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Artificial intelligence as an environment for strengthening the intellectual potential of a modern manager

Sztuczna inteligencja jako środowisko wzmacniania potencjału intelektualnego współczesnego menedżera

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Abstract:

Research objectives and hypothesis/research questions

Its primary objective is to demonstrate how AI tools and models are becoming integral components of the organizational environment, supporting decision-making, increasing operational efficiency, and improving management quality in dynamic business conditions. The central hypothesis profiles the entire content: AI systems not only enhance operational effectiveness but also significantly influence the development of managerial competencies – such as analytical capability, the ability to operate in a digital environment, and the management of a multidimensional risk landscape.

Research methods

To verify this hypothesis, a literature study was conducted at this stage, serving as the foundation for ongoing empirical research regarding the utility and impact of AI on both personal managerial development and the realization of strategic goals in modern organizations.

Main results

The essence and role of selected AI models are emphasized. Machine learning processes – including deep learning, natural language processing (NLP), and expert systems – are synthetically described, focusing

on their utility in the managerial environment as well as their inherent advantages and limitations. This includes the issue of algorithmic opacity (the "black box" problem), as well as uncertainty and the risk of algorithmic bias resulting from data quality and representativeness. Considerable attention is also given to predictive analysis, anomaly detection, trend forecasting, and the automation of repetitive tasks, which allow managers to focus on strategic imperatives. Application examples provided in the article include project management, task prioritization, scenario simulations, and crisis support, where the speed and accuracy of decisions are vital for maintaining organizational business continuity.

Implications for theory and practice

The final section underscores the role of the AI environment in shaping the quality and efficiency of contemporary managers. It highlights how AI integration serves as a foundation for both personal managerial development and the achievement of long-term strategic goals within modern organizations.

Keywords:

artificial intelligence, managerial competencies, machine learning, decision-making processes, intellectual potential

Abstrakt:

Cel badań i hipotezy/pytania badawcze

Głównym celem opracowania jest wykazanie, w jaki sposób narzędzia i modele sztucznej inteligencji stają się integralnymi elementami środowiska organizacyjnego, wspierając procesy decyzyjne, zwiększając efektywność operacyjną oraz podnosząc jakość zarządzania w dynamicznych warunkach rynkowych. Hipoteza główna nadaje kierunek całej treści artykułu: systemy AI nie tylko zwiększają skuteczność operacyjną, lecz także znacząco wpływają na rozwój kompetencji menedżerskich, takich jak zdolności analityczne, umiejętność funkcjonowania w środowisku cyfrowym oraz zarządzanie wielowymiarowym krajobrazem ryzyka.

Metody badawcze

W celu weryfikacji tak sformułowanej hipotezy na obecnym etapie przeprowadzono studia literaturowe, które stanowią fundament dla prowadzonych badań empirycznych dotyczących użyteczności i wpływu sztucznej inteligencji zarówno na rozwój osobisty menedżerów, jak i realizację celów strategicznych w nowoczesnych organizacjach.

Główne wyniki

W pracy wyeksponowano istotę oraz rolę wybranych modeli sztucznej inteligencji. Dokonano syntetycznego opisu procesów uczenia maszynowego – w tym uczenia głębokiego (ang. *deep learning*), przetwarzania języka naturalnego (NLP) oraz systemów ekspertowych – koncentrując się na ich użyteczności w środowisku menedżerskim, a także na ich immanentnych zaletach i ograniczeniach. Uwzględniono przy tym problem nieprzejrzystości algorytmicznej (problem „czarnej skrzynki"), a także kwestie niepewności i ryzyka błędu algorytmicznego (ang. *algorithmic bias*), wynikającego z jakości oraz reprezentatywności danych. Znaczną uwagę poświęcono także analizie predykcyjnej, detekcji anomalii, prognozowaniu trendów oraz automatyzacji powtarzalnych zadań, co pozwala menedżerom skoncentrować się na imperatywach strategicznych. Przytoczone w artykule przykłady aplikacyjne obejmują zarządzanie projektami, priorytetyzację zadań, symulacje scenariuszowe oraz wsparcie w sytuacjach kryzysowych, w przypadku których szybkość i trafność decyzji mają kluczowe znaczenie dla zachowania ciągłości biznesowej organizacji.

Implikacje dla teorii i praktyki

W końcowej sekcji podkreślono rolę środowiska AI w kształtowaniu jakości i efektywności współczesnych menedżerów. Wskazano, w jaki sposób integracja sztucznej inteligencji stanowi fundament zarówno dla osobistego rozwoju menedżerskiego, jak i osiągania długoterminowych celów strategicznych w nowoczesnych organizacjach.

Słowa kluczowe:

sztuczna inteligencja, kompetencje menedżerskie, uczenie maszynowe, procesy decyzyjne, potencjał intelektualny

Introduction

This review article analyzes the role of artificial intelligence (AI) in enhancing the competencies and intellectual potential of contemporary managers. Its primary objective is to demonstrate how AI tools and models are becoming integral components of the organizational environment, supporting decision-making, increasing operational efficiency, and improving management quality in dynamic business conditions.

The paper elucidates the essence and attributes of modern business organizations, highlighting key characteristics such as flexibility, adaptability, innovation orientation, and the utilization of knowledge as a strategic resource. Particular emphasis is placed on the growing role of data, its representativeness, and processing speed as the foundations of competitive advantage. Furthermore, information-decision processes within the enterprise are identified, indicating that contemporary organizations require complex mechanisms for data analysis and integration to support these processes across various management levels. Moreover, the article highlights areas particularly vulnerable to the materialization of error risks in strategic planning, considering the role of digitalization and analytical tools in reducing uncertainty and improving decision quality. Consequently, the essence and role of selected AI models are emphasized. Machine learning processes – including deep learning, natural language processing (NLP), and expert system – are synthetically described, focusing on their utility in the managerial environment as well as their inherent advantages and limitations. This includes the issue of algorithmic opacity (the "black box" problem), as well as uncertainty and the risk of algorithmic bias resulting from data quality and representativeness. Considerable attention is also given to predictive analysis, anomaly detection, trend forecasting, and the automation of repetitive tasks, which allow managers to focus on strategic imperatives. Application examples provided in the article include project management, task prioritization, scenario simulations, and crisis support, where the speed and accuracy of decisions are vital for maintaining organizational business continuity.

The final section underscores the role of the AI environment in shaping the quality and efficiency of contemporary managers. The central hypothesis profiles the entire content: AI systems not only enhance operational effectiveness but also significantly influence the development of managerial competencies – such as analytical capability, the ability to operate in a digital environment, and the management of a multidimensional risk landscape. To verify this hypothesis, a literature study was conducted at this stage, serving as the foundation for ongoing empirical research regarding the utility and impact of AI on both personal managerial development and the realization of strategic goals in modern organizations.

1. The essence and attributes of the contemporary business organization

The contemporary business organization constitutes a dynamic, complex system in which the boundaries between technological structure, decision-making processes, and human competencies are gradually blurring. It is an entity operating under conditions of advancing digitalization and global competition, while simultaneously engaging in extensive collaboration with its environment and recognizing the increasing role of data in shaping organizational value. Literature emphasizes that the 21st-century organization designs its strategy, structure, and processes to create and anticipate value within an environment based on information sharing, automation, and cross-sector cooperation (Bharadwaj, El Sawy, Pavlou et al., 2013, pp. 471-482). Consequently, the modern firm is no longer a closed entity but an element of a networked ecosystem. In this framework, flexibility and data integration capacity determine competitive advantage and the potential for synergistic cooperation among geographically dispersed entities, aligned with X-engineering strategies and the pooling of resources and potentials (see Fig.1) within the Industry 4.0/5.0 paradigm.

A key attribute of contemporary organizations is a highly developed digital infrastructure. Data, cloud systems, and analytical tools are becoming fundamental strategic assets that enable operational processes, communication, and real-time strategic planning (Bharadwaj, El Sawy, Pavlou et al., 2013, pp. 472, 474). Organizations increasingly adopt ecosystemic and platform-oriented perspectives, where value is generated through interactions between partners, customers, and suppliers. In such a model, the enterprise functions as a coordinator of information and transaction flows, leveraging the potential of automation and data analytics. In this context, data becomes the central organizational resource, and data-driven decision making (DDDM) replaces traditional intuitive models. Competitive advantage now stems from the ability to acquire, integrate, and interpret large, heterogeneous datasets – both internal and external (Bharadwaj, El Sawy, Pavlou et al., 2013, pp. 475, 477). This enables faster responses to changes, personalization of offerings, and a reduction in decision-making uncertainty. One of the pillars of modern management is scalability and operational flexibility, achieved through Cloud Computing (CC), which allows organizations to dynamically align IT resources with current needs and create alternative environments that enhance resilience and business continuity. Combined with modular and microservices architecture, this facilitates the reconfiguration of processes in response to market conditions or crisis situations (Ślusarczyk, 2019, p. 29).

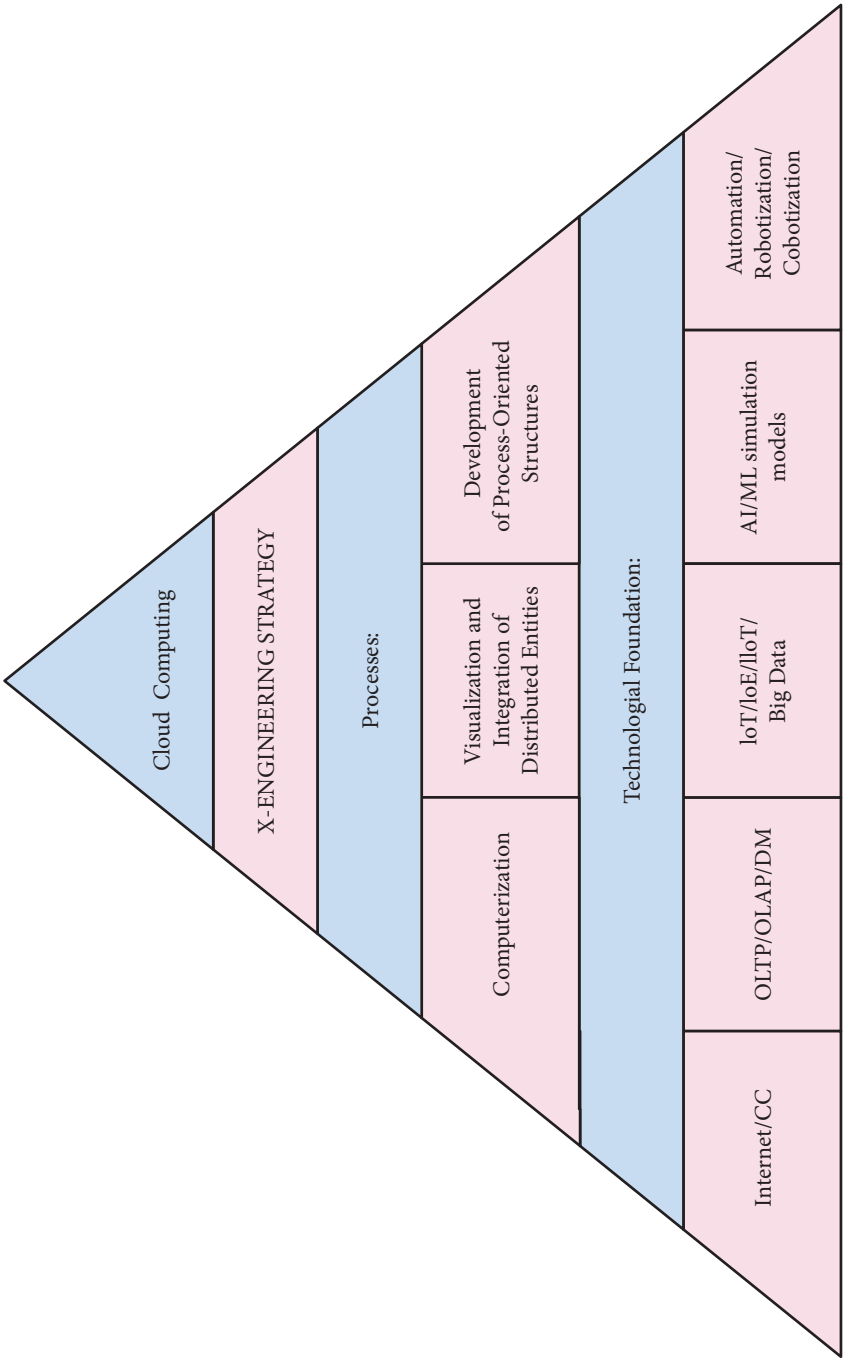

Fig. 1. Determinants of digitalization and the improvement of contemporary organizations
Source: own elaboration

Contemporary organizations are characterized by a high degree of process orientation, abbreviated decision cycles, and sense-and-respond mechanisms that facilitate the transformation of environmental signals into operational actions. This necessitates the integration of transactional and analytical systems, alongside well-developed organizational learning processes (Garvin, 1993, pp. 1, 3). A learning organization establishes mechanisms for the systematic accumulation of experience, the discovery and transfer of knowledge, and adaptation to emerging conditions. In the digital era, this entails the imperative to develop analytical competencies, data interpretation skills, and the capacity for critical evaluation of outputs generated by decision-support systems. Consequently, a pivotal aspect is the development of intellectual capital and the digital literacy of both employees and managers. This requires not only technical proficiency but also the capacity for analytical thinking, effective communication, and collaboration within diversified environments. Creativity, flexibility, and an openness to innovation are becoming fundamental determinants of success. There is an increasing adoption of the human-in-the-loop collaboration model, which synergizes the advantages of human intuition with the analytical precision of algorithms. In this framework, artificial intelligence does not replace the human element; instead, it provides cognitive augmentation, enabling faster, multidimensionally verifiable, and more accurate decisions (Fountaine, McCarthy, Saleh, 2019). Within the context of crisis management and business continuity, AI solutions can analyze real-time data from security systems, forecast potential threats, and support managers in prioritizing corrective interventions.

In the era of the information society, there is a profound need to establish connections between domains that currently function in isolation, such as machine learning and deep learning – characterized by limited interoperability and a reliance on vast datasets for training through correlations – and symbolic approaches, where rules are established through human intervention. The integration of symbolic reasoning with deep neural networks can significantly enhance the explainability of AI outcomes (European Commission, 2020).

The modern organization is also grounded in the principles of corporate governance, ethics, and regulatory compliance, which form the bedrock of stakeholder trust. Transparency in AI models, mitigation of algorithmic bias, data privacy protection, and the auditability of decision-making processes are essential elements in the development of technologies with significant socio-economic impact. Particularly in regulated sectors – such as finance, healthcare, or public administration – ensuring compliance is not merely a legal mandate but a strategic component of building and maintaining reputational resilience. Indeed, a key attribute of the contemporary organization is resilience, encompassing the capacity for risk management, incident prevention, and the restoration of operational efficiency following disruptive events (Dąbrowski, Zaskórski, 2022). In practice, this entails the integration of Business Continuity Plans (BCP) and Disaster Recovery Plans (DRP)

with analytical systems and AI solutions. These tools facilitate rapid anomaly detection, risk scenario simulations, and the automated initiation of preventive and corrective actions. An inherent attribute of the contemporary organization remains customer orientation and experience personalization, where AI and data analytics enable micro-targeting and the formulation of "segments-of-one" strategies (Taylor, 2020). The customer becomes the focal point of process design, while technology serves as a tool for understanding and anticipating their needs. Such an approach requires the synthesis of data analytics with organizational empathy and a culture of innovation.

A crucial pillar of modern organizations is accountability and corporate governance. Process transparency, data ethics, the auditability of models, and regulatory compliance build stakeholder trust and reputational resilience. In high-risk sectors – such as finance, healthcare, and public administration – this constitutes a fundamental prerequisite for sustainable development. Organizational resilience, in turn, manifests as the ability to respond rapidly to disruptions, implement contingency plans, and maintain business continuity through the use of automated analytical systems. Consequently, the contemporary organization is predicated on advanced digitalization processes and a networked structure, which enhances its flexibility and modularity. This allows the entity to achieve the status of a learning organization that extensively utilizes technology to continuously expand its information resources (the human competency augmentation model). The essence of such an organization lies in its capacity for rapid response to change while simultaneously upholding ethical principles, security, and regulatory compliance. This framework enables the effective management not only of data but, more importantly, of knowledge, risk, and change within a dynamic and uncertain business environment.

2. Identification of information and decision-making processes in a modern organization

The modern organization operates in an environment characterized by a high degree of informational complexity, where decision-making processes are inextricably linked to the flow, analysis, and utilization of data. Information systems and artificial intelligence tools have become an integral part of the management cycle, enabling the transformation of raw data into information and knowledge that supports decision-making. In this context, the information-decision process comprises eight distinct stages:

1. Data collection, verification, and classification.
2. Integration and storage of data and information.
3. Data preparation for analysis (pre-processing).

4. Modeling and analysis combined with the application of Machine Learning (ML/AI).
5. Generation of knowledge, insights, and forecasts.
6. Decision support and execution automation.
7. Monitoring, auditing, and feedback (verification of results and analytical resources).
8. Management and accountability for decisions.

Each of these stages constitutes a separate yet closely interrelated function within the information-decision chain (Griffin, 2017; Zaskórski, Zaskórski, 2017, pp. 119-132) of the contemporary organization.

The first stage – data collection, verification, and classification (sensing) – forms the foundation of the entire cycle. Organizations acquire both structured data (e.g., numerical values, system logs) and unstructured data (text, images, IoT sensor data), often in real-time (Zaskórski, Zaskórski, 2017, pp. 119-132). This facilitates the continuous monitoring of operational processes, consumer sentiment, and infrastructure health. Because the quality and completeness of acquired data determine the reliability of subsequent analyses, organizations increasingly utilize automated sensory systems and platforms that integrate data from multiple sources in real-time.

In the subsequent step, data is integrated and stored in complex repositories such as Data Warehouses, Big Data systems, or columnar databases. This facilitates multidimensional aggregation, historical analysis, and the generation of reports that support both strategic and operational decisions (Zaskórski, Zaskórski, 2017, pp. 119-132). Integrated data architecture provides managers with rapid access to consistent information, thereby accelerating the planning and response processes within a dynamic market environment.

The third stage involves preliminary data processing and preparation, encompassing ETL (Extract-Transform-Load) or ELT processes, as well as data cleansing, standardization, enrichment, and labeling (Griffin, 2017). At this stage, data and metadata catalogs are established, enhancing transparency and control over information sources. Without rigorous data preparation, even the most advanced algorithms may yield erroneous conclusions; thus, this process remains a critical component of the entire cycle.

The fourth stage involves modeling and analysis, utilizing machine learning algorithms, including Deep Learning (ML/DL) (Von Krogh, 2018, pp. 404-409). These models transform data into forecasts, recommendations, and decision scenarios, allowing managers to understand correlations between variables and anticipate potential risks. Within the context of project and operations management, predictive algorithms enable the forecasting of delays, demand fluctuations, and financial risks. The accuracy of results depends on the quality and representativeness of the training data, necessitating multi-stage control and model auditing.

In the fifth stage – knowledge/insight generation and recommendation – systems such as Business Intelligence (BI), Intelligent Decision Support Systems (IDSS), and Large Language Models (LLM) synthesize information into reports and "what-if" scenarios, simulating decision variants (Griffin, 2017). This enables managers to analyze alternative solutions and select optimal strategies under shifting conditions. In an AI-driven environment, this process is not limited to static reporting but involves interactive dialogues with the system, the interpretation of model outputs, and the collaborative formulation of decision recommendations. This signifies a transition from traditional reporting to active, real-time decision support.

The sixth stage involves decision support and execution automation, which may take the form of human-AI collaboration (human-in-the-loop) or full automation (decision-by-AI) (Constantiou, Joshi, Stelmaszak, 2024). In the former, the system provides recommendations while final accountability remains with the human. In the latter, decisions are executed automatically within strictly defined security, audit, and escalation protocols. Such solutions enhance operational efficiency and shorten the decision cycle while maintaining human oversight.

The next crucial stage is monitoring, auditing, and feedback, often referred to as part of MLOps (Machine Learning Operations). This includes continuous tracking of model performance, data flow control, algorithm re-training, and the analysis of decision outcomes. Implementing systematic auditing ensures continued alignment with organizational goals and maintains the transparency of decision-making processes (Harvard Business Review Analytic Services, 2022).

The final stage of this chain is management and accountability for decisions, executed within governance structures, AI Hubs (competency centers), and hub-and-spoke organizational models that provide oversight for decision processes and AI models. These structures comprise business "decision owners," line managers, business-IT analysts, data scientists, data engineers, and compliance/ethics specialists. Collaboration among these roles within an integrated decision ecosystem enables the effective implementation, supervision, and evaluation of data-driven actions (Fountaine, McCarthy, Saleh, 2019; European Commission, 2020).

Integral to managing this process are organizational artifacts such as Data Catalogs, Model Registries, Decision Inventories, as well as runbooks and RACI matrices (Responsible, Accountable, Consulted, Informed). These tools allow for the documentation and tracking of dependencies between data, models, and decisions, while supporting auditing and regulatory compliance. In business practice, these tools form the foundation of transparency and accountability in an AI-driven management environment (Griffin, 2017; Harvard Business Review Analytic Services, 2022; Zaskórski, Zaskórski, 2017, pp. 119-132).

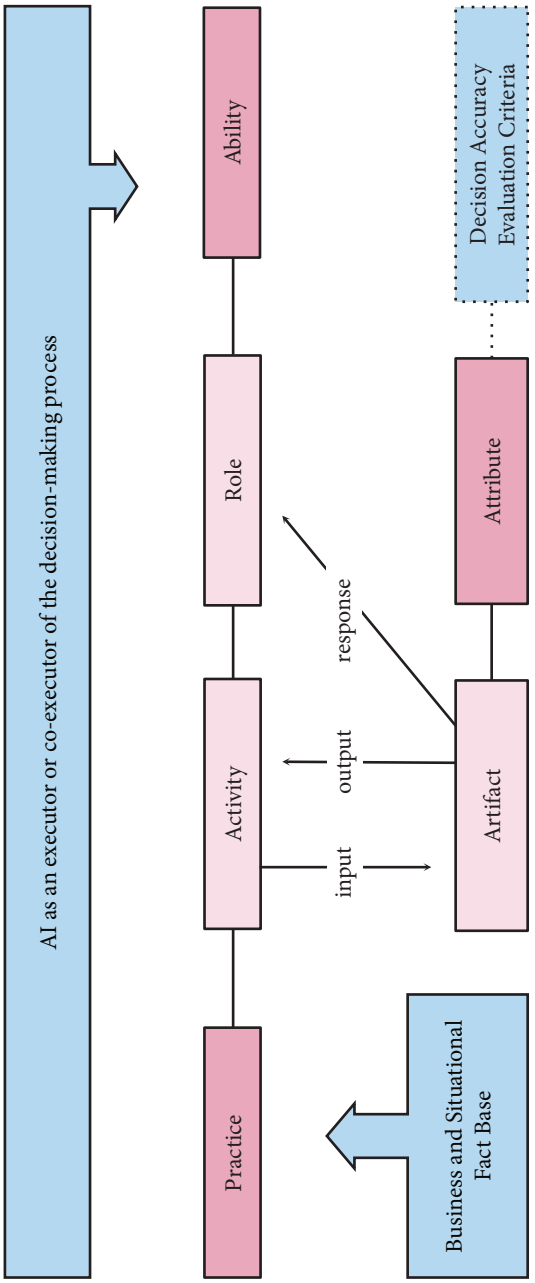

Fig. 2. The role of AI in the universal process model
Source: own elaboration based on: Krystian, Zaskórski, 2023

For the purpose of diagnosing and optimizing decision-making processes, a diagnostic procedure is proposed, consisting of the following steps:

1. Mapping of critical decisions and their corresponding success metrics.
2. Auditing of data sources and their quality.
3. Identification of models and algorithms along with their designated owners.
4. Assignment of responsibilities within a RACI matrix and the definition of ethical principles.
5. Implementation of a monitoring system and model re-training protocols.
6. Initiation of iterative test-and-learn cycles featuring A/B experiments.

Each stage should be documented in the organization's central repositories, ensuring transparency, regulatory compliance, and operational resilience. In the execution of these stages, appropriate technologies play a decisive role – ranging from ERP-class transactional systems through ETL and streaming processes, to columnar data warehouses and BI/OLAP platforms, and ultimately to Big Data and Machine Learning environments (such as TensorFlow, PyTorch, and MLFlow). Finally, LLM interfaces support the interpretation of results (Abou Tabl, Alkhateeb, ElMaraghy, 2021, pp. 1-14). The contemporary information technology landscape necessitates perceiving AI as an active component in the realization of information-decision processes (see Fig. 2).

Ultimately, information-decision processes form a complex ecosystem based on the complementarity of managerial and AI roles, in which data, people, and technologies interact through the ongoing assessment of the validity of AI-generated decision proposals and solutions. Their effectiveness is contingent upon data quality, the experience and competencies of decision-makers, and implemented governance mechanisms (structured management frameworks coupled with adherence to corporate governance principles). Organizations that master these elements attain not only a competitive advantage but also resilience, learning capacity, and operational sustainability under conditions of uncertainty. Furthermore, they gain the ability to synergistically enhance the executive potential of the modern organization through the cooperation and resource sharing advocated in the era of the Industry 4.0/5.0 technological revolution, with a particular emphasis on the benchmarking of organizational and technological solutions.

3. The essence and selected models of artificial intelligence

Artificial Intelligence (AI) constitutes one of the key tools for enhancing the intellectual potential of the modern manager and, simultaneously, represents the highest component of a contemporary organization's information strategy (see Fig. 3). Its essence lies in the creation of systems capable of perceiving information from the environment, analyzing it, and making decisions in a manner similar to human reasoning. In the context of management, AI does not merely automate processes; it primarily extends a manager's cognitive abilities through its capacity to process vast volumes of data, recognize patterns imperceptible to humans, and formulate more accurate conclusions and decisions in less time. Consequently, it supports the development of analytical, strategic, and reflective competencies, which form the foundation of effective leadership in knowledge-based organizations.

One of the fundamental pillars of AI is Machine Learning (see Fig. 3/ML), a set of methods that allow systems to learn functions mapping inputs to outputs based on examples, without the need for explicit programming (Russell, Norvig, 2022). In a managerial environment, ML strengthens the ability to analyze and interpret data, supporting decision-making under conditions of uncertainty:. Supervised learning models enable the forecasting of financial results, risk assessment, or the analysis of customer behavior. Unsupervised learning allows for the discovery of hidden dependencies and the segmentation of unlabeled data. Reinforcement learning is used to simulate decision scenarios and test strategies in controlled environments, allowing managers to analyze the consequences of decisions without incurring the actual costs of error, as it learns through trial and error to optimize action strategies within a given environment (Taulli, 2023, p. 53).

Another area that particularly enhances cognitive potential is Deep Learning (DL), which utilizes multi-layered neural network connections. These models can automatically identify significant patterns within multi-layered neural architectures using polymorphic data resources – such as images, text, or user behavior – allowing managers to respond more rapidly to market changes and detect hidden correlations (Russell, Norvig, 2022). Simultaneously, interpretable decision models, such as decision trees or Random Forests, along with ensemble methods, support transparent forecasting and data-driven decision-making, thereby increasing the stability and reliability of analyses (Syam, Kaul, 2021).

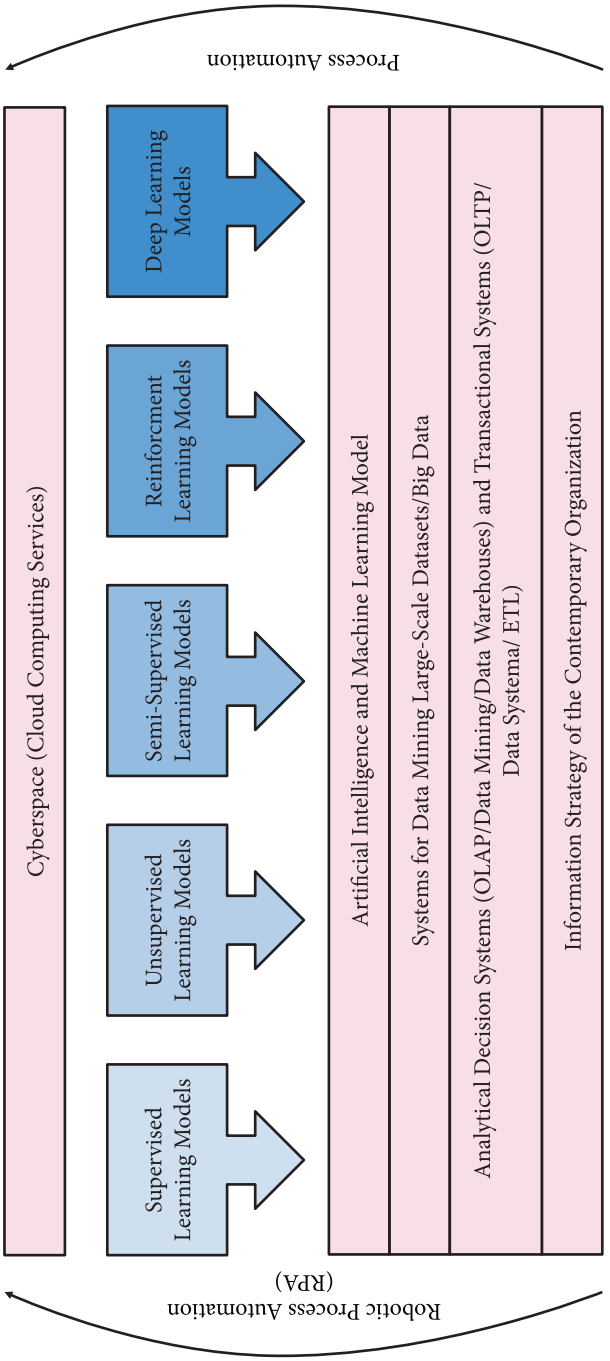

Fig. 3. A holistic approach and positioning of AI tools in the information strategy of a modern organization
Source: own elaboration based on: Zaskórski, Łukasik, 2025, pp. 87-110

Large Language Models (LLM) based on transformer architecture are also gaining increasing importance in the management environment. Their ability to understand and generate natural language opens new possibilities for document analysis, automated reporting, and supporting organizational communication. LLMs function as "cognitive assistants" – they can generate summaries, reports, or strategic recommendations, enabling the manager to focus on interpretation and decision-making rather than tedious information processing (Taulli, 2023). An important group of tools also includes generative models, such as Generative Adversarial Networks (GAN) and diffusion models, which can create realistic content, including data visualizations, simulations, or situational scenarios. Their application in management allows managers to better understand complex phenomena and visually present alternative decision paths. Combined with Bayesian models, which facilitate inference under uncertainty, they provide vital intellectual support in strategic processes and long-term planning (Taulli, 2023). It is worth emphasizing, however, that the effectiveness of AI in developing a manager's cognitive competencies depends on data quality and model transparency. Complex deep learning algorithms often function as "black boxes"; therefore, Explainable AI (XAI) is gaining significance by enabling an understanding of how models operate and maintaining trust in decision-making processes. Furthermore, AI is intended to support, rather than replace, humans; thus, maintaining a balance between automation and the decision-maker's reflection is crucial.

The essence of artificial intelligence in the context of management lies not only in the ability to process massive volumes of data but, above all, in mimicking human thought and expanding the decision-maker's cognitive competencies. AI creates a cognitive environment that strengthens the capacity to analyze, interpret, and predict complex market phenomena, enabling more accurate, ethical, and strategic decisions. The application of diverse AI models in the managerial environment leads to the development of analytical and decision-making capabilities (see Table 1). These systems allow managers not only to analyze data faster but also to learn through interaction with predictive and generative models that offer alternative scenario simulations, consequence forecasting, and strategy recommendations.

Effective utilization of AI, however, requires the conscious management of its limitations, such as ensuring data quality, providing algorithmic transparency, and addressing the costs of necessary infrastructure. In this context, the manager acts as an interpreter and integrator, synthesizing the analytical capabilities of AI systems with their own experience, intuition, and ethical responsibility. Consequently, artificial intelligence does not serve as a substitute for the decision-making process but rather as an environment for its augmentation. The synergy between humans and technology allows the manager to act more rapidly, accurately, and consciously, both under stable conditions and in crisis situations. Thus, AI becomes a factor that shapes the resilience, learning capacity, and long-term effectiveness of a knowledge-based organization.

Table 1. Application of selected artificial intelligence models in the decision-making processes of a modern manager

Decision area/application	Recommended AI models	Impact on manager's decision-making potential
Image, signal, and speech recognition	Convolutional Neural Networks (CNN), Deep Neural Networks (DNN), Transformers for sequential data	Automated analysis of large visual and acoustic datasets; decision support in monitoring, quality control, and customer behavior analysis.
Predictive analytics and scoring (e.g., credit risk, demand forecasting)	Supervised models: decision trees, random forests, gradient boosting, neural networks	Forecasting financial and operational results; development of data-driven management.
Modeling complex dependencies and uncertainty	Bayesian models, probabilistic graphs	Supporting strategic decisions in the presence of missing or incomplete data and market uncertainty.
Content creation and analysis (text, image, audio)	Generative models: transformers (text), GAN, diffusion models (images/audio)	Support for creative and communication processes; automated report generation and data visualization.
Sequential decisions and control processes (simulations, logistics, decision games)	Reinforcement Learning (RL), Deep RL	Optimization of decision strategies in simulation environments; development of scenario thinking.
Monitoring and decision improvement (continuous learning)	MLOps, recommendation systems, adaptive models	Continuous organizational learning; development of a manager's reflectivity and adaptability.

Source: own elaboration

4. The artificial intelligence environment in enhancing the decision-making processes of the modern manager

The dynamic development of artificial intelligence in recent years has fundamentally compelled a shift in how managers analyze data and obtained information, forecast phenomena, and make decisions. The AI environment does not merely represent a set of technologies supporting operational activities, but rather a complex analytical-decision ecosystem that reinforces the intellectual potential of the manager by transforming data into information and knowledge. This system supports rationality, objectification, and the generation of decision variants. Consequently, AI functions as an extension of human perception and cognitive abilities, enabling more accurate and multidimensional decisions in less time, grounded in factual analysis rather than intuition.

One of the key advantages of the artificial intelligence environment is the ability to collect, integrate, and analyze vast, heterogeneous data sources in real-time, utilizing various streams ranging from IoT sensors and system logs to social media data and Business Intelligence (BI) tools (Krystian, Zaskórski, 2023, pp. 135-152). Such integration allows for the creation of a comprehensive picture of the decision-making situation, minimizing uncertainty and increasing the accuracy of implemented actions. In this process, AI supports the entire data processing cycle – from descriptive and diagnostic analysis to predictive and prescriptive analytics. This creates opportunities to transition from mere reporting to generating recommendations and action guidelines (e.g., resource optimization, planning, and scheduling).

A particularly significant area of AI application in management is decision personalization and micro-targeting, referred to as the "segment-of-one" strategy. Thanks to advanced predictive and recommendation algorithms, a manager can tailor decisions to the individual circumstances and needs of customers, partners, or organizational units. In practice, this allows not only for increased precision in actions but also for enhancing the user experience and strengthening stakeholder loyalty.

The artificial intelligence environment is increasingly integrating the automation of operational decisions through "human-in-the-loop" systems or fully autonomous execution, particularly where safety levels and regulatory compliance permit. These solutions reduce response times, minimize errors, and allow managers to focus on strategic decisions. However, the human retains a paramount role and should continue to oversee the decision-making process, ensuring alignment with ethical values and bearing ultimate responsibility for the decisions made. It is noteworthy that the most frequently utilized technologies in the decision-making environment include predictive models based on Machine Learning (ML), neural networks, and deep learning algorithms, which enable the analysis of images, sound, text, and numerical data. Furthermore, transformers (LLMs) support natural language processing and user communication, allowing managers to engage in intuitive dialogue with the decision-making system. Recommendation systems, optimization models, and scenario simulations (Digital Twins) are also gaining significance, supporting planning and resource allocation in volatile environments.

The effective implementation and utilization of AI within an organization require a new management model and organizational structure. In practice, the hub-and-spoke model proves to be the most effective solution, where a central center of excellence (the hub) is responsible for standards, tools, and talent development, while individual business units (the spokes) execute specific implementation and adaptation projects. Within such an ecosystem, interdisciplinary teams collaborate, consisting of decision owners, analysts, data engineers, MLOps specialists, and ethics and compliance experts (Fountaine, McCarthy, Saleh, 2019). For a manager operating in this environment, competencies in data interpretation, hypothesis formulation, risk assessment, and technological change management become paramount.

In this context, strengthening intellectual potential signifies the ability to synthesize the analytical precision of machines with human strategic reflection, intuition, and ethical responsibility.

The implementation of an AI environment should be iterative and experimental in nature ("test-and-learn"), encompassing the following stages: identification of the decision-making problem, data auditing, prototype construction, results validation, production implementation utilizing MLOps, and continuous monitoring and model re-training (Fountaine, McCarthy, Saleh, 2019). An integral component of this process is the comparative analysis of decisions – both with and without the use of AI (A/B testing) – which allows for the measurement of the real impact of artificial intelligence on Key Performance Indicators (KPIs) and the refinement of models within a dynamically changing environment. In this manner, AI becomes a tool for organizational learning, supporting a culture of experimentation and decision improvement (Fountaine, McCarthy, Saleh, 2019). Notwithstanding the numerous benefits, the deployment of AI must occur in accordance with the principles of transparency, auditability, and human oversight. European regulatory frameworks (the AI Act, White Paper on AI) emphasize the necessity of ensuring model explainability, control over training data, the maintenance of model registries, and the preservation of accountability through human oversight (European Commission, 2020). Within the context of risk management, it is particularly vital to ensure data security, privacy protection, and system resilience against manipulation. Consequently, every organization should possess a set of artifacts supporting the management of the AI environment, such as a data catalog, a decision inventory, a model registry, and management dashboards (BI dashboards) integrated with AI recommendations (European Commission, 2020).

In general, it can be stated that the artificial intelligence environment is becoming a strategic space for the development of managerial competencies, achieved through both multifaceted analysis and the projection of future behaviors. This development places a particular emphasis not only on building a competitive advantage but, above all, on collaborating with the environment to achieve common business goals. Indeed, AI does not merely support the management process; it co-creates its new paradigms based on reflection, ethics, and sustainable cognitive responsibility.

5. The AI environment in shaping the quality and effectiveness of the modern manager

The Artificial Intelligence (AI) environment is becoming one of the pillars of modern management, influencing not only process efficiency but, above all, the quality and accuracy of decisions made by contemporary managers. In the digital economy, where data has become the most valuable organizational asset, AI enables

managers to transform an information surplus into strategic knowledge. By automating routine tasks, providing rapid data analysis, and generating precise decision recommendations, AI-based systems allow executives to focus on activities requiring creativity, intuition, and strategic thinking. In this context, artificial intelligence does not replace humans; rather, it augments their cognitive, analytical, and organizational capabilities, creating an environment that enhances the value of a manager's intellectual and decision-making potential. It is, therefore, possible to return to the previously formulated hypothesis: AI improves decision quality by integrating diverse data sources, ranging from internal data to market, social, and environmental data. Consequently, the manager gains access to a comprehensive, dynamic view of the decision-making situation (Osuszek, Stanek, 2021, pp. 507-518). Predictive and prescriptive models based on Machine Learning (ML) and Deep Learning (DL) facilitate a transition from classical descriptive analyses to modern forecasting and "what-if" action recommendations. This approach reduces decision-making uncertainty by allowing for the simulation of alternative scenarios and the selection of the optimal path of action (Le Manh, 2024). Decision Support Systems (DSS) and Large Language Models (LLM) support not only data interpretation but also automatically generate summaries, reports, and decision variants – even engaging in interactive dialogues with the user – which significantly shortens the decision cycle and increases the precision of expected results and actionable conclusions. Simultaneously, the AI environment increases a manager's operational efficiency by automating repetitive tasks such as reporting, project monitoring, and schedule management. This is linked to the ability to independently identify deviations from plans, analyze the causes of problems and operational errors, and generate proposals for corrective actions. Predictive resource management and intelligent scheduling enable optimal allocation of personnel and funds, reducing the risk of downtime and operational costs. AI assistants and generative tools further support communication processes within executive teams and content creation (from analyses to presentations), which increases productivity and shortens the preparation time for decision-making materials (Taulli, 2023).

The transformation introduced by AI into a manager's work is systemic in nature (see Fig. 2 and Fig. 3). The role of the manager is evolving from a performer of analyses into a leader who interprets data, ensures rational priorities for action, and coordinates interdisciplinary teams. The manager becomes a "translator" between the world of technology and the sphere of strategic decisions, synthesizing algorithmic recommendations with intuition and contextual knowledge (Bhanderi, 2024). This shift requires new competencies, such as: Data literacy: the ability to read and evaluate data; AI literacy: an understanding of the operating principles of AI models and their limitations; Change management: the capacity to lead organizational transitions; Ethical awareness: responsibility regarding the ethical use of technology (Le Manh, 2024).

Organizations are increasingly investing in the development of these skills by establishing AI academies and leadership training programs. These initiatives aim not only to increase efficiency but also to foster a culture of trust and accountability in the era of automation (Fountaine, McCarthy, Saleh, 2019).

At the organizational level, the implementation of the AI environment is based on the hub-and-spoke model, where a center of excellence is responsible for standards, tools, and competency development, while business units adapt solutions within their respective areas. Such a structure ensures operational consistency and flexibility, enabling the scaling of projects while maintaining high decision quality. Practice demonstrates that a "test-and-learn" strategy, based on iterative experimentation and continuous verification of results, fosters trust in AI and mitigates the risk of errors. Furthermore, the implementation of MLOps processes, model registries, and monitoring tools ensures the stability and transparency of the outputs generated by these systems (PWC, 2021; Harvard Business Review Analytic Services, 2022). The utilization of AI also requires addressing the challenges of risk, ethics, and regulatory compliance. "Black box" models, whose internal operational mechanisms are difficult to explain, can pose a challenge for organizations, particularly in regulated sectors. Therefore, Explainable AI (XAI) techniques are increasingly applied, allowing for the auditing and interpretation of system decisions. High data quality and representativeness form the foundation of reliable results, as erroneous or incomplete data can lead to distortions and flawed decisions. For this reason, AI implementation should be grounded in robust governance principles, namely human oversight, documentation of models and data, and clearly defined procedures for accountability and escalation. Simultaneously, organizations must ensure privacy protection, information security, and the resilience of systems against manipulation, including adversarial attacks (European Commission, 2020).

In practice, a manager implementing an AI environment should begin by mapping key business decisions and their associated key performance indicators (KPIs). The next step is a data audit – evaluating their quality, completeness, and sources of origin – along followed by the preparation of integration processes (ETL/ELT). It is advisable to start with pilot projects characterized by high value and low risk, which allow for the achievement of "quick wins" and build team confidence in the new technologies. Implementing MLOps mechanisms from the very beginning of the project will ensure control over model improvement and quality, while ongoing experiments (A/B testing, randomized testing) will enable a comparison of the effectiveness of AI-supported decisions against traditional methods. It is also crucial to establish clear governance principles and designate roles for product owners, business-data translators, and compliance experts alike. These initiatives will strengthen motivation, trust, and team engagement in the implementation process of this class of technology.

The experiences of organizations that have successfully integrated AI into their managerial processes demonstrate that the benefits are tangible. Companies that have established centers of excellence and interdisciplinary teams scaled their projects faster and achieved a higher return on investment (ROI). Pilot programs in customer service, reporting, and test automation have led to reduced labor hours and increased customer satisfaction; furthermore, in the manufacturing sector, they have resulted in decreased downtime and lower operational costs (Nilsson, 2024). Such cases confirm that a well-designed AI environment serves not only as a technical tool but, above all, as an organizational and strategic one.

6. Conclusions

Artificial intelligence currently represents one of the most significant environments supporting the intellectual and decision-making development of the modern manager. It is no longer merely a technological tool, but a cognitive ecosystem that integrates information processing, data analysis, and decision automation into a coherent system for supporting management processes. Its essence lies in the ability to collect, integrate, and interpret data sets of immense (theoretically infinite) volume, and subsequently transform them into knowledge that conditions the generation of forecasts, recommendations, and simulations supporting the decision-making process. This entails enriching the human intellect and strengthening the manager's cognitive potential to operate more effectively and make more accurate, rapid, and ethical decisions.

The contemporary business organization, within which the manager operates, is characterized by a high degree of digitalization, flexibility, and organizational learning. Data has become a key strategic resource, and the ability to process and interpret it forms the basis of competitive advantage, as well as rational cooperation and resource sharing through cyberspace services. In this context, the manager is no longer just a recipient of information but an active participant in an information environment that reacts dynamically to market shifts. The utilization of artificial intelligence enables the transformation of traditional decision-making processes into automated, iterative cycles based on data and prediction, allowing for the real-time correction of action paths and the reduction of the risk of erroneous decisions. The information-decision process in a modern organization is now continuous and integrated. It begins with data collection from diverse sources – both internal and external – followed by analysis and modeling using machine learning and deep learning techniques. Subsequent stages involve generating recommendations, automating actions, monitoring results, and implementing adjustments through feedback. This makes it possible to create a closed information loop where decisions become increasingly precise and aligned with reality.

The application of artificial intelligence models, such as machine learning, neural networks, Bayesian models, generative systems, or reinforcement learning algorithms, introduces a new quality to management. These models allow managers not only to analyze the past but also to simulate the future, predict scenarios, and test the effects of potential decisions. Furthermore, AI facilitates a transition from descriptive to predictive and prescriptive analytics, through which the manager becomes a more reflective decision-maker, aware of context, risk, and possible consequences.

The artificial intelligence environment significantly impacts the quality and efficiency of a manager's work. The automation of routine tasks allows for a focus on strategic, relational, and creative activities. AI can support time management, resource optimization, project planning, and risk analysis, while simultaneously providing tools to monitor results and respond quickly to changes. Consequently, the manager gains the ability to operate in a "Real-Time Management" mode, which increases the organization's resilience and competitiveness. As the AI environment develops, the role of the manager changes. From a person performing analytical tasks, they transform into a leader of interpretation and strategy, whose key competence becomes the ability to understand data, interpret models, and oversee the ethical use of technology. This requires the development of new skills, as well as competencies in change management, interdisciplinary communication, and ethical oversight of decision-making processes.

Implementing AI in an organization requires not only access to modern technology but also appropriate structures and a specific work culture. An effective solution is the hub-and-spoke model, in which a competency center creates standards, tools, and strategies, while teams in business units implement them in practice. Such an approach enables consistency of action, accelerates the adaptation of solutions, and fosters knowledge exchange while maintaining a governance framework. An important conclusion is that artificial intelligence constitutes a complementary, rather than a substitutive, environment for human intellect. Its strength lies in synergy with the manager's competencies, not in their replacement, because the effectiveness of AI implementation depends on data quality, technological maturity, organizational readiness, and the openness of the management culture to learning and experimentation.

In the long term, AI will become a key factor strengthening the intellectual potential of the modern manager. It will enable them to fulfill the role of a reflective leader capable of interpreting complex phenomena, managing risk, and creating value based on knowledge. AI will transform the way decisions are made, making the process more rational, rapid, and responsible. Organizations that integrate AI into their culture and management strategy will achieve sustainable development and the ability to adapt in an era of uncertainty and dynamic environmental changes.

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