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OPPORTUNITIES FOR INTEGRATING AI INTO THE RISK MANAGEMENT PROCESS IN FAST-GROWING HIGH-TECH STARTUPS

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ABSTRACT— *This article examines a contemporary and highly relevant issue: risk management in the development of high-tech startups. The significance of this topic motivates the present paper to explore the opportunities for integrating AI into risk management processes associated with the sustainable development of small high-tech startups. In this study, risk management is understood as the provision of rational and coordinated actions aimed at achieving the startup's development objectives, while the potential applications of AI are examined in the context of providing a consultative function to management in making decisions related to the identified risks. To reveal the possibilities for AI integration in risk management, the historical development of AI has also been reviewed and analyzed. The potential interactions between AI and the concept of risk management have been examined in the context of currently applicable risk management standards and AI governance frameworks. The applicability of contemporary advances in artificial intelligence has been explored for each stage of the risk management process. Perspectives have been identified regarding the opportunities that the future development of artificial intelligence and risk management concepts may offer, specifically from the standpoint of their combined application to achieve the development objectives of a high-tech startup.*

Keywords: artificial intelligence, opportunities, process, risk management

1. INTRODUCTUON

At the current stage, the development of artificial intelligence (AI) is attracting growing interest and popularity, with the scope of its applications continuously expanding. This is largely due to the unprecedented pace of technological advancement and its wide-ranging applicability, which practically affects all areas of business and social life. The intensity and pervasiveness of this impact are unprecedented at present (Elahi et al., 2023) and cannot be compared to the development of any other technology at this time. AI development both subtly and overtly affects and transforms the external and internal business environment, the advancement of science and technology, and the broader context of our daily lives. Hese effects are observed today, but the development of AI, when considered from a historical perspective, did not begin in the contemporary era. Mathematical algorithms exhibiting characteristics of AI have been developed and applied as early as the beginning of the last century. The foundational criteria for artificial intelligence were also established during this period, notably when Alan Turing introduced the so-called Turing Test in 1950 (French, 2000). The first definitions of AI also date back to this period. At that time, John McCarthy defined AI as the science and engineering of intelligent machines (Rajaraman, 2014). Since then, numerous definitions of AI have been proposed, and attempts have been made to synthesize criteria for its characterization; however, to date, no single,

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universally accepted definition exists. Nevertheless, most of the proposed definitions converge around the understanding that AI involves the application of mathematical algorithms to create a system capable of learning from the data it is provided. Subsequently, the system can generate solutions that heavily depend on the quality and volume of the data used during training. Equally important is the proper selection of algorithms and the quality of the structures they form. In its evolutionary development, and particularly at the current stage, AI faces various barriers that have significant social implications. These barriers are often shaped by differences in the values of diverse communities, which in turn influence political decisions and are reflected in a range of regulatory constraints (Morley et al., 2023). At the current stage, issues have also arisen regarding copyright for graphic objects and information used to train AI, as well as for the objects generated from this training (Lucchi, 2024). A step toward overcoming these barriers is the first AI standard—ISO/IEC 42001:2023, "Artificial Intelligence Management System". It highlights the challenges posed by AI applications while providing guidance on ethics and transparency in AI use. The standard offers a framework for implementing AI within organizations, creating conditions for the deployment, operation, and continuous development of an AI management system. A comparable role, but in the context of risk management, is fulfilled by the ISO 31000:2018 standard, "Risk Management – Principles and Guidelines." This is the second edition of the standard, with the first edition published in 2009 (ISO 31000:2009). The standard provides guidance for risk management, outlines the risk management process, and simultaneously expands the scope of risk oversight. The second edition emphasizes the leading role of top management in risk management, with the expectation that risk management will encompass the organization as a whole (ISO 31000:2018). According to the current standard, managing risk for an individual activity or process alone is now considered insufficient. It should be noted that a third edition of the ISO 31000:2018 risk management standard is expected, with anticipated further expansion of the scope of risk management.

At present, AI technologies and the concept of risk management are widely applied as part of the toolkit for managerial decision-making. This demonstrates their applicability toward a common goal: making informed managerial decisions to achieve the objectives of a business organization. This also provides a basis for identifying their shared characteristics and, consequently, for exploring opportunities for interaction between AI and the risk management concept. The following can be considered common characteristics: their comprehensive applicability; their impact across the entire organization and integration into all business processes; involvement in defining objectives and accounting for stakeholder interests; support of organizational management in achieving its goals; and the potential for both technologies to be applied in the context of ensuring reliability, safety, transparency, informed decision-making, and the quality of information and its sources. The outlined common characteristics provide confidence in the ease of integrating AI with the risk management concept. As a result, this integration is expected to generate significant utility, with the potential to produce a synergistic effect. Additional benefits may also be derived from the fact that the ISO 31000:2018 and ISO/IEC 42001:2023 standards provide guidance for the implementation, application, and control of AI and risk management practices.

Despite the indicated parallels, risk management and AI should be regarded as two distinct technologies, each with its own independent development. This does not preclude their integrated application as part of business organization management or the associated managerial decision-making process serving a common purpose of supporting the achievement of established business objectives. In this context, AI and risk management can be applied to provide a consultative function to the management of a business organization or to specific individuals authorized to make managerial decisions. The primary goal of this managerial function can be aligned with ISO 31000:2018: supporting the achievement of organizational objectives, without deviations or with

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minimal deviations that do not pose a threat to the development of the business organization. Effectiveness in achieving this functional goal can be pursued through the creation of a positive synergistic effect resulting from the symbiosis between AI and risk management. The investigation of opportunities for achieving synergistic effects requires: uncovering the conceptual foundations of both technologies; examining their development over time; reviewing their applications in support of top management; and analyzing the limitations associated with the application of these technologies in the context of the prerogatives of senior management.

The foregoing provides a basis for this paper to adopt the following research objective: to investigate the possibilities for integrating AI into risk management related to the sustainable development of small high-tech startups.

2. Opportunities for Integrating AI into Risk Management

Revealing the benefits of applying AI to risk management requires defining their significance in the context of ensuring the sustainable development of fast-growing startup companies. Establishing these definitions is necessary, but not sufficient, for determining the utility of AI in risk management. It is necessary to trace the development of AI from a historical perspective, revealing at each stage the enhanced capabilities it offers in supporting managerial decision-making to achieve objectives that characterize the sustainable development of a business. The capabilities thus revealed should then be mapped to the stages of the risk management process. This will uncover the full spectrum of benefits from applying AI to risk management.

Within the context of this study, AI can be defined as a class of mathematical algorithms and a field within computer science and technology which, when applied together, enable the development of systemic capabilities such as learning, reasoning, and decision-making. These capabilities can serve a consultative function for senior management, which is responsible for managing risk and, consequently, achieving the objectives of the business organization.

For the purposes of this study, risk management can be defined as the coordinated and rational actions undertaken by senior management to achieve the objectives of a business organization, allowing only safe deviations from these objectives. The execution of the actions outlined in the definition aims to assess and influence the factors of the external and internal environment, whose probabilistic occurrence and impact may lead to deviations from the established objectives.

Risk assessment and risk treatment are at the core of the risk management process. To carry out the stages of risk assessment and treatment, the IEC 31010:2019 standard outlines the applicability and specifics of a significant number of methods. In addition to their applicability, IEC 31010:2019 also provides a categorization of these methods in terms of their use within the risk management process. The criteria for categorizing the proposed methods are: application; scope; time horizon; decision-making level; requirement for initial information/data; expert experience; qualitative/quantitative/semi-quantitative method; and effort required for implementation. Based on this categorization and the specified criteria, the IEC 31010:2019 standard applies a total of forty-two methods in the risk management process. Notably, according to the standard's categorization, only ten of these forty-two methods are classified as requiring a low level of initial information. This places additional emphasis on the requirement to provide the necessary information resources for a significant portion of the methods used in risk management. Part of this information resource is generated through the documentation of the risk management process itself, as prescribed in ISO 31000:2018, which considers process documentation as a key stage of risk management. This, in turn, imposes specific requirements on management, such as:

- Management must ensure reliable documentation of the risk management process, which

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serves as a prerequisite for providing the resources necessary for its effective implementation. This resource is also valuable for proper training and effective utilization of AI within the risk management process. Additionally, management should ensure access to reliable and high-quality external sources for AI training and for the application of risk management methods.

- Management has the responsibility to provide the resources necessary for documenting the risk management process.

Proper fulfillment of these requirements is a prerequisite for management to receive reliable, timely, and sufficient information for making informed decisions. Decision-making with such a high level of information reduces uncertainty in achieving objectives that characterize the sustainable development of the business. At the same time, it should be recognized that the volume of documented information from the risk management process continuously grows over time, while the ability to ensure reliable and rapid access must be maintained. From a risk management perspective, access to this information should not be limited to company management alone; it must be made available to all stakeholders with an interest in risk management. It is important to note that mere access to information is no longer sufficient on its own to ensure effective management. What is needed is a resource capable of providing additional managerial analyses from the large and continuously growing volume of documented knowledge, and this must be done in real time. This raises the question of the extent to which the development of AI technology based on mathematical algorithms as well as information and communication technologies can provide up-to-date, timely, and continuously improving and cumulative knowledge on risk.

Providing this knowledge does not rely solely on high-quality AI training. It is also important to recognize that technologies grouped under the general term AI are undergoing rapid development, leading to a swift increase in both the scope and complexity of the tasks that this technology can perform. At the current stage, AI already performs information-analytical tasks and provides a consultative function in management decision-making (Haenlein et al., 2019). AI has become a technology capable of making decisions; however, the challenge of delegating this authority to it remains. The successful implementation of this consultative function by AI, as part of risk management, makes it a highly significant tool for the effective management of risk in terms of achieving business development objectives. This necessitates further investigation into the possibility of providing this functionality through AI, by tracking its evolutionary development and the progressively enhanced capabilities it acquires over time. For the purpose of this study, the following criteria are proposed to reveal the development of the capabilities required to implement the aforementioned consultative function:

- Ability to learn from large datasets.
- Ability to synthesize and propose alternative management decisions.

The first successful attempts to solve mathematical equations and develop computer logic were carried out by Turing machines by the mid-20th century. These machines operated with large volumes of data. During this period, it is difficult to speak of machines capable of forming an information-analytical resource sufficient to support well-informed managerial decisions. At that time, the machines being developed were primarily able to solve optimization tasks.

The next stage in the development of AI technology can be defined as the period between 1960 and 1970. This was the time when the first significant investments in AI were made under the DARPA program (DARPA, Defense Advanced Research Projects Agency) (Goldstein, 1992). A large portion of the first university AI laboratories were established under this program, laying the foundation for the future intensive development of the technology. It was during this program and stage that technologies such as automated planning, machine reasoning, and natural language

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processing began to develop. The technology also advanced the capability to work with large datasets.

During the period from 1970 to 1980, the development of AI was affected by global crises, which led to insufficient funding for scientific research. There was also a slowdown in the advancement of hardware technologies, which serve as the foundation for AI. This also led to limited enhancement and utilization of the AI technologies developed in the previous stage. One such technology, created at the end of the preceding period, was ARPANET (Advanced Research Projects Agency Network, ARPANET), which enabled rapid sharing of data and computational capacity (Packard, 2020).

The next stage in the development of AI can be defined as the period from 1970 to 1988. This period is associated with the expansion of AI beyond laboratory research and military applications. During this time, AI began to be applied in the fields of medicine and large corporate organizations. This is the stage in which AI began its commercialization. AI made significant, though challenging, progress its systems were expensive and not yet very flexible or adaptive but the commercialization of AI had begun, opening the path for its accelerated development. During this stage, AI continued to advance its ability to work with large volumes of data, and its application in developing alternative solutions was beginning to emerge.

The period from 1988 to 2010 can be considered the next stage in the development of AI. This stage was marked by profound global changes, including the end of the Cold War. For parts of the world, it represented a challenging new beginning, with changes in economic models leading to the emergence of new priorities and development opportunities. At the same time, this stage saw the development of internet technologies, which began to be widely adopted by both general users and developers, moving beyond their strictly military applications. The development of internet technologies created a broad foundation on which AI algorithms could confidently build, providing easy access to large volumes of data. During this stage, machine learning began to develop, significantly expanding the applications of AI. AI started to enter everyday life, enabling improved internet search, travel and vacation recommendations, assistance in extracting desired information from large datasets, and the emergence of AI as a consultative tool. Many of the software products and electronic devices we use in daily life now have integrated AI and internet connectivity, making AI's presence constant, though less visible to society. This is a clear indicator that AI has established itself as a highly effective assistant for everyday tasks, used for developing and selecting alternatives, supporting well-informed decision-making, and aiding engineering across a wide range of activities. This applicability of AI demonstrates that it has reached a level of development enabling it to perform information-analytical tasks, integrated into a consultative function for management. Its purpose is to support well-informed decision-making that leads to minimal risk, ensuring safe deviations from established objectives.

After 2010, AI continued to develop, particularly in the field of neural networks, which began to be built with multiple hidden layers. This advancement enabled applications in areas such as image diagnostics, cybersecurity, fraud prevention, behavioral analysis, chatbots, and humanoid robots. This represents only a part of the expanding spectrum of AI applications, while simultaneously there has been an increase in the intensity of its development. This is facilitated by the high speed and wide accessibility of internet technologies, including 5G. This stage in the development of AI largely coincides with the beginning of the standardization of risk management the first risk management standard being ISO 31000:2018, published in 2011. This provides yet another opportunity for their successful combined application and the potential to achieve a synergistic effect. To explore this possibility, the applicability of AI at each stage of the risk management process has been examined, as presented in Table 1, Table 2, Table 3, Table 4, Table 5 and Table 6.

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Stages of the risk management process:	**Applicable AI technology:**
Information exchange and consultation	The primary objective of this stage is to assist stakeholders in understanding risk. To achieve this goal, AI can provide information, perform analyses, and summarize the results.
Scope, context, and criteria	AI can prepare analyses based on which it can determine the scope and context for implementing risk management. This can be viewed as performing a consultative function for management involved in risk management. The same applies to defining the criteria that will be used throughout the risk management process.

Table 1: Application of AI in first two stages of the Risk Management Process

Stages of the risk management process:	**Applicable AI technology:**
Stage: Risk assessment Substage: Risk identification.	Machine Learning: Detects patterns within large-scale datasets that may indicate potential risks. By analyzing vast amounts of information, machine learning models can uncover correlations, anomalies, and trends that signal emerging or hidden risks. Deep Learning: A more advanced subset of machine learning capable of identifying and amplifying even subtle patterns within massive datasets. Through multilayered neural networks, deep learning can reveal complex relationships and weak signals for risk, that might otherwise remain undetected in traditional analysis.

Table 2: Application of AI in stage Risk Assessments, substage Risk Identification

Stages of the risk management process:	**Applicable AI technology:**
Stage: Risk assessment: Substage: Risk analysis.	AI Agent: Capable of processing large volumes of raw data and generating expert-level alternative solutions based on the analysis and system of criteria. Domain-Specialized Agents: Individual AI agents may be designed with expertise in specific domains such as marketing, healthcare, finance, or other functional fields.

Table 3: Application of AI in stage Risk Assessments, substage Risk Analysis

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Stages of the risk management process:	**Applicable AI technology:**
Stage: Risk assessment. Substage: Risk estimation.	Artificial Intelligence for Risk Pattern Recognition: AI can detect emerging risk patterns that may remain hidden from risk management stakeholders. These patterns may appear in the results of conducted analyses or within the proposed alternative solutions for managing or mitigating risk. Evaluation of Risk Significance: By applying these criteria, AI agents can estimate the significance and potential impact of risks within each alternative solution, model, or scenario. This enables more informed decision-making.

Table 4: Application of AI in stage Risk Assessments, substage Risk Estimation

Stages of the risk management process:	**Applicable AI technology:**
Impact on risk:	Support in Decision-Making process: AI primarily provides extra analytical and informational support to assist leaders in making informed decisions regarding risk response. Selection of alternative for impact, Planning, and Control on its implementation: AI can also support the process of selecting the most appropriate alternative, planning its implementation, and monitoring its execution. Through continuous data analysis, application of set criteria and feedback mechanisms.

Table 5: Application of AI in stage Inpact on Risk

Stages of the risk management process:	**Applicable AI technology:**
Monitoring and review:	An AI agent can provide: Real-time control based on set criteria. Automate the preparation of reports, reports and statements from observations - controls.
Documentation and reporting:	The use of an AI agent can provide automation of the documentation of the risk management process, while at the same time being able to report the status of the documentation of the process, as well as identify deviations in the documented data based on predefined criteria.

Table 6: Application of AI in the Risk Management Process

It is evident from Table 1, Table 2, Table 3, Table 4, Table 5 and Table 6 that all successive evolutionary developments in the field of Artificial Intelligence are applied within the risk management process. This does not exclude the use of early AI algorithms, such as those used for formulating and solving optimization problems. However, at the present stage these algorithms have been significantly enhanced and their application has been broadened. They are now often integrated as part of a broader analytical toolkit that supports managerial decision-making while

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maintaining an acceptable and sustainable level of business risk.

3. TRENDS IN THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE AND ITS ROLE IN RISK MANAGEMENT

From the perspective of risk management in rapidly developing high-technology startup companies and the role of AI within it, several significant trends can be identified. The first trend is related to the development of so-called AI teamwork (Dennis et al., 2023. From a risk management standpoint, this approach enables close interaction and communication among multiple AI agents specialized in different domains. Such collaboration between agents can elevate risk management to a new level by integrating diverse analytical perspectives and expertise. As a result, the scope and effectiveness of AI applications in risk management can be significantly expanded.

Another emerging trend in the development of AI is related to marketing AI agents capable of conducting purchases and sales on behalf of users (Barbosa et al., 2023). This development is leading to the emergence of a new form of marketing based on AI agents that can analyze the purchasing behavior and decision-making models of other agents AI agent-to-AI agent interactions which perform transactions on behalf of consumers. Unlike human buyers, these agents do not possess emotions and are not influenced by psychological biases when making purchasing decisions. As a result, market dynamics may increasingly be shaped by data-driven interactions between autonomous systems. Marketing agents are therefore becoming highly significant for risk management in technological and product commercialization. Their ability to analyze demand patterns, optimize pricing strategies, and anticipate market reactions can reduce uncertainty and support more effective decision-making. This is particularly important for the sustainable development of technology companies and the advancement of their innovation processes.

An increased integration of AI-based technologies into the processes of fintech companies is expected (Cao et al., 2021). In this context, particular emphasis is placed on addressing and preventing cyber threats, which can have a devastating impact on the development of rapidly growing technology businesses and startups. Within this framework, AI agents are evolving as advanced tools capable of monitoring, analyzing, and processing vast numbers of operations and financial transactions in real time. Their ability to detect anomalies, identify potential fraud, and respond quickly to cybersecurity risks makes them an essential component in strengthening risk management and ensuring the stability and resilience of fintech-driven technological ventures.

Another area where the interaction between AI and risk management is expected to continue expanding is medicine (Ahmad et al., 2021). In this sector, the integration of AI is anticipated to advance significantly in several key areas:

- Diagnostic Systems – The development of AI-powered systems for more accurate, timely, and predictive diagnosis.
- Medical Technology Integration – The design of new technologies and their incorporation into medical devices to enhance performance, safety, and reliability.
- Pharmaceutical Innovation – The development and testing of new, effective pharmaceutical products, with AI helping to accelerate drug discovery, optimize clinical trials, and reduce associated risks.

Overall, AI-driven risk management in medicine strengthens decision-making, improves patient safety, and supports the sustainable innovation of healthcare technologies.

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4. CONCLUSION

As a result of the research conducted and presented, it can be concluded that the research objective of this paper has been achieved. The study has examined the potential for interaction between AI technologies and the modern concept of risk management as defined in ISO 31000:2018. The findings highlight how AI can support, enhance, and expand the processes of risk identification, analysis, assessment, and mitigation in alignment with established international standards. This has been carried out in the context of the evolution of AI technology over time. The study presents the capabilities developed by AI that contribute to improving the effectiveness of risk management related to the sustainable development of technology startup companies. Key capabilities include:

- Stage One: Solving optimization problems and initiating the processing of significant volumes of data.
- Stage Two: Automated planning, machine reasoning, and natural language processing.
- Stage Three: Development of capabilities for rapid data sharing and computational power, despite slower advancements in hardware.
- Stage Four: AI moves beyond laboratories and military applications, beginning to be implemented in medicine and large corporate environments.
- Stage Five: The emergence of machine learning and the development of capabilities for creating an information-analytical resource.
- Stage Six: The development of neural networks advances, including the construction of multi-layered architectures. This enables their application for a variety of purposes within risk management and mitigation activities, such as: Medical imaging and diagnostics; Cybersecurity; Prevention of financial fraud; Behavioral analysis; Development and deployment of chatbots and humanoid robots.

The potential applications of AI have also been identified for each stage of the risk management process. It has been demonstrated that AI can be applied across all stages of the process, enhancing risk identification, analysis, assessment, mitigation, and monitoring. The results obtained highlight the usefulness of AI technologies and their strong potential for integration into risk management. This provides a foundation for further research aimed at developing and testing tools and mechanisms for risk management that incorporate the latest advancements in AI technology. Such work could support more effective, data-driven, and adaptive approaches to managing risk in dynamic and high-tech business environments.

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