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**MODERN TRENDS IN THE FIELD OF FUNCTIONAL STABILITY  
OF COMPLEX SYSTEMS**

**Abstract.** *This paper explores the concept of functional resilience in organizations, highlighting its importance in management and strategic development. Functional resilience is a relatively new concept aimed at addressing the shortcomings of traditional analytical approaches, which often fail to consider critical aspects such as flexibility, adaptability, stability, endurance, and the ability to respond to challenges that may arise during the functioning of organizational structures. The key components of functional resilience include the organization's ability to effectively tackle tasks in various scenarios and conditions, such as economic changes, personnel reshuffles, technological transformations, and other adverse impacts. Effective communication and internal coordination are essential to avoid problems in management processes and interactions between structural units. Ensuring operational reliability, the soundness of decisions, and the ability to adapt to unforeseen circumstances are fundamental elements of organizational resilience. Functional resilience requires a systematic approach to risk management, strategic planning, and the development of a culture of continuous improvement and adaptation. In addition to functional resilience, other important system characteristics include robustness, fault tolerance, and reliability, which together ensure the effectiveness and long-term stability of the system. The paper also investigates the interrelationships and differences between reliability, functional resilience, and robustness, emphasizing the need for integrated approaches to managing complex systems. Developing methods and tools to ensure functional resilience is a critical task for organizations aiming to achieve stability and success in an environment of constant change and uncertainty.*

**Keywords:** *functional sustainability, organizational system, quality of functioning, evaluation of the level of performance of functions, efficiency of the complex system, performance of functions*

**Introduction**

Functional resilience of complex systems is a key characteristic that determines their ability to adapt and operate under external and internal disturbances. In today's world, technological and social changes lead to increased system complexity, requiring new approaches to their analysis and management. Consequently, new scientific and engineering paradigms, methodologies, and technologies are emerging, aimed at ensuring high levels of resilience and reliability in complex systems.

In addition to functional resilience, systems possess other important characteristics such as robustness, fault tolerance, and reliability. These terms are often interrelated, and their successful combination can be crucial for ensuring the system's effectiveness and long-term stability. System reliability is associated with its ability to perform its functions without failure over a

specified period, focusing on avoiding breakdowns and ensuring continuous operation.

Functional resilience implies the system's ability to maintain its functions in the face of failures or abnormal situations, emphasizing the importance of normal operation even when problems arise. Robustness includes aspects of adaptability, flexibility, and the ability of the system to successfully cope with environmental changes, crises, or attacks. It is characterized by the system's ability to survive and adapt to variable and complex conditions, preserving its core functions even under adverse factors.

Another important characteristic is strength or robustness, defined as the system's ability to remain stable and functional under a given set of difficulties, maintaining the stability of its structure. On the other hand, anti-fragility reflects the system's ability not only to withstand stress and negative impacts but also to benefit from them, becoming stronger and more developed.

### The main material of the article

The study of functional sustainability in organizations is an important aspect in management and strategic development. This concept is relatively new and aims to eliminate the shortcomings of analysis approaches that do not take into account such key aspects as flexibility, adaptability, stability, endurance and response to challenges that may arise during the functioning of organizational structures.

One of the main requirements for functionally sustainable organizations is their ability to effectively solve tasks under different scenarios and conditions. This may include changes in the economic environment, staff turnover, technological transformations and other negative impacts. An organization's ability to adapt to change and maintain stability is key to its long-term success.

The functional stability of the organization is also related to the effectiveness of communication and internal coordination, which allow avoiding problems in management processes and interaction between structural parts. Ensuring the reliability of operations, the acceptability of decisions and the ability to effectively adapt to unforeseen circumstances are key components of the functional sustainability of organizations.

Important is the idea that the property of functional sustainability in organizations requires a systemic approach to risk management, strategic planning and an internal culture aimed at continuous improvement and adaptation. Functional stability of organizations is an important indicator of their ability to function successfully in conditions of change and turbulence.

In addition to functional stability, systems have other important characteristics such as survivability, fault tolerance, and reliability [1]. These terms are often interrelated, and their successful combination can be critical to ensuring the effectiveness and long-term sustainability of the system. These are concepts that may overlap in certain aspects, but they indicate different characteristics of systems and processes.

The reliability of the system is related to its ability to perform its functions without failures during a certain period of time. With a focus on avoiding failures and ensuring uninterrupted system operation. This definition is confused with Functional Sustainability in English-language traditions [2].

Functional stability implies the system's ability to maintain the performance of its functions in conditions of failure or abnormal situations. Focused on ensuring the normal operation of the system, even if events occur that can affect its operation.

Resiliency includes aspects of adaptability, flexibility and the ability of a system to successfully cope with changes in the external environment, crises or attacks. The system's ability to survive and adapt under

changing and complex conditions. The ability of the system to maintain its, at least, basic functions under the influence of negative environmental factors that go beyond the design operating conditions. Simply put, it is the property of a system to continue to work and perform tasks even under undesirable circumstances, although the quality of performance may suffer [3].

So, reliability focuses on avoiding failures and ensuring stable operation of the system under normal conditions, functional stability focuses on maintaining the functionality of the system even when problems occur, and survivability covers aspects of adaptability and survival in changing environments or extreme conditions.

Also, in [4], the concepts Stability of functioning and functional stability are separated. Functional stability characterizes the system's ability to maintain its basic functions in the presence of random errors, failures, or other random events. While Functional stability determines the extent to which the system can perform its functions under the influence of random events, failures or external factors.

The idea of "functional stability", its definition and the main principles of guaranteeing this stability were first presented in the scientific publications of O.A. Mashkov, dedicated to solving specific tasks of managing complex autonomous systems. It was established that the key condition for ensuring this property is the ability to redistribute available resources within the system itself.

In [5], the problems that arose during the development of complex autonomous technical systems, especially in the aviation industry, are considered, and they indicate the inefficiency of traditional methods of ensuring reliability. Instead of simply increasing reliability through redundancy, an approach based on functional resilience is proposed, which allows the system to effectively respond to emergency situations and ensure the performance of its functions. It is specified that the basis for this is the ability to redistribute resources within the system.

To ensure the functional stability of a system, whether it is a business process, software or other system, it is important to implement effective monitoring and forecasting. Algorithms for system control are described in work [6].

In many studies, functional sustainability is considered in the context of technical systems such as computer networks, information and telecommunication systems, systems of automatic management of autonomous objects, etc. Moreover, the issue of functional stability in the context of organizations is no less important [7].

The stability of the organization is determined by its ability to function effectively, adapt to changes in the environment and avoid risks and crisis situations [8].

From the point of view of organizations, in the context of sustainability, more attention is paid to such aspects as economic sustainability, financial sustainability, risk management, etc.

In the Western infocfield, considerable attention is paid to such a concept as business continuity [9]. It is a management system that aims to protect against failures, reduce their probability, prepare for them, respond to and recover from various types of failures. Also, such important concepts as Operational sustainability and Organizational sustainability are highlighted.

Also distinguish such a characteristic of the system as strength or robustness [10]. Robustness can be considered as the ability of a system to remain stable and functional under a given set of difficulties, while maintaining the stability of its structure. Resilience, on the other hand, is defined as the ability of a system to adapt and recover from adversity, maintaining its ability to perform its functions even when conditions or influences change. Thus, robustness focuses on maintaining stability, while resilience emphasizes the ability to adapt and recover.

In work [11] such a characteristic as antifragility is emphasized. Anti-fragility reflects the concept that a system is not only resistant (robust) to stresses or negative influences, but also benefits from their influence, strengthens and develops. An anti-fragile system gets a boost in benefits from testing and pressure. The main idea of anti-fragility is that the system is not only able to withstand pressure and stress, but reacts to these factors, becomes stronger, optimizes its structure and functions, adapts and improves. The natural processes of evolution, where organisms become adapted and improved through natural selection, can be seen as an

example of antifragility. In the context of organizational management and business, antifragility can mean a company's ability not only to survive difficulties, but also to use them to improve and strengthen its position in the market [12].

An important aspect of the development of the direction of functional sustainability of the organization is the formalization of the measurement of organizational sustainability. In [13], a scale for measuring organizational sustainability was developed and described. This can contribute to the further development of quantitative research in the field of organizational sustainability and its relationship with other factors.

In [14], organizational sustainability is presented as a concept that includes five levels, starting from visible features and ending with the root sources for the survival of the organization. Here, organizational sustainability is a multidimensional phenomenon that can be understood as traits, processes, capabilities, and resources simultaneously.

The lack of consensus on how to measure organizational sustainability indicates uncertainty in approaches and methods for assessing this important aspect of organizations' activity [15]. The variety of proposed tools and approaches, which include measurement by organizational characteristics, performance, or recovery from failure, indicates ambiguity in the understanding and assessment of the term "sustainability". This situation determines the need for further research and development of uniform standards or methodologies that will contribute to the creation of more objective and universal mechanisms for measuring organizational sustainability.

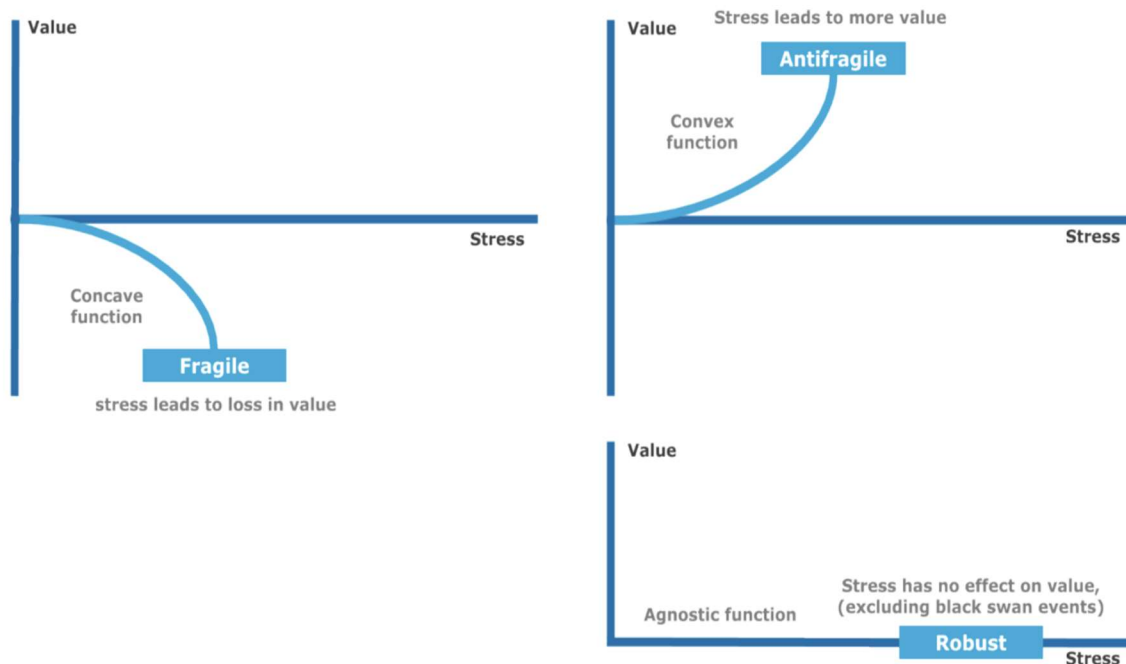


Figure – Fragile, antifragile and robust system behaviour to stress [11]

## Conclusions

The study of functional stability in organizations represents an important aspect of management and strategic development. Functional sustainability aims to eliminate shortcomings in existing analytical approaches that do not take into account such key aspects as flexibility, adaptability, stability, endurance and responsiveness to challenges that may arise during the functioning of organizational structures.

Based on the authors' analysis of functional sustainability in organizations, a comprehensive framework is proposed that emphasizes key aspects and their main characteristics. Opportunities to use systematic approaches to risk management, strategic

planning and improving internal culture to ensure continuous improvement and adaptation are considered.

The authors identified a number of tasks that require formalization, algorithmization, and development of tools for measuring organizational sustainability. These tasks include risk identification and management, strategic scenario planning, and building a culture of continuous improvement.

The set of problems identified by the authors is a prerequisite for further formalization and development of a single standard or methodology for measuring organizational sustainability. The proposed framework will contribute to organizations' ability to adapt, endure and thrive in the face of change and turbulence, ultimately enhancing their long-term success.

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## СУЧАСНІ ТЕНДЕНЦІЇ ЗАБЕЗПЕЧЕННЯ ФУНКЦІОНАЛЬНОЇ СТІЙКОСТІ СКЛАДНИХ ОРГАНІЗАЦІЙНИХ СИСТЕМ

**Анотація.** У цій роботі досліджено концепцію функціональної стійкості в організаціях з наголосом на її важливості в управлінні та стратегічному розвитку. Функціональна стійкість є відносно новою концепцією, яка має на меті усунути недоліки традиційних аналітичних підходів, що часто не враховують такі критичні аспекти, як гнучкість, адаптивність, стабільність, витривалість та здатність реагувати на виклики, які можуть виникнути під час функціонування організаційних структур. Ключовими компонентами функціональної стійкості є здатність організації ефективно вирішувати завдання в різних сценаріях і умовах, таких як економічні зміни, кадрові перестановки, технологічні трансформації та інші негативні впливи. Ефективна комунікація і внутрішня координація є важливими для уникнення проблем в управлінських процесах та взаємодії між структурними підрозділами. Забезпечення надійності операцій, обґрунтованості рішень та здатності адаптуватися в непередбачених обставинах є основними елементами організаційної стійкості. Функціональна стійкість складних організаційних систем вимагає системного підходу до управління ризиками, стратегічного планування і розвитку культури постійного вдосконалення й адаптації. Крім функціональної стійкості, інші важливі характеристики систем включають живучість, відмовостійкість та надійність, які разом забезпечують ефективність і довгострокову стабільність системи. У роботі також досліджено взаємозв'язки і відмінності між надійністю, функціональною стійкістю та живучістю, що підкреслює необхідність інтегрованих підходів до управління складними системами. Розроблення методів та інструментів для забезпечення функціональної стійкості є важливим завданням для організацій, які прагнуть досягти стабільності й успіху в умовах постійних змін та невизначеності.

**Ключові слова:** функціональна стійкість; організаційна система; якість функціонування; оцінка рівня виконання функцій; ефективність комплексної системи; виконання функцій

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