

## **Fundamentals of applying technology to support intelligence in decision-making systems**

### **Fundamentos da aplicação da tecnologia para apoiar a inteligência em sistemas de tomada de decisão**

### **Fundamentos de la aplicación de la tecnología para apoyar la inteligencia en los sistemas de toma de decisiones**

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## ABSTRACT

The article substantiates a new way to solve the classic problems of the "agent theory", including the problems of "information asymmetry", "opportunistic behavior" of management, "bounded rationality", trust between the board of directors and management, and adapts the principles of applying artificial intelligence technologies to the corporate governance system. The features and negative factors that boards of directors face when making decisions are identified, and the tasks of the board of directors for which the influence of the identified negative factors (in various fields, including cybersecurity risk management throughout the supply chain) can be reduced using artificial intelligence technologies are assessed. An algorithm for the decision-making process by the board of directors in the corporate governance system using artificial intelligence technologies is developed. Qualitative and quantitative effects, as well as the risks of using artificial intelligence technologies in the corporate governance system are determined.

**Keywords:** Artificial Intelligence Technologies, Supply Chain Management, Cybersecurity, Risk Management, Corporate Governance System, Management, Artificial Intelligence

## RESUMO

O artigo fundamenta uma nova forma de resolver os problemas clássicos da “teoria da agência”, incluindo os problemas de “assimetria de informação”, “comportamento oportunista” da gestão, “racionalidade limitada”, confiança entre o conselho de administração e a gestão, e adaptar o princípios de aplicação de tecnologias de inteligência artificial ao sistema de governança corporativa. São identificadas as características e fatores negativos que os conselhos de administração enfrentam na tomada de decisões, e são avaliadas as tarefas do conselho de administração para as quais a influência dos fatores negativos identificados (em várias áreas, incluindo a gestão de riscos de cibersegurança em toda a cadeia de suprimentos) pode ser reduzida por meio de tecnologias de inteligência artificial. Foi desenvolvido um algoritmo para o processo de tomada de decisão do conselho de administração no sistema de governança corporativa utilizando tecnologias de inteligência artificial. Foram identificados os efeitos qualitativos e quantitativos, bem como os riscos da utilização de tecnologias de inteligência artificial no sistema de governança corporativa.

**Palavras-chave:** Tecnologias de Inteligência Artificial, Gestão da Cadeia de Suprimentos, Cibersegurança, Gestão de Riscos, Sistema de Governança Corporativa, Gestão, Inteligência Artificial

## RESUMEN

El artículo fundamenta una nueva forma de resolver los problemas clásicos de la “teoría de la agencia”, incluidos los problemas de “asimetría de información”, “comportamiento oportunista” de la dirección, “racionalidad limitada”, confianza entre el consejo de administración y la dirección, y adaptar la Principios de aplicación de tecnologías de inteligencia artificial al sistema de gobierno corporativo. Se identifican las características y factores negativos a los que se enfrentan los consejos de administración a la hora de tomar decisiones y se evalúan las tareas del consejo de administración para las cuales se puede reducir la influencia de los factores negativos identificados (en diversos campos, incluida la gestión de

riesgos de ciberseguridad a lo largo de la cadena de suministro) utilizando tecnologías de inteligencia artificial. Se ha desarrollado un algoritmo para el proceso de toma de decisiones del consejo de administración en el sistema de gobierno corporativo utilizando tecnologías de inteligencia artificial. Se han identificado los efectos cualitativos y cuantitativos, así como los riesgos del uso de tecnologías de inteligencia artificial en el sistema de gobierno corporativo.

**Palabras clave:** Tecnologías de Inteligencia Artificial, Gestión de la Cadena de Suministro, Ciberseguridad, Gestión de Riesgos, Sistema de Gobierno Corporativo, Gestión, Inteligencia Artificial

## 1 INTRODUCTION

At the present stage of accelerating technological development, competition between companies is becoming more intense, and, as Nobel laureate J. Stiglitz notes, the "information asymmetry" between boards of directors and management is increasing, and the amount of data required for high-quality decision-making is constantly growing. At the same time, there is a limit to the information a person can analyze over a certain period of time.

The studied circumstances of the largest corporate scandals, starting from Enron, WorldCom, Parmalat, according to the assessment of corporate governance in companies with state participation in 2022, showed that there are problems in corporate governance systems related to the "human factor": insufficient transparency of decisions, nominal independence of directors in decision-making, corruption elements, incompetence and dishonesty of decision-makers. The presence of these problems is also confirmed by the number of significantly increasing claims filed and satisfied against members of boards of directors around the world. Thus, in the 21st century, the need to improve the efficiency of decision-making processes in the corporate governance system becomes especially urgent. While management as an "insider" has the ability to analyze large amounts of information and see the company from the inside, the board of directors is often limited in its access to full information about the company when making decisions, as well as in the time allocated for its analysis, "which is confirmed by the results of a survey of board members." "In such conditions, given the necessary rapid adaptation of corporate strategies to the era of technological shifts," it is the board of directors that is forced to change and restructure decision-making processes in such a way as to withstand the load, process increasing amounts of information with the increasing problem of "information asymmetry" and regulatory pressure.

The main studies aimed at solving the classic "agent-principal" problem are based on the search for ways to "force" management to act in the interests of shareholders and the board

of directors representing them, while the issues of increasing the effectiveness of the board of directors' control over management and the quality of decisions made by the board of directors are raised in studies much less frequently. Moreover, the results of such studies, as a rule, end with recommendations to increase the number of independent directors and experts with certain competencies, to ensure diversification in the board, and state agreement with other recommendations already enshrined in corporate governance codes. However, such recommendations do not contribute to solving a large pool of identified problems associated with asymmetry and increased information flows characteristic of decision-making by the board of directors. In this regard, the work focuses on the activities of the board of directors and raises the question of finding a new way to improve the effectiveness of decision-making processes by the board of directors, ensuring higher-quality work with data. According to the results of the study, technologies that allow high-quality and independent processing of large data sets necessary for informed decision-making in the 21st century, as well as avoiding the phenomenon of "group thinking" and other "human biases" in decision-making, are artificial intelligence technologies. Trends in the development of areas of application of artificial intelligence technologies allow us to conclude that these technologies can also be used in corporate management to improve the efficiency of the decision-making process of the board of directors.

## **2 LITERATURE REVIEW**

A significant contribution to the development of scientific substantiation of corporate governance issues and management decision-making processes was made by McCarthy, Keynes, Abrams and others. The issues of changes in management systems in the era of the information society, industrial revolutions and the digital economy were considered by Jones, C., Hesterly, W. S., & Borgatti, S. P. The issues of applying artificial intelligence technologies, starting with J. McCarthy and A. Turing, were studied by Mittelstadt, B. D., Allo, P., Taddeo, M., Wachter, S., & Floridi, L. Cutting-edge research at the intersection of the works of the listed authors, focusing on the specifics of changes in corporate governance in the 21st century, is carried out by Sorensen, E., & Torfing, J., Voitovych, R., Hewage, A.

The analysis of the works of the listed authors showed that the researchers focus on the problems of corporate governance and on the description of decision-making processes in the corporate governance system, analyze technological trends, the possibilities of digital technologies and their impact on the economy and companies as a whole, but the search for

new ways to improve the efficiency of decisions made in the corporate governance system taking into account the technological trends of the 21st century has not found sufficient theoretical, methodological and practical justification, so these issues require additional study. This fact determined the choice of the research topic, setting the goal, objectives, as well as the logic of the research.

### **3 SEARCH METHOD**

The purpose of the article is to provide theoretical and methodological justification for the use of artificial intelligence technologies in the process of making management decisions by a manager in the corporate governance system.

The object of the article is the corporate governance system of joint-stock organizations.

The subject of the article is organizational and economic relations arising in the process of decision-making by the board of directors in the corporate governance system using artificial intelligence technologies.

The theoretical significance of the article lies in the development of the theory of corporate governance in terms of proposing a new way to improve the efficiency of management decisions of the board of directors - the use of artificial intelligence technologies in the corporate governance system, as well as the adaptation of the principles of applying AI technologies to the corporate governance system. The theoretical significance of the results also lies in the development of the theory of decision-making in terms of identifying the features and negative factors that boards of directors face in the process of making management decisions, and assessing the tasks of the board of directors for which the impact of the identified negative factors can be reduced using AI technologies.

Methodology and research methods. The theoretical and methodological basis of the article was the scientific works of world researchers in the field of corporate governance, decision-making processes, artificial intelligence, behavioral economics, new information theory, as well as applied works on the functioning of modern artificial intelligence technologies. In accordance with the stated goal and objectives, general scientific methods of management theory, statistical, comparative and logical analysis, generalization, systems approach to the study of economic phenomena and processes were used, methods of in-depth interviews and expert assessments were applied.

## 4 RESULTS

Scientific results:

a) A new way to solve classical problems of the "agent theory" is proposed, including the problems of "information asymmetry", "opportunistic behavior" of management, "bounded rationality", trust between the board of directors and management, through the use of artificial intelligence technologies, based on the trends in the development of corporate governance and the functions of artificial intelligence technologies. The principles of applying artificial intelligence technologies, associated with the principles of corporate governance and the principles of applying artificial intelligence, are adapted to the corporate governance system: responsibility, transparency, security, adjustability, trust, which allow increasing the efficiency of the decision-making process using artificial intelligence technologies in the corporate governance system.

b) Factors that have a negative impact on the decision-making process by the manager are identified and classified: unprofessional work of management and low quality of prepared materials; lack of time and an unfair approach to the work of directors; lack of qualifications, experience and personal characteristics of directors; cognitive distortions in the decision-making process by the board of directors. An assessment was made of the tasks of the board of directors for which the impact of negative factors can be reduced by using artificial intelligence technologies, namely: control over procurement policy, cybersecurity risk management throughout the supply chain, decisions on major transactions and related-party transactions, control over executive bodies, etc.

c) A new algorithm for the decision-making process by the board of directors in the corporate governance system using artificial intelligence technologies was developed, the peculiarity of which is the parallel analysis of the issues under consideration by the system using artificial intelligence, which allows improving the quality of decisions made, smoothing out the identified negative factors characteristic of decision-making by the board of directors, and solving the problems of the "agent theory".

d) Using the example of the task of the board of directors to control the activities of executive bodies in matters of implementing procurement policy (as part of supply chain management policy and addressing related critical technological risks, such as cybersecurity risks), a system of performance indicators for procurement activities using artificial intelligence technologies for monitoring performance indicators by the board of directors was formed, which includes indicators of customer savings, an increase in the share of competitive



purchases, an increase in the share of electronic purchases, a decrease in the share of ineffective purchases, cybersecurity resilience across the supply chain, etc. A list of technical measures and areas of application of artificial intelligence technologies (a system of intelligent search for suppliers, price monitoring, supplier scoring) have been developed, which allows solving the problems of preventing ineffective purchases by the board of directors in advance, reducing the degree of “opportunistic behavior” of management and the manifestation of corrupt elements.

## **5 DISCUSSION**

A new method for increasing the efficiency of decisions made in the corporate governance system is proposed due to the identified advantages of AI technologies that allow solving the problems of the "agent theory", and principles of applying AI technologies adapted to the corporate governance system are proposed (Abrams, 2009).

It was revealed that the dynamic development of society and companies in the 21st century dictates new requirements for decision-making systems: the need to increase the speed, flexibility, accuracy, and analytical validity of decisions is increasing (Hewage, 2023). Along with this, it was found that the amount of data required for decision-making is rapidly growing, the physical capabilities of a person to process data are limited, and the decision-making processes in the corporate governance system have not changed since the last century. In this regard, the classic problem of "information asymmetry" between the board of directors and management, which is typical for corporate governance theory, is growing.

A study of the transformation of the role and responsibility of boards of directors showed that new requirements for the level of transparency of decisions made are imposed on the board of directors in the era of technological shifts and critical cybersecurity risks described in the concept of the fourth industrial revolution against the background of increasing regulatory and public requirements for the management bodies of companies. These requirements are reflected in the British Guide to the Effectiveness of the Board of Directors, the Corporate Governance Codes of Singapore, Hong Kong, the Netherlands, the USA, and Africa (McCarthy, 1988). A study of the features of decision-making in the "classic triangle" of shareholders - board of directors - management showed that decisions of the board of directors (for example, approval of the company's development strategy, dismissal of managers, control of purchases, and cybersecurity risk management throughout the supply chain) are "complexly structured", associated with the adoption of greater risk and a higher level of responsibility compared to management decisions (Keynes, 1930). And it is at the level of the board of

directors as a strategic management body that the need arises to adapt the company's activities to the new strategic opportunities and risks of the fourth industrial revolution. In the context of increasing "information asymmetry", the board of directors risks becoming a "weak link" in the decision-making process in the corporate governance system, unless these processes are changed taking into account the modern external environment.

It has been established that in the 21st century, technologies are actively developing that can support decisions based on expert opinion with recommendations based on a larger volume of factors than management takes into account and the board of directors evaluates. Such technologies are AI technologies that ensure objectivity and independence from limited cause-and-effect relationships formed and embedded in classical systems by humans.

It was revealed that most of the listed systems using narrow-focus AI technologies (in this case, neural networks), which are capable of performing individual functions with a specific task based on machine learning methods based on specified parameters, their coefficients, methods of their processing and proven test efficiency (Sorensen & Torfing, 2005). Standard functions of neural networks allow offering solutions for individual tasks that are not always obvious to humans, and testing in the listed areas allows us to draw a conclusion about their applicability in corporate management. The studied functions and possibilities of applying AI technologies can help solve such classic problems of the "agent theory" as: "information asymmetry", "opportunistic behavior of management", "limited rationality", weak trust between directors and management.

All the possibilities for solving the problems of the "agent theory" are available to a person using an AI-based system with the described functions. However, recognizing the provisions of the "stakeholder theory", it was concluded that the moment of negotiations to take into account and balance the interests of stakeholders, as well as the possibility of creating innovative solutions, leadership, decision-making taking into account the corporate culture and non-formalized specifics of the organization, responsibility for decisions remain problematic for AI. Touching upon the question of whether it is possible to solve the tasks of the board of directors using systems without AI, it is substantiated that, since systems without AI are built exclusively on human logic (for example, a manager), the results of the system's work will take into account the same relationships and logic that the manager takes into account when developing recommendations. Thus, the classic problems of corporate governance will not be solved, therefore, AI-based systems will be productive for solving complexly structured tasks of the board.



The functions of systems based on AI technologies can allow the use of these technologies in corporate management, since they have the following capabilities: ensure decision-making based on independent data analysis and a larger number of decision options, reduce the degree of "information asymmetry", ensure an increase in the degree of transparency, control over the risks of "opportunistic behavior" of management, help to insure the liability of directors for decisions made by more thoroughly elaborating decisions and associated risks. Therefore, a new way to improve the efficiency of the decision-making process is proposed through the use of AI technologies.

The development trends of corporate governance and the role of the board of directors, the identified advantages of AI technologies have allowed us to expand our understanding of the possibilities of AI in relation to the corporate governance system to solve the problems of the "agent theory". The application of AI technologies in corporate governance should be carried out within the framework of the proposed adapted principles to ensure that the requirements imposed on systems using AI do not contradict the requirements for the corporate governance system.

Based on the identified typical problems, factors that have a negative impact on the decision-making process of the board of directors are identified and classified. In particular, factors related to:

- unfair work of management and low quality of prepared materials;
- lack of time and unfair approach to the work of directors;
- insufficient qualifications, experience, other characteristics of directors;
- cognitive distortions in the decision-making process of the board of directors.

As a result of the analysis of the activities of the executives, a high degree of influence of the identified negative factors on the decision-making of directors was established, since each member of the board of directors included in the sample is on average a member of four boards of directors at the same time. The number of documents, reports and other materials required for study by a director for 1 year in one company ranges from 60 to 120 documents. The average time for preparing for meetings during the year for one director reaches 840 hours in one board of directors. The listed indicators emphasize that the amount of information that a director must study in order to conscientiously fulfill his duties, the amount of time required and the decisions made for which the director is responsible are large. The analysis showed that the presence of negative factors, including poor elaboration of materials by management and insufficient preparation of directors for meetings, can lead to low quality of decisions and pose risks for the corporate governance system, which increases the need to use AI technologies.

The key features of the algorithm are:

Stage 1

The classic decision-making process of the board of directors.

Stage 2

Shows what additional actions are carried out by the corporate secretary, management, administrator using AI technologies, and what is carried out by the AI system.

In this case, AI refers to a neural network, which is the most universal, and the deep learning method is used, in particular, supervised learning. The choice of this method is due to the high risk of incorrect recommendations appearing in the absence of human control over learning, as well as the need to record the data that the board of directors wants to receive from the system at the output during training. These capabilities are not available in other options for using AI technologies. Training a neural network using this method is classic and ends when the neural network stops making mistakes, in the opinion of the person training it.

It is noted that the use of AI technologies differs from systems without AI technologies that are ineffective for similar tasks in that it is capable of:

- recognizing and extracting unstructured data: contract terms, phrases from reports of different formats, combining them with data from external sources;
- classifying, assigning properties to objects that are not specified in the documents;
- identifying a greater number of correlations that are not obvious or accessible to human logic, constantly improving the quality of analytics.

To implement the algorithm, it is proposed to carry out organizational and technical measures: develop a task / purchase a ready-made system; select a supplier and system administrator, determine the parameters, risks (including technological risks, such as cybersecurity-related risks), restrictions, and those responsible at each stage; develop a system for implementing the presented algorithm, train it and test it; regulate in internal documents the procedure for making decisions using the system.

The new algorithm, thanks to parallel independent data analysis, will improve the quality of decisions, smooth out the negative factors typical for decision-making by the board of directors, and solve the problems of the "agent theory".

Improving the decision-making process in the corporate governance system using artificial intelligence technologies, one of the tasks of the board of directors was chosen as an example of the practical application of the new algorithm for the decision-making process in the corporate governance system - control of executive bodies in matters of implementing procurement policy. A system of procurement performance indicators was developed using AI

technologies for the board of directors to control the events for its implementation, the effects of implementation for the entire corporate governance system were assessed, and the risks of using AI technologies were taken into account.

The study identified the qualitative and quantitative effects of implementing a procurement performance indicator system for control by the board of directors based on the proposed decision-making process algorithm. Among the qualitative effects, the key ones are:

- reducing the "information asymmetry" in which the board of directors finds itself and increasing the degree of transparency of procurement activities in the supply chain;
- ensuring the possibility of independent, analytically supported control of procurement by the board of directors, getting rid of the "opportunistic behavior" of management and corruption elements in the field of procurement;
- ensuring a reduction in the impact of identified negative "human factors" in the decision-making process by the board of directors by providing analytics as a support for decision-making and risk management;
- increasing the overall efficiency of interaction between the board of directors and management, ensuring trust, technological awareness, and better work with suppliers as one of the key categories of company stakeholders.

It is concluded that since AI technologies have not been widely used in corporate governance before, it is important to develop a risk management system in advance, regulate the use of AI technologies in internal documents and be guided by the developed principles.

## **6 CONCLUSION**

During the research, an important scientific task was solved - a new method for increasing the efficiency of the decision-making process by the board of directors in the corporate governance system using AI technologies was identified and tested in real corporate governance practice. Based on the proposed developments, a scalable system was created using AI technologies, which is being implemented by company boards of directors. The proposed developments are relevant, in demand, and in the case of adapting the developments to other tasks of the board of directors that require decision-making based on data analysis, they can become a significant factor in the competitiveness of the company, making the transition from decision-making by directors based on expert knowledge to decisions based, among other things, on high-quality independent analytics.

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