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Artificial Intelligence for Innovation in Business & Engineering: A Systematic Literature Review

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Resumo

The increasing focus on artificial intelligence (AI) since 2023, especially due to ChatGPT, has left gaps in understanding its application and impact in research and development, as well as innovation management. This article aims to systematically analyze scholarly publications on AI and innovation, addressing questions about AI's use, benefits, challenges, and best practices in innovation management. Utilizing a systematic literature review methodology, the study analyzes 858 articles from ISI Web of Science, filtered by business economics and engineering fields. Results show a concentration of publications in top journals, with IEEE Access leading. Content analysis highlights AI's role in various sectors, such as healthcare and aerospace, and its contribution to operational efficiency and sustainability. The study provides insights into AI's potential, challenges like data privacy, and future research directions focusing on ethical considerations and integration with emerging technologies.

Keywords: Artificial Intelligence; Innovation Management; Systematic Literature Review; AI in R&D; Innovation Practices; Data Privacy; Operational Efficiency; Sustainable Development; AI Integration; Ethical Considerations

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1. INTRODUCTION

Companies have been innovating using different strategies, and the artificial intelligence "revolution" has pushed forward the change from a traditional business model to a digitalized business model (Chatterjee et al., 2022). The way of managing innovation arguably requires renovation and change (Hutchinson, 2021).

With the increase in attention over the role of Artificial Intelligence (AI), that got into focus in 2023 mainly due to ChatGPT, there is still little knowledge over how scholars have been looking at its usage and impact in research and development, as well as innovation and innovation management. Do innovation managers use AI in their companies? If so, for what purpose? Are there good practices worth sharing? Are there hurdles that come with this new tool? Are there privacy or intellectual property concerns?

So, all these questions being raised, the focus of the current submission is on the systematic analysis of scholarly publication on the topic of AI and Innovation, aiming to analyze, integrate and seek relevant answers to the questions posed. The research uses a systematic literature review methodology and provides a more detailed and complex understanding of the roles, methodologies, contributions, and future directions of AI in innovation as typically discussed in scientific literature.

We start by presenting the methodology, then we look into the results, using a quantitative and a qualitative approach, and we finish with conclusions.

2. METHODOLOGY

Some reviews have been developed by scholars on the topic of AI (Akter et al., 2023; Cioffi et al., 2020; Kumar et al., 2023; Pereira et al., 2023; Whittaker et al., 2023; Zirar, 2023; Zirar et al., 2023), however they approach specific topics, e.g. the role of AI on workers, the impact on consumer – machine relationship (Pentina et al., 2023), the usage of AI technology per se, on sustainability (Di Vaio et al., 2020) or specific industries (Ali et al., 2023). In some cases, the sample of papers analyzed is not very high.

Systematic literature review is a methodology that has been used in several reviews (Ali et al., 2023; Ardito et al., 2022; Li et al., 2023; Pentina et al., 2023; Pereira et al., 2023), and that is the methodology we adopt in this research, as well. As mentioned by several scholars (e.g., Aragonez et al., 2021; de Santana Porte et al., 2015; Saur-Amaral et al., 2018; Tranfield et al., 2003), the systematic literature reviews are divided in three phases: planning, execution and reporting.

After an initial planning of the research goals, a search was performed on ISI Web of Science, in the Current Contents Content, with no time filter (from 1998 to date).

Results were filtered to include only scientific articles and reviews, and the research areas selected were business economics and engineering, as they are two key research fields related to innovation management.

All abstracts were read by both researchers and a total of 858 valid results were obtained, which were further exported to Endnote. VOS Viewer was used to cluster the topics before the qualitative analysis. Finally, the results were analysed in NVivo, using a content analysis approach.

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3. RESULTS

3.1. DESCRIPTIVE STATISTICS

The final sample of articles was exported from Endnote and cleaned up for the descriptive statistical analysis.

As we may observe in Figure 1, the publication of articles on the analyzed topic was rather scarce until 2016. In 2017, nine articles were published, and from 2018 onwards the number increased significantly, reaching a total of 296 articles in 2023.

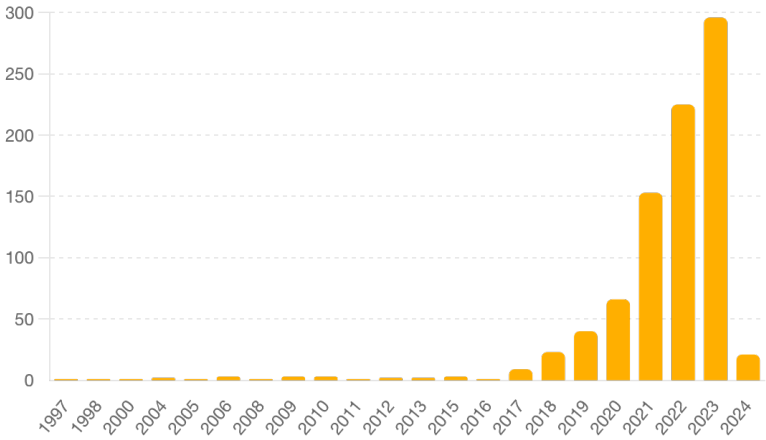

Figure 1 Distribution of articles per publication year

There is a visible concentration of publications in the top journals. IEEE Access is the most prolific publication, with 76 articles from 2018 to 2023, and an average of 20 papers per year in 2022 and 2023. Applied Sciences – Basel and Journal of Business Research follow with 38 and 28 publications. Technovation is the 6th journal, with 22 publications and Journal of Innovation and Knowledge occupies the 10th place (see Figure 2).

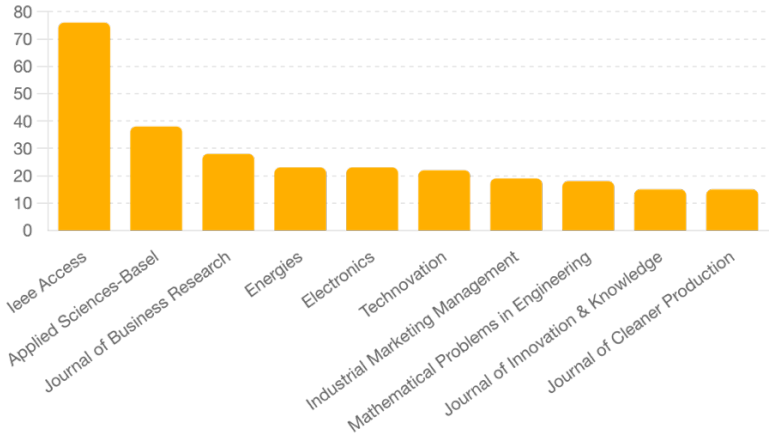

Figure 2 Distribution of articles per scientific journal – Top 10

The authors with most articles published are Vinit Parida (8 articles), Alexander Brem (7 articles), Yogesh K. Dwivedi and Francesco Schiavone (5 articles) (see Figure 3).

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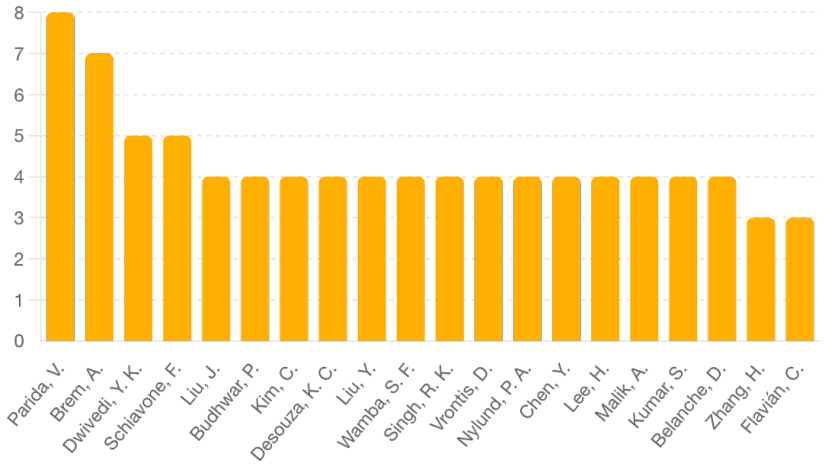

Figure 3 Distribution of articles per author – Top 20

Vinit Parida's research focuses on AI business model innovation and transformation, particularly in manufacturing and industrial ecosystems. He emphasizes the need for aligning AI capabilities with value creation and capture mechanisms to commercialize AI technologies successfully. His studies cover digital servitization, the shift from traditional products to smart solutions, and the dynamics of revenue enhancement through digital offerings. Additionally, he explores agile co-creation processes for digital service innovations and smart factory implementation, providing frameworks for integrating AI into manufacturing to achieve efficiency and sustainability.

Alexander Brem's research addresses AI and digital technologies in innovation management, focusing on retail, manufacturing, and sustainability. He examines how digital entrepreneurs and public-private partnerships can leverage hybrid value creation to tackle showrooming in retail. His framework for AI in innovation management highlights AI's dual role as an originator and facilitator of innovation. He also explores digital transformation's broader implications and the support of frugal innovation for Sustainable Development Goals (SDGs). Additionally, his work on trust in AI-generated knowledge addresses ensuring stakeholder trust in AI applications.

Yogesh Dwivedi's research focuses on AI applications in healthcare, digital entrepreneurship, and innovation research. His systematic reviews provide insights into AI's benefits, challenges, and methodologies in healthcare. He explores touchless travel during pandemics through AI and robotics, and theorizes AI acceptance in digital entrepreneurship, offering a conceptual framework for adoption factors. Additionally, his research on machine autonomy for elderly rehabilitation highlights the importance of trust in AI applications for vulnerable populations, balancing machine intelligence with consumer trust.

Francesco Schiavone's research primarily focuses on AI's impact in the healthcare sector, examining innovation adoption, value co-creation, and competitive positioning within healthcare networks. He explores how AI enhances value co-creation in industrial markets and impacts human resources performance in healthcare organizations. He also investigates AI's role in improving the competitive positioning of healthcare organizations and its influence on the venture creation process, providing theoretical propositions. His work underscores AI's critical role in driving innovation and competitiveness in healthcare.

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3.2. THEMATIC ANALYSIS WITH VOS VIEWER – KEYWORDS AND TOPIC ANALYSIS

The sample was exported from Endnote and analysed with VOS Viewer to identify major research areas and topics. As it may be observed in Figure 4, the articles are from engineering and business and economics, which was expectable considering the nature of the search.

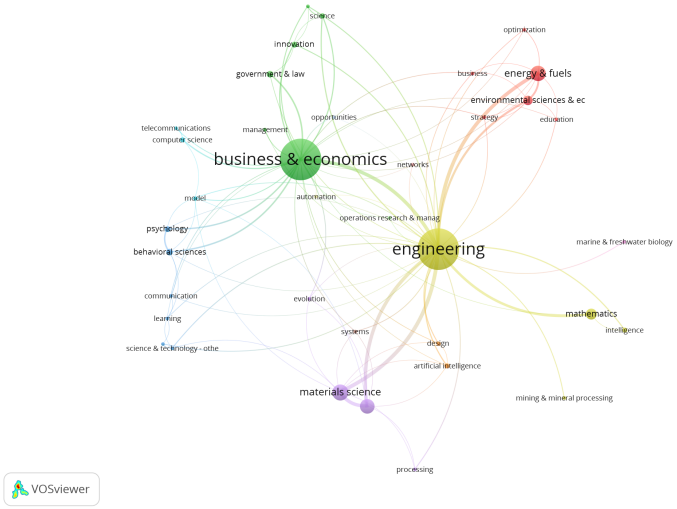

Figure 4 Major topics in the sample – VOS Viewer graphical representation

When analyzing the abstracts and keywords, four clusters can be identified (see Figure 5): machine learning / deep learning, Internet of Things (IoT), digital technology / blockchain, business and innovation effects.

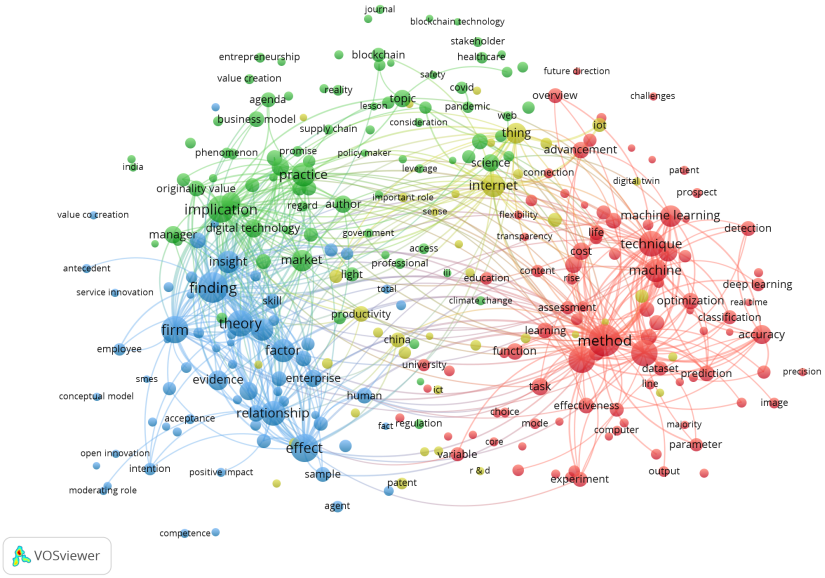

Figure 5 Clusters of topics in the sample – VOS Viewer graphical representation

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3.3. THEMATIC ANALYSIS WITH NVIVO

The content analysis reflects that different lenses have been used by scholars.

They often explore how AI drives advancements across various sectors, including healthcare, where it might predict patient outcomes or improve diagnostic accuracy and patient outcomes through machine learning and data analytics (Abbate et al., 2023; Lebovitz et al., 2022; Schmidt et al., 2022) or it might support the drug discovery process (Liu et al., 2019; Lou & Wu, 2021); in aerospace, for optimizing design and maintenance processes, integrated with blockchain to enhance the operational efficiency and the supply chain (Abdulrahman et al., 2023); in nuclear sector, to predict thermal-hydraulic parameters of nuclear reactors using deep learning algorithms (Lu et al., 2021); in environmental science, to support and monitor environmental parameters, to promote the use of renewable energy development (Liu et al., 2024) and sustainable development (Di Vaio et al., 2020; Ebolor et al., 2022; Jiang et al., 2021); and within business, to automate and refine decision-making processes (Goto, 2023).

The interplay between AI and blockchain reflects the concern for enhanced security and transparency in transactions and data management, in different industries (Abdulrahman et al., 2023; Akter et al., 2022; Chen et al., 2022).

AI applications in R&D focus on enhancing research capabilities through data analytics, automation, and predictive modelling (Ahmed et al., 2023; Andronie et al., 2023; Balcioglu et al., 2023; Barro & Davenport, 2019; Nezhad et al., 2024; Zhai et al., 2023). This includes areas like healthcare, materials science, and engineering.

AI drives innovation by enabling new product developments, improving service delivery, and creating novel business models (Botega & Silva, 2020; Broekhuizen et al., 2023; Chen et al., 2021; Cioffi et al., 2020; Kandampully et al., 2023; Lebovitz et al., 2022; Payne et al., 2021; Wexler & Oberlander, 2021). This spans various industries including digital entrepreneurship, financial services, and smart manufacturing.

AI contributes to innovation management by enhancing decision-making processes, optimizing operations, and fostering sustainable and ethical business practices (Acquarone et al., 2023; Agramelal et al., 2023; Dahlke et al., 2024; Malik et al., 2021; Schmid et al., 2022).

Scholarly contributions include insights into AI's potential for driving innovation, addressing challenges like data management and regulatory compliance (Abbate et al., 2023; Ahmed et al., 2022; Rojek et al., 2023).

The methodologies range from quantitative analyses, employing statistical or machine learning techniques to assess AI's impact on performance metrics (Abou-Foul et al., 2023; Baabdullah et al., 2021; Badini et al., 2023), to qualitative studies that explore the implementation and adoption of AI technologies within organizations (Allal-Chérif et al., 2023; Åström et al., 2022). Simulation models and algorithm development are also used to address specific industry challenges, e.g., optimizing supply chains or energy consumption (Borsato & Lorentz, 2023; Jacobsen et al., 2023).

Future research directions point at the need to improve AI's integration into industry practices (Amjad et al., 2020; Baabdullah et al., 2021; Castro et al., 2021) and to enhance its ethical and societal impacts, including its impact on employment and privacy (Campbell et al., 2022; Chouk & Mani, 2022; Daza & Ilozumba, 2022; Galetsi et al., 2023). There is a strong emphasis on developing more robust, explainable AI models that stakeholders can trust and understand. Other directions point towards the integration of AI with other emerging technologies, like the Internet of Things (IoT), to explore new innovation paths (Buhmann & Fieseler, 2023; Buster et al., 2021; Robertson et al., 2022; Tsolakis et al., 2022; Wang & Lee, 2023; Wang et al., 2023).

In some industries, e.g., pharma, AI is seen as a way to further enhance personalized medicine by integrating genomic, proteomic, and other omics data to tailor treatments to individual patients, or explore the combination of AI and nanotechnology for more efficient drug delivery systems, focusing on targeted therapies and minimal side effects (Abbate et al., 2023; Lou & Wu, 2021). It may be also used for advance materials discovery to unveal new materials with unique properties for applications in energy storage,

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electronics, and other high-tech industries (Lu et al., 2021; Schmid et al., 2022) or for social innovation, addressing challenges in healthcare, education, and social services (Kumar et al., 2023)

3.4. Best Practices and Barriers when Using AI

The role of AI in innovation, R&D, and new product or technology development has become increasingly important, focusing on enhancing creativity, reducing time-to-market, and improving efficiency (Abrardi et al., 2022; Agramelal et al., 2023; Ameen et al., 2022; Oduro et al., 2023).

AI is a recent technology, and both practitioners and scholars are studying it to identify the best way to use it. Several scholars argue that combining AI with traditional research methods may increase the accuracy and efficiency, and be used to support complex decision-making processes and strategic planning in R&D (Abbate et al., 2023; Acquarone et al., 2023; Schmid et al., 2022), or to encourage an organizational culture that embraces innovation (Chatterjee et al., 2022). AI may be also used to interact with consumers, learning and adapting to their changing needs and improving their experience (Kumar et al., 2023; Pentina et al., 2023), to attract and retain talent skilled in AI and innovation management (Malik et al., 2021), yet they should be interpretable and transparent to gain trust and facilitate adoption (Liu et al., 2024; Schmid et al., 2022).

However, there are difficulties in integrating AI solutions with legacy systems (Lee et al., 2022), regulatory challenges and difficulties in ensuring compliance and data privacy (Di Vaio et al., 2020; Whittaker et al., 2023), organizational resistance to adopting new AI technologies and processes (Grashof & Kopka, 2023), while maintaining high-quality, comprehensive datasets for AI training and keeping pace with the rapid advancements in AI technology may be challenging (Dahlke et al., 2024; Lebovitz et al., 2022).

3.5. Implications for Innovation Management Practitioners

AI provides data-driven insights and predictive analytics that can significantly enhance decision-making processes. It can streamline operations through automation of routine tasks, thus allowing practitioners to focus on more strategic activities, including process optimization, supply chain management, and customer relationship management. Practitioners may also leverage AI tools to analyze market trends, forecast product success, and optimize resource allocation (Abdulrahman et al., 2023; Acquarone et al., 2023).

By integrating AI into the innovation process, organizations can accelerate the development and commercialization of new products and services. AI-driven R&D can lead to faster discovery of insights and reduction in time-to-market, allowing to personalize customer interactions and improve service delivery. This may lead to higher customer satisfaction and loyalty (Goto, 2023; Pentina et al., 2023).

However, independently of the benefits, special care should be taken to ensure that AI models are free from biases that could affect outcomes, ensure that the AI-driven processes are accurate, transparent and accountable, and that data privacy is ensured and safe from human and cyber threats (Abdulrahman et al., 2023; Acquarone et al., 2023; Goto, 2023; Kumar et al., 2023). Also, collaboration should be promoted in the R&D and innovation departments, along the supply chain and in local or regional innovation ecosystems, as well as alignment with organizational strategic goals (Broekhuizen et al., 2023; Faraj & Leonardi, 2022; Gebhardt et al., 2022; Kolary & Mohanraj, 2023).

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4. CONCLUSIONS

We set out to systematically analyze the application and impact of AI in R&D and innovation management, addressing questions about AI's usage, benefits, challenges, and best practices. Utilizing a comprehensive systematic literature review methodology, we examined 858 scholarly articles from the ISI Web of Science, filtered by business, economics, and engineering fields. The findings offer several contributions and practical implications for academia and industry.

The key objective of our research was to fill the knowledge gap regarding the role of AI in R&D and innovation management. The results indicate a growing concentration of AI-related publications in top journals, with IEEE Access leading the way, followed by Applied Sciences - Basel and the Journal of Business Research. AI has diverse applications, e.g. in healthcare, aerospace, or sustainable development. There is an increasing scholarly interest in AI's potential to drive innovation and operational efficiency.

Key contributions of our study include a detailed mapping of AI's role in enhancing research capabilities through data analytics, automation, and predictive modelling. E.g., in healthcare, AI improves diagnostic accuracy and patient outcomes, while in aerospace, it optimizes design and maintenance processes. We also identify the integration of AI with blockchain technology to enhance transparency and security in various industries, further illustrating AI's transformative impact.

From a theoretical perspective, our study enriches the existing body of knowledge by providing a comprehensive overview of AI's applications and implications in R&D and innovation management. It highlights the methodologies employed in AI research, ranging from quantitative analyses using statistical and machine learning techniques to qualitative studies exploring AI adoption within organizations. Additionally, the study outlines future research directions, emphasizing the need for developing robust, explainable AI models that stakeholders can trust and understand.

There are, as well, valuable insights for innovation management practitioners. AI can significantly enhance decision-making processes, streamline operations, and accelerate the development and commercialization of new products and services. However, we also point out several challenges that need to be addressed to fully realize AI's potential. These include e.g., data privacy concerns, the integration of AI solutions with legacy systems, regulatory and compliance issues, and the need to manage organizational resistance to AI adoption.

Future research should focus on addressing these challenges by developing more robust and transparent AI models and exploring the integration of AI with other emerging technologies such as the Internet of Things (IoT). This integration could open new pathways for innovation, particularly in areas like smart manufacturing, healthcare, and environmental sustainability.

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