

The Role of AI in Risk-Based Decision-Making: A Systematic Review and Future Directions

The Role of Artificial Intelligence in Risk-Based Decision-Making

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ABSTRACT

This study examines the role of artificial intelligence in enhancing risk-based decision-making across multiple sectors. The rapid adoption of AI has transformed organizational approaches from reactive to proactive risk management; however, gaps remain in governance, ethical readiness, and real-world implementation. Therefore, this study aims to systematically review the application of AI, identify its benefits and challenges, and analyze the relationship between AI capabilities, risk management processes, and decision outcomes. This research employs a systematic review method guided by the PRISMA framework, analyzing recent literature published between 2023 and 2025 from major academic databases. The findings indicate that AI significantly improves predictive accuracy, operational efficiency, and decision quality through advanced data processing techniques such as machine learning and deep learning. AI applications are widely observed in healthcare, finance, and environmental risk management, demonstrating strong performance in prediction and analysis. However, challenges related to data quality, model transparency, ethical risks, and governance limitations persist. This study concludes that AI should be implemented as a socio-technical system supported by robust governance frameworks and human oversight to ensure responsible, transparent, and sustainable risk-based decision-making.

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INTRODUCTION

In recent years, artificial intelligence has fundamentally transformed how organizations and individuals address complex problems, particularly in the context of risk-based decision-making. The integration of AI technologies such as machine learning, deep learning, and natural language processing enables the processing of vast amounts of both structured and unstructured data, thereby generating more accurate predictions and supporting faster and more effective decision-making processes (Albert & Alijoyo, 2024). In practice, AI facilitates a shift from reactive to proactive approaches in risk management, allowing organizations to anticipate potential threats more systematically (Mogoale et al., 2025). This transformation highlights the strategic role of AI in enhancing decision quality across various sectors. Moreover, AI-driven systems can analyze large datasets, identify hidden patterns, and provide predictive insights that significantly improve risk assessment and management processes (Zong & Guan, 2025; Sarfraz et al., 2025).

However, despite these advancements, a significant phenomenon gap persists between the rapid adoption of AI technologies and the readiness of organizations to manage the associated risks effectively. Many organizations have implemented AI systems without establishing adequate governance frameworks to address emerging risks, including algorithmic bias, uncertainty in outputs, and a lack of transparency and accountability in AI-driven decision-making processes (Nuryadin & Marlina, 2023). Furthermore, existing evidence suggests that while AI can enhance analytical performance, its real-world impact

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on decision outcomes remains inconsistent, particularly in high-stakes domains such as healthcare (Sahoh & Choksuriwong, 2023; Mukala, 2025). This condition reflects a critical issue that justifies the need for further research on AI in risk-based decision-making contexts.

In addition, the relationship among key variables in this study constitutes an important area of analysis. AI capabilities, particularly in data processing and predictive analytics, directly contribute to the effectiveness of risk management processes, which subsequently influence decision-making quality. In other words, there is a causal relationship between AI capability, risk management performance, and decision outcomes. Nevertheless, this relationship is not strictly linear, as it is influenced by factors such as data quality, human expertise, and organizational governance structures (Nuryadin & Marlina, 2023). Furthermore, ethical risks, including algorithmic bias, lack of explainability, and accountability concerns, may also affect the reliability of AI-driven decisions (Munifah et al., 2024; Bamigbade et al., 2024).

From an academic perspective, a notable research gap exists in the limited integration of technical, organizational, and ethical dimensions within existing studies. Prior research has predominantly focused on the technical capabilities of AI, such as predictive accuracy and computational efficiency, while often neglecting the broader governance, ethical, and social implications. In addition, many studies remain sector-specific, resulting in fragmented insights that lack generalizability across different contexts. Although AI has demonstrated its potential to improve risk prediction and decision-making efficiency, challenges related to transparency, real-world implementation, and data governance remain insufficiently addressed (Kehinde, 2025; Nwoke, 2025).

Based on these gaps, the novelty of this study lies in its integrative approach, which combines technological, managerial, and ethical perspectives in analyzing AI-driven risk-based decision-making. This study not only emphasizes the technical strengths of AI but also highlights the importance of governance frameworks, human involvement, and ethical considerations in ensuring responsible implementation. By adopting a comprehensive perspective across multiple sectors, this research seeks to provide a more holistic understanding of AI's role in contemporary risk management practices.

The objective of this study is to systematically review the application of AI in risk-based decision-making, identify its key benefits and challenges, and examine the relationships between AI capabilities, risk management processes, and decision outcomes. Furthermore, this study aims to propose recommendations for improving AI governance, enhancing data quality, and fostering adaptive systems, thereby ensuring that AI can be effectively and responsibly utilized to support sustainable decision-making in an increasingly complex and uncertain environment.

LITERATURE REVIEW

Use or Application of AI Technology

Artificial intelligence has rapidly evolved from a theoretical concept into a transformative technology with significant impacts across multiple sectors. Supported by advances in computing and the availability of large-scale data, AI has become a key driver of innovation in the digital era (Albert & Alijoyo, 2024). Its applications span education, healthcare, finance, transportation, and manufacturing, highlighting its broad implementation. AI enhances efficiency, accuracy, and productivity by automating tasks that previously required human intervention (Mogoale et al., 2025). In education, AI enables adaptive learning systems and real-time performance analysis, while in healthcare, it supports medical diagnosis, decision-making, and drug discovery (Nuryadin & Marlina, 2023; Widodo et al., 2024). In finance, AI is widely used for fraud detection, risk management, and automated investment recommendations (Pranata, 2024; Vieriu & Petrea, 2025).

Despite these advantages, AI implementation presents critical challenges, particularly regarding ethical issues such as algorithmic bias, data privacy, and potential job displacement (Alijoyo et al., 2025a). Effective adoption also requires robust digital

infrastructure, skilled human resources, and strong governance frameworks to ensure responsible use. Recent developments indicate rapid expansion of AI adoption, especially with the emergence of generative AI for content creation and business process automation (Wang et al., 2024). Furthermore, AI has become increasingly important in risk-based decision-making by accelerating data analysis, improving risk prediction, and enhancing decision quality through complex variable processing (Alijoyo et al., 2024c). Therefore, future AI development must emphasize transparency, ethical responsibility, and multidisciplinary collaboration to maximize its societal and business benefits.

AI in Risk-Based Decision Making

Artificial intelligence has increasingly become a key driver in enhancing risk-based decision-making across various sectors. The integration of technologies such as machine learning, natural language processing, and predictive analytics has shifted organizational approaches from reactive to proactive in identifying and managing risks. In general, AI enables organizations to analyze large and complex datasets rapidly and accurately, thereby improving the quality and timeliness of decisions (Guler et al., 2024). In practice, AI supports functions such as fraud detection, credit risk assessment, and continuous monitoring of risk indicators, allowing organizations to detect anomalies and respond in real time (Setyowati et al., 2025). These capabilities contribute to improved predictive accuracy and enable organizations to anticipate potential risks before they occur, ultimately enhancing decision effectiveness and operational efficiency (Wang & Aviles, 2023; Alijoyo et al., 2024b).

However, despite its transformative potential, the implementation of AI in risk-based decision-making presents several significant challenges. Issues related to data quality, model transparency, algorithmic bias, and regulatory compliance remain critical concerns that must be addressed (Alijoyo et al., 2024a; Bahangulu & Owusu-Berko, 2025). The complexity of AI systems often limits interpretability, reducing trust in automated decisions and highlighting the importance of explainable AI to ensure accountability. Furthermore, organizations must invest in digital infrastructure, develop appropriate governance frameworks, and continuously monitor AI systems to mitigate emerging risks and ensure reliable outcomes (Hasan & Jahan, 2024; Alijoyo et al., 2025b). Therefore, while AI significantly enhances the speed and comprehensiveness of risk assessment, its effective utilization depends on balancing technological advancement with ethical considerations, transparency, and strong organizational oversight.

RESEARCH METHODS

This study employs a systematic review approach with a research design guided by the PRISMA framework to ensure transparency, consistency, and reproducibility in synthesizing scholarly evidence on the role of Artificial Intelligence in risk-based decision-making (Netto, 2020). The systematic review design was selected because it enables researchers to identify, evaluate, and integrate findings from previous studies in a structured manner, thereby providing a comprehensive understanding of the development of AI applications in risk management and decision-making processes. This approach also facilitates the identification of research trends, theoretical gaps, and future research directions related to AI-supported risk-based decision-making.

Data collection was conducted through a comprehensive literature search across several major academic databases, namely Scopus, Web of Science, IEEE Xplore, and Google Scholar. The search strategy employed combinations of keywords such as "Artificial Intelligence," "AI," "risk-based decision-making," "risk assessment," and "systematic review." The search process focused on articles published in English between 2023 and 2025 to ensure that the analyzed studies reflect the most recent developments in the application of AI for risk-based decision-making. All retrieved articles were subsequently imported into a reference management tool to facilitate literature organization and the removal of duplicate records prior to the screening stage.

The population of this study consists of all scholarly articles addressing the application of Artificial Intelligence in risk-based decision-making contexts available within the selected databases. The article selection process followed several stages in accordance with the PRISMA procedure, beginning with title and abstract screening based on predefined inclusion and exclusion criteria (Acevedo, 2020). Studies included in the analysis comprised empirical research, comprehensive reviews, and conceptual papers that explicitly discuss the use of AI in risk-based decision-making. Conversely, articles unrelated to the research topic or not available in full text were excluded from the selection process. The subsequent stage involved a full-text review to assess the methodological quality and relevance of each article to the research objectives (Bahroun, 2023).

Data analysis was conducted through systematic data extraction and synthesis of all articles that met the established selection criteria. Extracted data included research objectives, Artificial Intelligence techniques employed, risk domains examined, methodological approaches, key findings, as well as identified challenges and future research opportunities. The extracted information was then analyzed using descriptive and thematic synthesis to identify patterns, research trends, and the major contributions of AI in supporting risk-based decision-making. The analytical tools used in this study included reference management software for organizing literature and the PRISMA framework as the primary guideline for identifying, screening, assessing eligibility, and including articles in the systematic review. This approach ensures that the literature synthesis process remains systematic, transparent, and replicable for future research.

The literature selection process was conducted in stages, starting with source identification and screening and ending with eligibility assessment, to ensure the quality and relevance of the studies included in the review. The PRISMA flow diagram illustrates the steps and the number of articles at each stage of the study selection process.

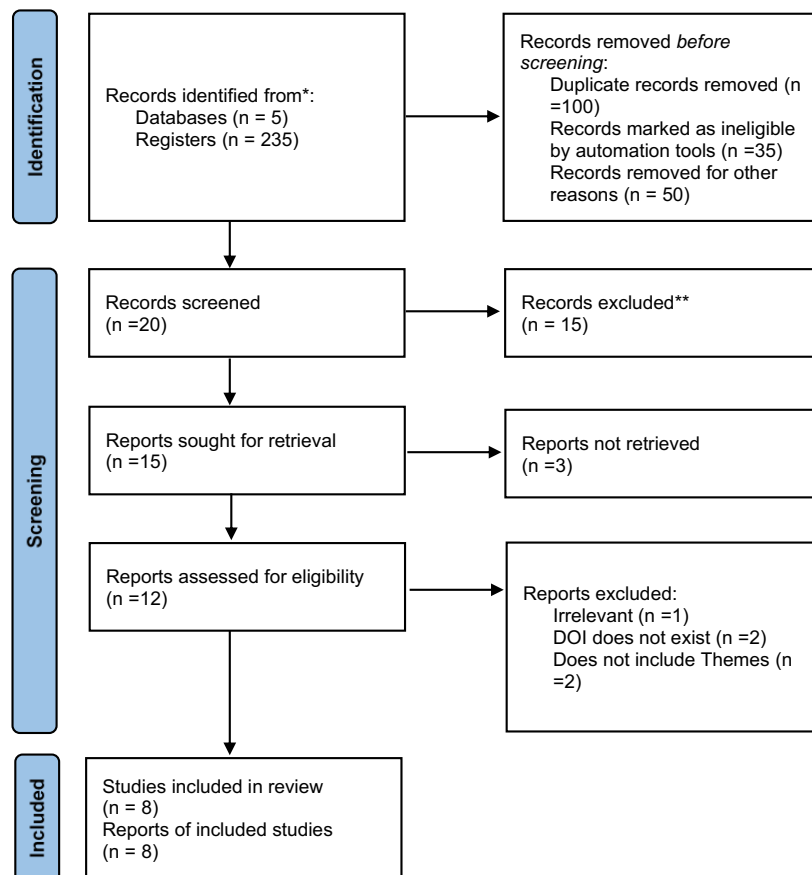


Figure 1. PRISMA Flow Diagram

Based on Figure 1, searching and selecting studies in this research were conducted systematically following the PRISMA guidelines. At the identification stage, 240 records were obtained from two main sources: 5 from databases and 235 from registers. Before screening began, 185 records were removed for various reasons, including 100 duplicate records, 35 marked as ineligible by automation tools, and 50 removed for other reasons. The screening stage was then performed on the remaining 20 records, where 15 were excluded for not meeting the selection criteria. From the 15 records that passed the screening, attempts were made to retrieve the full reports, but three were unavailable. During the eligibility assessment stage, 12 available reports were evaluated, with four reports excluded due to reasons such as irrelevance, absence of a DOI, and lack of required themes. Ultimately, eight studies that fulfilled all criteria were included in this systematic review. This rigorous selection process ensures that only high-quality and relevant studies are incorporated into the analysis.

RESULTS

The Role and Contribution of AI in Risk-Based Decision-Making

In the context of systematic reviews, such tabulation is essential for transparently reporting study characteristics and findings, as well as supporting the systematic integration of evidence (PRISMA guidelines), thereby enhancing the clarity, comparability, and reliability of the review results (Adekunle et al., 2023). Table 1 presents a structured summary of eight selected studies included in the systematic review, outlining the authors, titles, and key conclusions of each article related to the application of Artificial Intelligence in risk-based decision-making. The table serves as a synthesis tool that enables clear comparison across studies, facilitating the identification of patterns, research trends, and the main contributions of existing literature.

Table 1. Summary for 8 Articles

Author(s)	Title	Conclusion
Verdugo-Velázquez et al. (2024)	“Artificial Intelligence, the New Tool in Perioperative Medicine and Postoperative Pain Management”	AI (ML/DL) improves clinical decision-making in anesthesiology and postoperative pain management by enabling personalized care, automating pain evaluation, and supporting regional anesthesia. Despite some technical and ethical challenges, AI has a promising impact.
Aladağ (2023)	“Assessing the Accuracy of ChatGPT Use for Risk Management in Construction Projects”	ChatGPT shows moderate effectiveness in construction risk management, performing better for risk response and monitoring. However, it has shortcomings in real-time data access and risk identification. Hence, it is recommended as a support tool, not a replacement for experts.
Aloisi & De Stefano (2023)	“Between Risk Mitigation and Labour Rights Enforcement: Assessing the Transatlantic Race to Govern AI-Driven Decision-Making”	Current risk-based AI regulations are fragmented and poorly protect workers’ rights. Participatory governance involving stakeholders like labor unions is crucial to ensure transparency, social justice, and ethical AI use in workplaces.
Liu (2024)	“Enterprise Financial Risk Management Framework Based on AI Fintech”	Improved Random Forest algorithm offers high accuracy (AP 0.9919) and efficiency in fintech financial risk prediction, outperforming other models, and supports an AI-based financial risk management framework with scalability via parallel computing.
Rezvani et al. (2024)	“Mapping Geospatial AI Flood Risk in National Road Networks”	GeoAI combined with random forest strongly predicts flood risk on Portugal’s road networks (~92–96% accuracy), providing essential spatial flood risk insight to support infrastructure planning, emergency preparedness, and enhance urban resilience to climate hazards.
Niazi (2025)	“Regulatory Perspectives for AI/ML Implementation in Pharmaceutical GMP Environments”	Regulatory frameworks emphasize risk-based lifecycle approaches, validation, data integrity, explainability, and human oversight for AI/ML in pharma manufacturing; ongoing challenges remain, but AI adoption promises increased efficiency and compliance.

Author(s)	Title	Conclusion
Albert and Alijoyo (2024)	“Systematic Review: How Artificial Intelligence Impacts Supply Chain Capability and Capacity in Emerging Markets”	AI substantially enhances supply chain efficiency, resilience, sustainability, and competitiveness in emerging markets, driving operational optimization, risk management, and economic growth, with regulatory and educational support necessary for continued adoption.
Mogoale et al. (2025)	“Evaluating the Efficacy of AI Tools in Systematic Literature Reviews: A Comprehensive Analysis”	AI tools improve the efficiency and accuracy of systematic literature reviews in various stages, although human oversight remains critical. Concerns arise about ethics, bias, and quality, while widespread adoption supports faster and more rigorous research workflows.

Artificial intelligence plays a strategic role in enhancing the effectiveness of risk-based decision-making across various sectors. Based on the synthesis of eight studies, AI through approaches such as Machine Learning (ML), Deep Learning (DL), and GeoAI significantly improves risk prediction accuracy and accelerates data analysis processes. In the healthcare sector, for instance, AI is utilized to manage large volumes of patient data to support diagnosis, automate pain evaluation, and enable personalized treatment strategies, thereby improving clinical decision-making efficiency (Verdugo-Velázquez et al., 2024).

In the construction sector, AI, particularly language-based models such as ChatGPT, demonstrates the ability to support risk management subprocesses, especially in the stages of risk response and monitoring. Although its effectiveness remains moderate, AI contributes meaningfully as a decision-support tool that enhances analytical speed and efficiency (Albert & Alijoyo, 2024; Verdugo-Velázquez et al., 2024). These findings reinforce the notion that AI functions primarily as a decision support system rather than a replacement for human expertise.

Furthermore, in the financial and infrastructure sectors, AI exhibits high performance in risk prediction and assessment. The use of algorithms such as Random Forest achieves high accuracy in financial risk evaluation, while GeoAI effectively maps flood risks with accuracy levels reaching 92–96% (Rezvani et al., 2024; Niazi, 2025). These findings are consistent with the broader literature, which suggests that AI transforms risk management from a reactive to a predictive approach through large-scale and real-time data analysis (Anshori & Akbar, 2025).

Challenges, Limitations, and Ethical Issues in AI Implementation

Despite its significant advantages, the implementation of AI in risk-based decision-making faces several critical challenges. One of the primary limitations is the reliance on data quality and the lack of access to real-time data, which can affect the accuracy and contextual relevance of AI-generated insights. This limitation is evident in the application of ChatGPT in construction projects, where the model struggles to produce context-specific and tailored risk assessments (Albert & Alijoyo, 2024; Verdugo-Velázquez et al., 2024).

Another major challenge lies in the issue of transparency and model interpretability. Many AI systems, particularly those based on deep learning, operate as “black boxes,” making it difficult to understand how decisions are generated. This lack of explainability can reduce user trust and increase the risk of biased outcomes. Existing literature highlights that challenges such as algorithmic bias, data limitations, and model complexity remain key barriers to the effective implementation of AI in risk management (Budihewanto, 2025).

From a regulatory and ethical perspective, the application of AI in labor contexts raises concerns regarding the protection of workers’ rights, including privacy, fairness, and transparency. Current regulatory frameworks across regions remain fragmented and insufficient to address the complexities of AI deployment. Therefore, participatory governance involving key stakeholders, particularly labor unions, is essential to ensure

responsible and ethical AI implementation (Aladağ, 2023; Aloisi & De Stefano, 2023; Liu, 2024).

Future Directions and Implications for AI in Risk Management

The findings of this study suggest that future AI development should focus on enhancing dynamic data integration, improving model accuracy, and increasing adaptability to rapidly changing risk environments. AI systems are expected to process real-time data more effectively and generate more responsive predictions, thereby supporting timely and evidence-based decision-making across sectors (Lainjo, 2023).

In addition, the human-in-the-loop approach emerges as a critical direction for future AI applications. While AI excels in processing large datasets and generating predictive insights, human involvement remains essential for interpretation, ethical judgment, and strategic decision-making. The integration of human expertise with AI capabilities is considered the most effective approach to maximizing benefits while minimizing risks associated with over-reliance on automated systems (Akter & Kudapa, 2024).

Future research should emphasize the development of inclusive and sustainable governance frameworks. Evaluating the long-term social, economic, and regulatory impacts of AI is crucial to ensure that its implementation promotes fairness, accountability, and transparency. By addressing these aspects, AI has the potential to become a foundational element in transforming risk management into a more adaptive, ethical, and resilient system (Rainy et al., 2023).

DISCUSSION

This study aims to examine the role of AI in enhancing risk management across multiple domains, including labor governance, financial risk management, and environmental risk mitigation. The findings demonstrate that AI significantly contributes to improving predictive accuracy, decision-making efficiency, and strategic planning, although its implementation remains highly dependent on regulatory, ethical, and contextual factors. This aligns with previous findings that AI-driven risk assessment improves decision quality and operational responsiveness, yet requires robust governance to mitigate ethical and transparency risks (Alijoyo et al., 2024a; Bahangulu & Owusu-Berko, 2025). Furthermore, the effectiveness of AI in risk management is consistently shown to depend on the integration of human oversight, data integrity, and adaptive regulatory frameworks (Niazi, 2025; Mukala, 2025).

In the context of labor governance, the findings reveal that AI-driven decision-making is characterized by regulatory fragmentation across jurisdictions such as the European Union, the United States, and Canada. The EU's risk-based regulatory framework, particularly through the AI Act, provides structured mechanisms to mitigate technical risks while ensuring transparency and accountability. However, the results indicate that such frameworks are not fully sufficient to safeguard broader worker rights, including privacy, dignity, and equality, especially when overlapping with other regulations such as GDPR and labor laws. Similarly, the decentralized regulatory approach in the United States and the evolving framework in Canada highlight significant gaps in enforcement and protection. These findings align with prior studies emphasizing that AI governance must go beyond technical risk classification to incorporate participatory approaches involving stakeholders, particularly labor unions, to ensure ethical and socially responsible implementation (Alijoyo et al., 2024b; Alijoyo et al., 2024c; Wang et al., 2024; Widodo et al., 2024; Vieriu & Petrea, 2025). This confirms that achieving the study's objective requires integrating governance, transparency, and social impact considerations into AI deployment.

In financial risk management, the findings demonstrate that AI, particularly through an improved Random Forest algorithm, significantly enhances predictive performance and operational efficiency. The model achieves high accuracy levels and effectively balances precision and recall, outperforming alternative approaches such as Support Vector Machines (SVM) and CRAT models. The integration of parallel computing

technologies further strengthens scalability and enables near real-time risk assessment, which is critical in dynamic financial environments. These results are consistent with previous research indicating that machine learning models, especially ensemble methods like Random Forest, are highly effective in handling complex and non-linear financial data while maintaining interpretability (Alijoyo et al., 2024c; Alijoyo et al., 2024b; Guler et al., 2024; Alijoyo et al., 2025a). Faisal et al. (2025) highlight that AI-driven risk management improves decision accuracy but must address issues such as algorithmic bias and model transparency to ensure reliability and fairness. Thus, the findings support the study's objective by confirming that AI-based financial models provide robust and scalable solutions for enterprise risk management.

In the environmental domain, particularly flood risk management, the study finds that the integration of GeoAI and machine learning techniques offers highly accurate and data-driven risk mapping capabilities. By combining diverse datasets such as topographical, geological, and infrastructural information, AI models can effectively identify vulnerable areas and support proactive infrastructure planning. The reported accuracy levels of approximately 92–96% indicate strong predictive performance, reinforcing the reliability of AI-based approaches. These findings are supported by prior research demonstrating that AI significantly enhances flood prediction and risk assessment compared to traditional methods, particularly in handling large-scale and complex datasets (Deep & Verma, 2024). Moreover, GeoAI approaches facilitate cross-sector collaboration and improve decision-making in disaster preparedness and urban resilience, aligning with earlier studies emphasizing the importance of data-driven and interdisciplinary strategies in disaster risk management (Zhao et al., 2025). This confirms that AI plays a critical role in achieving the study's objective of improving risk mitigation strategies through advanced analytics.

The findings indicate that while AI substantially enhances risk management capabilities across sectors, its effectiveness depends on the integration of technical performance, ethical governance, and stakeholder involvement. Therefore, this study concludes that AI should be positioned not merely as a technological tool but as a socio-technical system requiring balanced implementation to ensure accuracy, fairness, and sustainability in risk management practices.

CONCLUSION

This study demonstrates that artificial intelligence possesses transformative capabilities in risk management across multiple sectors by enhancing predictive accuracy, accelerating decision-making processes, and enabling more proactive strategic planning. AI-driven approaches allow organizations to transition from reactive to predictive risk management, while improving operational efficiency and scalability. The ability of AI to analyze large volumes of data and generate real-time insights significantly strengthens organizational resilience and decision quality. However, the findings also reveal critical limitations, including issues related to data quality and availability, limited real-time adaptability, and challenges in model interpretability and transparency. Furthermore, ethical and regulatory concerns, such as data privacy, security risks, and governance gaps, remain significant barriers to effective implementation. These findings imply that AI should not be viewed solely as a technological tool, but rather as a socio-technical system that requires robust governance frameworks and active stakeholder engagement.

Future research should prioritize the development of AI systems that integrate real-time data more effectively, incorporate adaptive learning mechanisms, and enhance model interpretability to ensure reliability in dynamic environments. Interdisciplinary approaches are also essential for designing participatory governance frameworks that safeguard human rights and promote transparency in AI deployment. In addition, longitudinal studies are needed to assess the long-term impacts of AI on organizational performance, regulatory effectiveness, and social equity. Addressing the gap between static risk models and dynamic real-world conditions remains a critical challenge, necessitating continuous model validation and methodological innovation. Strengthening

human-in-the-loop mechanisms and advancing comprehensive AI governance frameworks will be crucial to ensuring that AI adoption remains ethical, sustainable, and aligned with broader societal interests.

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