSAM, which illustrates how the idea of initiating a business emerges and, subsequently, how all the general indicators of administrative activity are gradually formed, usually in four stages (Fig. 5).

Considering the presented model (Fig. 5) and recognizing the conceptual and methodological significance of each general indicator of administrative activity for the object of study selected, the second stage of modeling can be carried out:

- Stage II: At this stage, it is necessary to abstract from the specific nature of the general indicators in the visualized BSAM model and focus on the algorithms for solving the task we have posed. In other words, to ensure systematic representation of the foundational object of study, established mathematical tools should be employed, including both classical methods (numerical methods, differential equations theory, optimization, etc.) and modern approaches using computational algorithms (fuzzy logic, neural networks, genetic algorithms, etc.) [3, 4, 7, 8, 14, 15].
- Stage III: At this stage, it is appropriate to interpret the previously obtained solutions to the task: to verify whether they provide the most accurate representation of the BSAM as the established object of study and of the functional-mathematical construction of its analogue. These actions should serve to validate the results, identify new hidden properties, and reveal interconnections. If the obtained results do not pass the verification stage, it is necessary to return to the previous stages and adjust or revise the input data for the proposed mathematical model (3), which forms the basis of the functional-mathematical model [4, 14].

Despite these procedures, it is important to objectively consider that determining the appropriate place and role of each general indicator of the BSAM (Fig. 5) occurs sequentially and/or in parallel through the meaningful development of their administrative potential. As noted, these actions, operations, and procedures follow four relatively distinct, logically interconnected, and mutually complementary stages.

Particular attention should be paid to the formation of the *Subsystem for Communication with Stakeholders* and the *Subsystem for Record-Keeping and Documentation of Activities.* A key feature of the development of these subsystems is that the initiation of administrative work in their creation coincides with the inception of the idea to establish the legal entity. The completion of filling these general indicators occurs upon the formal transfer of official documents concerning the entity's activities to the archive, following its liquidation or reorganization, in accordance with regulations [1, 11].

The delineated stages of administrative activity in an enterprise (organization, institution) involve the development, coordination with key stakeholders, and formal official approval of the complete set of current internal organizational regulatory documents. These documents conceptually and methodologically define the actual place and role of each general indicator of the BSAM, both individually and in relation to others, as well as the optimal and adapted use of digitalization resources [1].

At the same time, it should be understood that general indicators such as *Values, Vision, Mission, Outlook, Policy, Goal(s), Functions, Tasks, Development Strategy(ies),* and the *Organizational-Legal Form of Management* by the governing body of a specific legal entity may, if necessary, be formalized in one or more official documents, such as the Charter or other acts. Under certain circumstances, the formation of subsystems for *Communication with Stakeholders* and *Record-Keeping and Documentation of Activities* requires regular updates to the corresponding regulations. However, in any case, to ensure sustainable development and achieve the desired level of competitive and reputational advantages, the significance of each individual general indicator of the BSAM (Fig. 5) remains essential [2, 16].

This analysis serves as the foundation for constructing a functional-mathematical model that justifies a unified approach to the conceptual development of the general indicators of the BSAM (Fig. 5). Accordingly, taking into account the features of the overall management process scheme (Fig. 1), the related processes (Figs. 2 and 3), and, under these conditions, the time-based management process (Fig. 4), and — most importantly — the stepwise formation of the BSAM's general indicators for the legal entity (Fig. 5), we can develop a functional

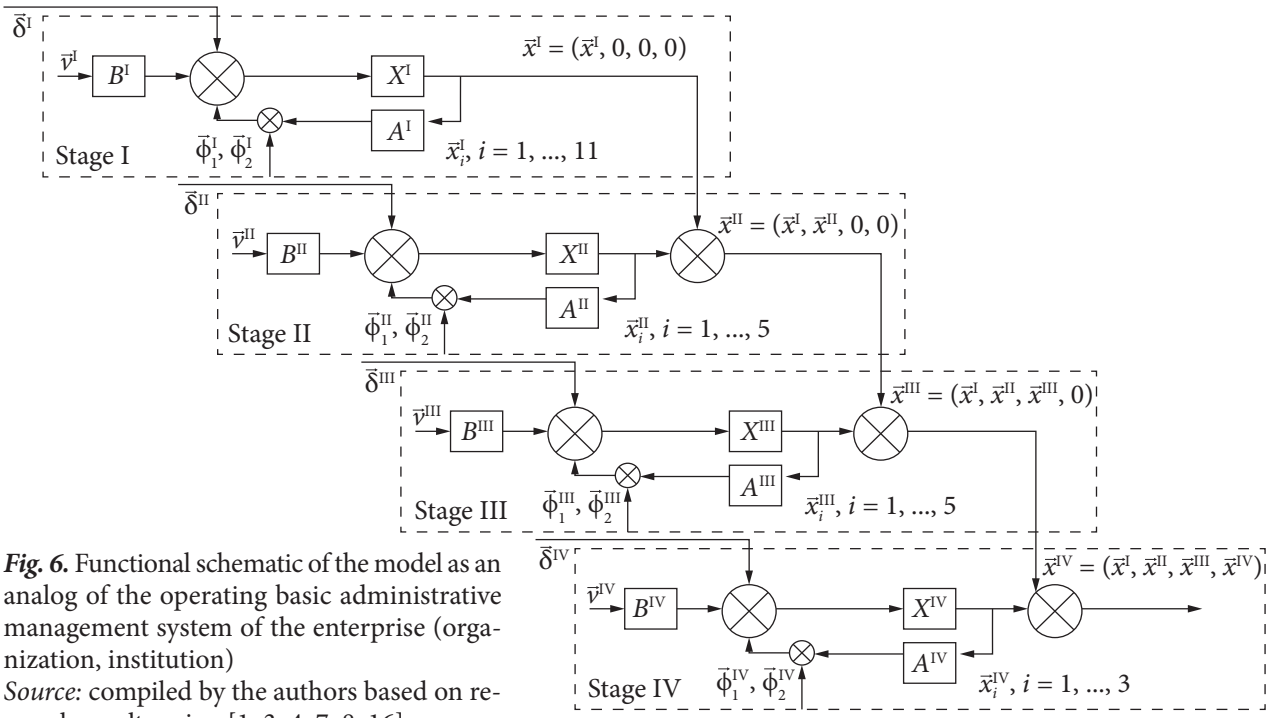

Fig. 6. Functional schematic of the model as an analog of the operating basic administrative management system of the enterprise (organization, institution)

Source: compiled by the authors based on research results using [1, 3, 4, 7, 8, 16].

Note: In Fig. 6, all vectors are, by default, considered time-dependent, with time denoted as t in Figs. 1 and 4 and in the expressions; ϕ represents the vector of internal influence at the corresponding stage N; $\vec{x}^{\mathrm{I}}, \vec{x}^{\mathrm{II}}, \vec{x}^{\mathrm{III}}, \vec{x}^{\mathrm{IV}}$ are the state vectors of the BSAM after the completion of Stages I, II, III, and IV, respectively.

schematic of the model as an analogue of the selected object of study.

This schematic is presented as a sequential, stepwise structure, where at each stage (N = I, II, III, IV) of administrative activity, the implementation of the expression (3) described above is required. This expression indeed characterizes the continuity of the management process within the enterprise (organization, institution) (Fig. 6).

Thus, at Stage N = I (Fig. 6), where 11 BSAM indicators are formed (see Fig. 5), the vector of internal environment factors (IE) serves as the input for module B^{I} (see Fig. 4). This vector generates the parameters of enforcement or motivation of the controlling system on the controlled object in response to changes in the behavior of internal factors, which may be determined by the elements shown in Figs. 2 and 3.

In turn, the object X^{I}, which is being managed at Stage N = I (Fig. 6), under the influence of the adopted administrative decision and taking into account the corresponding BSAM indicators for Stage I $\vec{x}_i^{\mathrm{I}}$, i = 1, …, 11 (see Fig. 5) and the behavior of external business environment and/or operating environment factors $\vec{\delta}^{\mathrm{I}}$ (see Fig. 4), forms the state vector of the CO after the implementation of the administrative decision: $\vec{x}^{\mathrm{I}} = (\vec{x}^{\mathrm{I},0}, \overrightarrow{0,0})$. The module for accounting of parameters A^{I} transforms the state of the CO $\vec{x}_i^{\mathrm{I}}$ in accordance with the directives established by internal organizational official documents, using the appropriate set of acts, actions, procedures, and operations of direct or indirect administration. This transformation also takes into account the behavior of relevant factors (Figs. 2 and 3) to ensure the legal entity's sustainable development and the attainment of desired competitive and reputational advantages [1, 16].

Next, at Stages N = II, III, and IV (Fig. 6) — where the following BSAM indicators are formed (Stage II: five indicators; Stage III: five indicators;

Stage IV: three indicators; see Fig. 5) — the process of generating the state vector of the controlled object X^N, aimed at the establishment and development of a given legal entity, is again carried out under the enforcement or motivational influence of directives established by internal organizational regulations. This process is repeated for each corresponding group ($\vec{x}_i^{\,\mathrm{II}}$, $i = 1, \ldots, 5$; $\vec{x}_i^{\,\mathrm{III}}$, $i = 1, \ldots, 5$; $\vec{x}_i^{\,\mathrm{IV}}$, $i = 1, \ldots, 3$), respectively, given the influence of external business environment and/or operating environment factors $\vec{\delta}^{\,\mathrm{II}}, \vec{\delta}^{\,\mathrm{III}}, \vec{\delta}^{\,\mathrm{IV}}$ (see Fig. 4), as well as the factors depicted in Figs. 2 and 3 [1, 16].

Next, at Stages N = II, III, IV (Fig. 6), where the following BSAM indicators are formed — Stage II: five indicators; Stage III: five indicators; Stage IV: three indicators (see Fig. 5) — the process of generating the CO state vector X^N, for the purpose of building and developing a given legal entity, is again carried out under the enforcement or motivation of directives established by internal regulations. This process is repeated for each corresponding group ($i = 1, \ldots, 5$ for Stage II; $i = 1, \ldots, 5$ for Stage III; $i = 1, \ldots, 3$ for Stage IV), taking into account the influence of external business environment and/or operating environment factors $\vec{\delta}^{\,\mathrm{II}}, \vec{\delta}^{\,\mathrm{III}}, \vec{\delta}^{\,\mathrm{IV}}$ (see Fig. 4), as well as the factors depicted in Figs. 2 and 3 [1, 16].

Moreover, at the output of each N stage of the functional schematic model, the actual influence of the *Record-Keeping and Documentation of Activities* $\vec{\varphi}_1^N$ and *Communication with Stakeholders* $\vec{\varphi}_2^N$ subsystems (Fig. 6), which are approved by separate regulations, is necessarily taken into account [1]. The resulting outcome is the CO state vector of the BSAM, based on the previously obtained performance results $\vec{x}(t)$ (see Fig. 6), which characterizes the management process of the legal entity. The absence (or disregard) or underestimation of the role of even a single general indicator of administrative activity (Fig. 5) reduces the accuracy of determining the overall vector of the state of the operating BSAM. This may lead to an increase in organizational entropy and, consequently, to a decrease in the efficiency and effectiveness of the work of individual staff members, structural units, and the enterprise (organization, institution) as a whole. Ultimately, it may prevent its sustainable development and become one of the main reasons for failing to achieve the desired competitive and reputational advantages [16].

For this reason, and considering that the management process of an enterprise (organization, institution) — given the specific features of the processes of preparation, adoption, and implementation of administrative decisions (Fig. 2), as well as the processes ensuring sustainable development and the attainment of the desired competitive and reputational advantages (Fig. 3) — is continuous, expression (3) should appropriately be written, taking into account Fig. 6, as a system of differential equations. In this system, each differential equation describes the process of administrative management at Stages I, II, III, and IV of the formation of the BSAM indicators:

$$\begin{cases} \dfrac{d\vec{x}^{\,\mathrm{I}}(t)}{dt} = A^{\mathrm{I}}(t)\vec{x}^{\,\mathrm{I}}(t) + \vec{\varphi}_1^{\,\mathrm{I}}(t) + \vec{\varphi}_2^{\,\mathrm{I}}(t) + \\ + B^{\mathrm{I}}(t)\cdot\vec{\nu}^{\,\mathrm{I}}(t) + \vec{\delta}^{\,\mathrm{I}}(t),\ \vec{x}^{\,\mathrm{I}}(0) = x(0) = (0,0,0,0), \\ \dfrac{d\vec{x}^{\,\mathrm{II}}(t)}{dt} = A^{\mathrm{II}}(t)\vec{x}^{\,\mathrm{II}}(t) + \vec{\varphi}_1^{\,\mathrm{II}}(t) + \vec{\varphi}_2^{\,\mathrm{II}}(t) + \\ + B^{\mathrm{II}}(t)\cdot\vec{\nu}^{\,\mathrm{II}}(t) + \vec{\delta}^{\,\mathrm{II}}(t), \\ \vec{x}^{\,\mathrm{II}}(0) = \vec{x}^{\,\mathrm{I}}(0) = \left(x^{\mathrm{I}}, 0, 0, 0\right), \\ \dfrac{d\vec{x}^{\,\mathrm{III}}(t)}{dt} = A^{\mathrm{III}}(t)\vec{x}^{\,\mathrm{III}}(t) + \vec{\varphi}_1^{\,\mathrm{III}}(t) + \vec{\varphi}_2^{\,\mathrm{III}}(t) + \\ + B^{\mathrm{III}}(t)\cdot\vec{\nu}^{\,\mathrm{III}}(t) + \vec{\delta}^{\,\mathrm{III}}(t), \\ \vec{x}^{\,\mathrm{III}}(0) = \vec{x}^{\,\mathrm{II}}(0) = \left(0, \vec{x}^{\,\mathrm{II}}, 0, 0\right), \\ \dfrac{d\vec{x}^{\,\mathrm{I}}(t)}{dt} = A^{\mathrm{IV}}(t)\vec{x}^{\,\mathrm{IV}}(t) + \vec{\varphi}_1^{\,\mathrm{IV}}(t) + \vec{\varphi}_2^{\,\mathrm{IV}}(t) + \\ + B^{\mathrm{IV}}(t)\cdot\vec{\nu}^{\,\mathrm{IV}}(t) + \vec{\delta}^{\,\mathrm{IV}}(t), \\ \vec{x}^{\,\mathrm{IV}}(0) = \vec{x}^{\,\mathrm{III}}(0) = \left(0, 0, \vec{x}^{\,\mathrm{III}}, 0\right). \end{cases} \quad (4)$$

Thus, the overall state vector of the BSAM after the completion of the four stages of forming its indicators, $\vec{x}(\mathrm{IV})$, is described by the following equation:

$$\vec{x}(\mathrm{IV}) = \vec{x}(0) + \sum_{i=\mathrm{I}}^{\mathrm{IV}} \vec{x}^{\,i}(t), \quad (5)$$

where: $\vec{x}(0)$ is the BSAM state vector at time $t = 0$; $\sum_{i=\mathrm{I}}^{\mathrm{IV}} \vec{x}^{\,i}(t) = \vec{x}^{\,\mathrm{I}}(t) + \vec{x}^{\,\mathrm{II}}(t) + \vec{x}^{\,\mathrm{III}}(t) + \vec{x}^{\,\mathrm{IV}}(t)$; $\vec{x}^{\,i}(t)$ are functions representing the change in the BSAM state at the i-th stage.

Thus, expression (4) may be considered the starting point for the mathematical formalization and evaluation of the applied influence of each BSAM general indicator, as well as other internal and external factors, on the management process of a particular enterprise (organization, institution), its structural units, and staff members, taking into account the defined stages of formation of a given legal entity (Fig. 5). At the same time, expression (5) describes this process as the sum of the contributions $\vec{x}^{\,i}(t)$ at each stage, i = I, …, IV. This makes it possible to confirm that disregarding even a single general element or subsystem of the BSAM — which formally and purposefully, through conceptual and methodological provisions, ensures enforcement and/or motivation toward safe, coordinated, rational, productive, effective, and timely work — as well as ignoring existing factors of direct and/or indirect influence, may lead to an imbalance in the overall organizational management system and make it impossible to ensure sustainable development or achieve the desired competitive and reputational advantages of the legal entity. In other words, this confirms that any existing internal organizational regulatory (administrative) act — including provisions *On Record-Keeping and Documentation of Activities* $\vec{\varphi}_1^{N}$ and *On Communication with Stakeholders* $\vec{\varphi}_2^{N}$ — formally obliges every staff manager of a particular enterprise (organization, institution), during the preparation, adoption, and implementation of administrative decisions (Fig. 2), to unequivocally take into account the conceptually and methodologically defined standards, rules, and recommendations of each general indicator of the BSAM (Fig. 5), which have been duly coordinated with stakeholders and officially approved, in order to support the organization's continuous development and the achievement of leadership in a given field of activity (Fig. 3).

In addition, managers must also take into account [1]:

- the influence of previously obtained performance results $\vec{x}(t)$;
- changes in the behavior of internal environment factors, including available resources and those that may be timely mobilized $\vec{v}(t)$;
- the projected state and possible changes in the behavior of factors of the external business environment and/or the operating environment $\vec{\delta}(t)$.

At the same time, if an enterprise (organization, institution) is certified for compliance with a Technical Regulation and/or Standard, or has implemented one of the internationally recognized Business Excellence models, this also necessitates the introduction of appropriate amendments and additions to the content of the existing internal regulations.

Moreover, it should not be overlooked that, in a specific operational situation, the choice of the required configuration of administrative instruments of direct or indirect action also depends on the conceptual and methodological potential of the existing internal organizational regulatory (administrative) documents.

Thus, administrative acts of direct action —particularly organizational acts —are essentially internal regulations that define the foundations of administration for any legal entity. The effectiveness of directive or reference acts, as well as the actions, operations, and procedures involved in organizing work (of both direct and indirect nature), also directly depends on the quality and substance of the general indicators (elements and subsystems) of the BSAM [1].

CONCLUSIONS

1. A functional mathematical model has been developed to describe the influence of the BSAM general indicators, considered as a type of information and communication system, on the performance results of an enterprise (organization, institution).

2. The enterprise management process has been formalized in the form of a system of differential

equations (4—5), which describes the change in the state of the controlled object depending on: previous performance results; vectors of influence from the internal and external environments; adopted administrative decisions; and the characteristics of the elements and subsystems of the BSAM.

3. Four stages of forming the BSAM indicators (I—IV) have been proposed, each characterized by a corresponding set of managerial parameters and its own functional influence on the performance results of the enterprise (organization, institution). The systemic nature of the model is ensured through the gradual contribution of each stage — Stage I (organizational and legal), Stage II (regulatory), Stage III (regulatory and functional), and Stage IV (strategic development) — to the overall BSAM effectiveness.

4. Model (5) demonstrates that the complete or partial omission of at least one BSAM general indicator in the management process may lead to a decrease in the integrated efficiency indicator of the enterprise.

5. The proposed model, as a managerial innovation, may be useful for the practical assessment of the level of administrative efficiency, forecasting the performance results of a legal entity, and optimizing the management system of personnel and resources.

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Received 21.07.2025
Revised 02.12.2025
Accepted 25.12.2025

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МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ ВПЛИВУ ЗАГАЛЬНИХ ПОКАЗНИКІВ БАЗОВОЇ СИСТЕМИ АДМІНІСТРАТИВНОГО МЕНЕДЖМЕНТУ НА РЕЗУЛЬТАТИ ДІЯЛЬНОСТІ ПІДПРИЄМСТВА (ОРГАНІЗАЦІЇ, УСТАНОВИ)

Вступ. Нині перед керівництвом постає завдання: які управлінські новації необхідно враховувати, реалізуючи адміністративні рішення, щоб забезпечити стійкий розвиток юридичної особи для здобуття конкурентнихі репутаційних переваг.

Проблематика. Розроблення наукового способу оцінювання загальних показників базової системи адміністративного менеджменту (різновиду інформаційно-комунікаційної системи, базису раціонального отримання очікуваних підсумків праці), зважаючи на досягнення у роботі, потенціал адміністративних документів, фактори внутрішнього та зовнішнього середовища, норми впроваджених управлінських новацій.

Мета. Науково обґрунтувати математичну модель, яка відображає вплив загальних показників базової системи адміністративного менеджменту на результати діяльності підприємства (організації, установи), із визначенням характерних функціональних взаємозв'язків між складовими елементами останньої.

Матеріали й методи. Досліджено джерела та використано методи математичного моделювання, аналізу та синтезу, графічний, діалектичний, економічного моделювання, системно-структурного та структурно-функціонального аналізу.

Результати. Використовуючи формули, схеми і моделі, доведено ефект впливу загальних показників досліджуваної системи на результати роботи юридичної особи. Окреслено умови результативності застосування такої управлінської новації. Вперше формалізовано процес керування юридичною особою для оцінювання особистої адміністративної ваги визначених показників означеної базової системи у відповідному середовищі функціонування.

Висновки. Результати підтвердили значення всіх загальних показників організації праці та базової системи адміністративного менеджменту. Запропоноване сприятиме подальшому пристосуванню математичних моделей до умов роботи конкретної юридичної особи і напрацюванню методики, що унормує використання розробленого та стане вагомим засобом гарантування конкурентних і репутаційних переваг.

Ключові слова: базова система адміністративного менеджменту, інформаційно-комунікаційна система, загальні показники адміністрування діяльності, управлінські новації, математичне моделювання, адміністративне рішення, стійкий розвиток, конкурентні та репутаційні переваги.