Optimizing sales processes with Artificial Intelligence (AI) and Machine Learning (ML): a scientometric analysis

Otimização dos processos de vendas com Inteligência Artificial (IA) e Aprendizado de Máquina (AM): uma análise cienciométrica

Optimización de los procesos de venta con Inteligencia Artificial (IA) y Aprendizaje Automático (AM): un análisis cienciométrico

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ABSTRACT

This study explores the literature that evaluates how artificial intelligence (AI) and machine learning (ML) can affect the optimization of sales processes, using a scientometric and bibliometric approach. Through keyword co-occurrence analysis in the scientific literature, the main trends and patterns in AI and ML research applied to sales were identified. VOSviewer software was used to map the relationships between key terms and visualize the predominant focus areas in the field. The results reveal that the adoption of AI and ML technologies is highly correlated with improvements in the efficiency of sales processes, highlighting the growing importance of these technologies in the development of business strategies. However, limited participation of researchers from developing countries was observed in this cutting-edge field, underscoring the need for greater inclusion and international collaboration. This study provides a comprehensive view of the current state of AI and ML research in sales, identifying both the advances made and the gaps in the literature that require further attention. The findings provide a solid basis for future research seeking to delve into the practical applications of these technologies in different industrial and geographical contexts, as well as for the development of policies that promote a more equitable distribution of knowledge and resources in this emerging area.

Keywords: bibliometric analysis; sales automation; machine learning; artificial intelligence; sales process.

RESUMO

Este estudo explora a literatura que avalia como a inteligência artificial (IA) e o aprendizado de máquina (AM) podem afetar a otimização dos processos de vendas, usando uma abordagem cientométrica e bibliométrica. Por meio da análise de co-ocorrência de palavras-chave na literatura científica, foram identificadas as principais tendências e padrões na pesquisa de IA e AM aplicada a vendas. O software VOSviewer foi usado para mapear as relações entre os termos-chave e visualizar as áreas de foco predominantes no campo. Os resultados revelam que a adoção de tecnologias de IA e AM está altamente correlacionada com melhorias na eficiência dos processos de vendas, destacando a crescente importância dessas tecnologias no desenvolvimento de estratégias de negócios. No entanto, foi observada uma participação limitada de pesquisadores de países em desenvolvimento nesse campo de ponta, ressaltando a necessidade de maior inclusão e colaboração internacional. Este estudo oferece uma visão abrangente do estado atual da pesquisa sobre IA e AM em vendas, identificando tanto os avanços obtidos quanto as lacunas na literatura que exigem mais atenção. As descobertas fornecem uma base sólida para pesquisas futuras que buscam se aprofundar nas aplicações práticas dessas tecnologias em diferentes contextos industriais e geográficos, bem como para o desenvolvimento de políticas que promovam uma distribuição mais equitativa do conhecimento e dos recursos nessa área emergente.

Palavras-chave: análise bibliométrica; automação de vendas; aprendizado de máquina; inteligência artificial; processo de vendas.

RESUMEN

Este estudio explora la literatura que evalúa cómo la inteligencia artificial (IA) y el aprendizaje automático (AM) pueden afectar a la optimización de los procesos de venta, utilizando un enfoque cienciométrico y bibliométrico. Mediante un análisis de co-ocurrencia de palabras clave en la literatura científica, se identificaron las principales tendencias y patrones en la investigación sobre IA y ML aplicados a las ventas. Se utilizó el software VOSviewer para mapear las relaciones entre los términos clave y visualizar las áreas de interés predominantes en este campo. Los resultados revelan que la adopción de tecnologías de IA y ML está altamente correlacionada con mejoras en la eficiencia de los procesos de ventas, lo que pone de relieve la creciente importancia de estas tecnologías en el desarrollo de estrategias comerciales. Sin embargo, se observó una participación limitada de investigadores de países en desarrollo en este campo de vanguardia, lo que subraya la necesidad de una mayor inclusión y colaboración internacional. Este estudio ofrece una visión global del estado actual de la investigación sobre IA y ML en el ámbito de las ventas, identificando tanto los avances realizados como las lagunas bibliográficas que requieren mayor atención. Los resultados proporcionan una base sólida para futuras investigaciones que traten de profundizar en las aplicaciones prácticas de estas tecnologías en diferentes contextos industriales y geográficos, así como para el desarrollo de políticas que promuevan una distribución más equitativa del conocimiento y los recursos en este ámbito emergente.

Palabras clave: análisis bibliométrico; automatización de ventas; aprendizaje automático; inteligencia artificial; proceso de ventas.

INTRODUCTION

In recent years, the optimization of sales processes has become a crucial factor for the competitiveness and sustainability of companies in an increasingly dynamic and demanding global market. The integration of advanced technologies, such as Artificial Intelligence (AI) and Machine Learning (ML), has revolutionized the way organizations manage and improve their sales strategies, offering powerful tools to transform data into strategic decisions. These technologies make it possible to analyze large volumes of data in real time, predict purchasing behaviors, segment markets more precisely, and personalize offers with unprecedented accuracy. In addition, the automation of repetitive tasks and the continuous improvement of predictive models are leading to greater operational efficiency and a more satisfying customer experience. This article conducts a comprehensive bibliometric analysis to explore the impact and emerging trends in the application of AI and ML in sales process optimization, highlighting recent advances, current challenges, and future lines of research in this dynamic and ever-evolving field.

The adoption of Artificial Intelligence (AI) and Machine Learning (ML) by companies has undergone a significant evolution in recent decades. In their beginnings, these technologies were mainly the domain of academia and research laboratories, due to computational limitations and the lack of accessible data. During this period, AI and ML applications were restricted to controlled experiments and basic research projects, with a focus on developing fundamental theories and algorithms. However, as hardware costs decreased and processing capacity increased, along with the emergence of the internet and mass digitization, companies began to recognize the potential of these technologies to solve complex problems and improve operational efficiency. The increasing availability of big data was a crucial catalyst in this transformation. Companies from various sectors began to explore practical applications of AI and ML in areas such as predictive analytics to anticipate market trends, process automation to reduce operational costs, and logistics and supply chain optimization. This research is particularly relevant within Peru and the Latin-American context, where the advancement of technology has the potential to revolutionize several economic and society sectors (Puican Rodriguez et al., 2024; Muro et al., 2024; Olano et al., 2024; Filgueiras, 2024; Santa Cruz et al., 2024   ).

Since 2014, the proliferation of cloud computing platforms and the development of more sophisticated algorithms have democratized access to AI and ML, enabling companies of all sizes to implement these technologies in their operations. Cloud computing has played an essential role in providing the infrastructure needed to handle large volumes of data and perform intensive computations without the need for large investments in hardware.[1] This has allowed small and medium-sized enterprises, which previously could not access these technologies due to budget constraints, to also benefit from them. Large corporations, in particular, have led this adoption, using AI and ML to optimize the supply chain, improve the customer experience, and develop innovative products. It is also often pointed out in the literature as a potential catalyst for financial convergence at the level of international norms and standards between countries (Rodriguez et al., 2024; Rufasto et al., 2024).

Companies such as Amazon, Google, and Microsoft have developed and opened up their AI platforms, providing accessible tools that have facilitated the integration of these technologies in various sectors. These platforms offer pre-trained and customized AI and ML services, which allow companies to implement advanced solutions quickly and efficiently. In addition, collaboration between companies and tech startups has accelerated the pace of innovation, leading to the creation of AI applications ranging from virtual assistants to advanced fraud detection systems and real-time data analytics.

With the aim of recording the main co-authorship networks, areas, topics researched and the current state of studies that aim to understand and develop how AI and ML can promote sales in different markets, this work makes use of a rigorous scientometric approach. For the selection and classification of articles, starting with an exhaustive search in the Web of Science database, specific terms related to sales optimization through Artificial Intelligence and Machine Learning are used. Articles are filtered by relevance, year of publication, and number of citations, prioritizing those that are most influential and recent. Subsequently, a keyword co-occurrence analysis is applied using VOSviewer software to identify emerging themes and trends, allowing the classification of articles into thematic clusters that reflect the main areas of research in the field. This approach allows for a precise selection of the most relevant studies, providing a solid basis for the scientometric and bibliometric analysis performed.

The results of the research reveal a significant growth in scientific production in recent years, especially from 2018 onwards. The temporal analysis shows a sustained increase in the number of publications, peaking in 2022, which can be attributed to technological advancement and the increasing adoption of these technologies in various sectors. Keyword co-occurrence analysis identified two main clusters, where terms related to machine learning, data mining, and deep learning have gained popularity, especially since 2022, reflecting the focus on predictive models and data analytics in sales

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[1] Cloud computing has not only democratized access to AI and ML by providing scalable and cost-effective infrastructure, but it has also enabled the development of new business models and the rapid prototyping of AI-driven solutions. The elasticity and availability of cloud services allow businesses to experiment with and deploy AI applications without the need for significant upfront investment in physical infrastructure.

optimization. In addition, the co-authorship analysis reveals a strong collaboration between authors from the United States and China, the main contributors in this field, while authors from developing countries show low participation. Finally, the studies reviewed highlight the relevance of emerging technologies such as recommendation systems, chatbots and social media integration in sales optimization, underlining the impact of AI in the transformation of sales and marketing practices in the digital age. These results provide a comprehensive view of how AI and ML are being applied in sales optimization, and how these technologies are shaping research practices and global collaboration in the area.

The prevailing viewpoint in the literature asserts that machine learning (ML) is a fundamental catalyst for artificial intelligence (AI) (Kühl et al., 2022). The unequivocal majority of modern AI applications extensively leverage ML. It is crucial to note that this analysis deliberately excludes AI cases that do not involve ML. Thus, it is imperative to recognize the simultaneous and interdependent usage of both concepts when discussing the sales technologies under examination.

This research is crucial to understanding how Artificial Intelligence (AI) and Machine Learning (ML) are revolutionizing sales processes in an increasingly digitized business environment. By analyzing the evolution of scientific production and advances in the application of these technologies, this study offers a comprehensive view of how AI and ML tools are not only optimizing sales, but also redefining marketing and customer management strategies. The importance lies in its ability to identify emerging trends, provide insights into global research collaborations, and highlight how these innovations are being adopted in business practice. This not only contributes to the academic body, but also has practical implications for companies looking to improve their competitiveness and efficiency in the global marketplace.

The structure of the article is organized into four sections: the introduction, which presents the problem addressed and highlights the relevance of the study; the methodology, which details the data and methods used in the bibliometric analysis; the results, which present and explain the analyses carried out, discussing the main findings and reflecting on their scope and implications; and finally, the conclusions, where the contribution of the study is summarized and possible directions for future research in this field are proposed.

An overview of the literature on the use of AI and ML in sales

The literature on the effects of Machine Learning (ML) and Artificial Intelligence (AI) on sales offers a detailed look at how these technologies are revolutionizing both marketing and sales management. In the early years of this field, research focused on the application of artificial neural networks to analyze the quality of relationships in marketing.[2] A pioneering study by Bejou, Wray, and Ingram (1996) showed that neural networks could more accurately predict the factors that determine the quality of customer relationships, compared to conventional techniques such as multiple regression. This approach allowed the researchers to better understand how to maintain long-lasting and effective relationships with customers, which is crucial for success in a competitive environment.

On the other hand, Smith and Gupta (2000) delved into the use of neural networks to solve business problems, highlighting their importance in data mining. This data analysis is critical to understanding and predicting consumer behavior in the context of sales. By using neural networks, companies can process large volumes of data and extract valuable patterns that inform strategic marketing and sales decisions. These early studies laid the groundwork for further integration of ML and AI into business practices, which has led to significant improvements in the efficiency and effectiveness of sales strategies.

As the field of artificial intelligence and machine learning in sales matured, a crucial focus was the development and implementation of recommendation systems in e-commerce. Ben Schafer, Konstan, and Riedl (2001) explored how these systems evolved from a simple novelty to indispensable tools for businesses. Personalized recommendation systems, powered by ML techniques, not only improve the user experience by guiding consumers to products of interest to them, but also significantly increase sales by optimizing the purchase decision process. This study highlighted how the ability of these systems to analyze and predict consumer preferences transformed the way companies interact with their customers, turning data into a key competitive advantage. The evolution of these systems reflects the growing importance of ML and AI in business strategy, where personalization and accuracy in product offerings have become essential for success in today's digital environment.

In the field of product portfolio planning for sales, the work of Jiao and Zhang (2005) marked a significant advance in integrating association rule mining techniques to identify product portfolios based on specific customer needs. Not only did this methodology allow for a better understanding of consumer preferences, but it also optimized the product offering by aligning product specifications with market demands, which is crucial for maximizing profitability in a competitive environment. On the other hand, in the sphere of sales prediction, Chang and Wang (2006) introduced a model that combines neural networks with fuzzy logic to forecast sales in the PCB industry, showing how integrating production control

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[2] Artificial neural networks (ANNs) can be used to analyze the quality of relationships in marketing by processing and learning from large datasets that capture various customer interactions and behaviors. By identifying patterns in this data, ANNs can predict customer satisfaction, loyalty, and potential churn, allowing marketers to assess the strength and quality of relationships with their clients. This enables more targeted and personalized marketing strategies, fostering stronger customer connections and improving overall relationship management.

experts into the modeling process significantly improves the accuracy of forecasts.[3] This approach was complemented by Thomassey (2010), who explored the use of neural networks and data mining to address the unique challenges of the textile industry, such as volatile demand and seasonality of sales. Both studies underscore the importance of ML and AI technologies in improving supply chain management, minimizing the bullwhip effect and ensuring a more agile and accurate response to market fluctuations.

Recent literature on the impact of Machine Learning (ML) and Artificial Intelligence (AI) on sales and other areas of the business continues to highlight how these technologies are transforming various industries. Rui, Liu, and Whinston (2013) underscore the ability of text analysis on social networks, specifically Twitter, to predict the success of film sales. Their study shows that not only the quantity of mentions matters, but also the quality of them, by identifying that the opinions of influential users and the content of their messages are determining factors for commercial success. This research highlights how advanced social data analytics can provide a significant competitive advantage in the entertainment industry. Including in the financial sector, AI has broad applications but in particular stands out the exponential growth in security and fraud protection (Ali, et al., 2022).

On the other hand, in the realm of real estate, studies such as those by Park and Bae (2015) and Rafiei and Adeli (2016) illustrate the growing use of ML algorithms to improve the accuracy of home price prediction. Park and Bae demonstrated that, among several ML models, the RIPPER algorithm showed superior performance in ranking and predicting real estate prices. Rafiei and Adeli, meanwhile, integrated advanced techniques such as Boltzmann machines and genetic algorithms to develop an innovative model that not only accurately predicts prices, but also considers temporal and seasonal variations, which is crucial for planning and decision-making in the real estate sector. These studies show how advanced ML techniques are revolutionizing the way forecasting is done and strategies are managed across different industries, from entertainment to real estate.

Syam and Sharma (2018) conducted a thorough exploration of the impact of AI and ML on personal selling in the context of the fourth industrial revolution, underlining how these technologies are redefining the entire sales process. In their study, they highlight that automation and real-time data processing capacity are allowing companies to develop more accurate and personalized sales strategies, which in turn improves operational efficiency. This work also emphasizes the importance of AI integration in the critical stages of the sales cycle, from prospecting to closing, suggesting that AI can play a key role in empowering salespeople and optimizing their daily activities.

In parallel, Cui et al. (2018) investigated the use of social media data in sales predictions, demonstrating that incorporating this information significantly improves the accuracy of predictions. This study suggested that companies should consider exploiting the vast amounts of data generated on social media to improve their operational decision-making capabilities, such as inventory planning and marketing campaigns. Cui and his team's findings highlight the importance of combining internal data with external data, such as social media data, to develop more robust predictive models adapted to changing market needs.

In the fashion industry, Loureiro, Miguéis, and da Silva (2018) explored the use of deep neural networks to improve sales predictions in fashion retail. Their research reveals that while deep neural networks can offer significant improvements in prediction accuracy, in some cases, less complex techniques such as Random Forest can also provide competitive results. This finding suggests that choosing the right model may depend on the specific context and available resources, raising the need for a flexible approach to the application of ML in the retail sector.

In recent years, the study of the impact of chatbots on sales has gained importance. In one of the most important papers in this field, Luo et al. (2019) investigated the use of AI-powered chatbots in the field of sales, revealing that customer perception towards AI can have a negative impact on conversion rates. Their study shows that when customers are aware that they are interacting with a chatbot, they tend to perceive the interaction as less empathetic and less trustworthy, which reduces the likelihood of making a purchase. However, the authors also found that implementing a chatbot identity late disclosure strategy can mitigate these negative effects, allowing businesses to reap the benefits of chatbots without compromising the customer experience.

Recent work has shown that emerging technologies such as AI and ML are revolutionizing marketing strategies, transforming the way companies interact with consumers and manage their digital content. According to Dwivedi et al. (2021), one of the most comprehensive studies on this topic, these technologies offer a wide range of opportunities to personalize the customer experience, improve market segmentation, and optimize social media advertising campaigns. However, along with these opportunities, significant challenges also arise, such as the need to address ethical and privacy issues in the handling of personal data. The analysis by Dwivedi et al. underscores that the transition to more data-driven

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[3] The PCB (Printed Circuit Board) industry is fundamental in the manufacture of electronic devices. PCBs provide the physical foundation for connecting and supporting electronic components using traces, pads, and other conductive elements etched into layers of copper laminated on a non-conductive base. They are used in almost all electronic devices, from mobile phones and computers to cars and industrial systems.

marketing requires companies to not only adopt these technologies, but also to continuously adapt to rapid technological and regulatory changes. This dynamic approach is essential to staying competitive in an increasingly digitized environment.

The field of research on the impact of ML and AI on sales has reached a level of maturity that evidences its transformative potential in various industries (Policarpo et al., 2021). Together, these studies underscore how ML and AI are not only improving the accuracy and efficiency of sales and pricing predictions, but also transforming the way companies interact with consumers and make strategic decisions in industries as diverse as personal selling, fashion, and e-commerce. However, despite significant progress, significant challenges remain that need to be addressed.

One of the current challenges is the effective integration of these systems into business processes without compromising the customer experience, as negative perception towards AI can influence sales results. In addition, it is essential that ML models are adaptive and can be applied to different industrial contexts, ensuring their effectiveness and scalability. Looking ahead, research could focus on developing solutions that optimize not only prediction accuracy and operational efficiency, but also ethical and transparent interaction with consumers, ensuring that the use of these technologies is both effective and accepted by users.

METHODS

Data and Estimation Techniques

The first step in our study was to break down the initial research question into relevant keywords, a critical process for guiding the search for information effectively. This decomposition involved a detailed analysis of the subject of study, identifying specific terms and key concepts that capture the different dimensions of the use of Artificial Intelligence (AI) and Machine Learning (ML) in the optimization of sales processes in companies. Initially, brainstorming was conducted to generate a preliminary list of keywords, based on the review of existing literature and current trends in the field of AI and ML applied to sales.

As we progressed, these keywords were iteratively refined. This process of refinement included the elimination of overly broad or vague terms, as well as the inclusion of synonyms and terminological variations to encompass all possible ways in which concepts could be represented in the literature. In addition, the relevance and specificity of each keyword was considered, ensuring that each term selected was not only relevant, but also accurately and comprehensively captured the scope of our research. This stage was crucial to ensure that subsequent database searches were focused enough to retrieve highly relevant articles, while minimizing the number of irrelevant or out-of-context results.

Subsequently, we proceeded to formulate, test and adjust the search terms, using the previously identified keywords. This process was essential to ensure that our searches were accurate and effective in retrieving relevant literature. We started by combining the keywords in different configurations, using Boolean operators such as AND, OR, and NOT to create a variety of search queries that could capture the various ways in which key concepts might appear in the scientific literature.[4] These combinations included both general and specific terms, encompassing synonyms, linguistic variations and related terms, with the aim of expanding the scope of the search without losing precision.

Once the combinations of search terms have been formulated, we perform preliminary searches in the selected database to evaluate the effectiveness of each set of terms. During this phase, we analyzed the results obtained, observing not only the number of articles retrieved, but also their relevance with respect to the research question posed. This allowed us to identify patterns and adjust search terms iteratively. For example, certain terms have been added or removed, or combinations have been modified to exclude irrelevant results and improve search targeting. The adjustment process was continuous until we managed to formulate search terms that generated an optimal balance between breadth and precision, recovering a set of articles that reflected in a representative and exhaustive way the state of the art in the application of Artificial Intelligence and Machine Learning in the optimization of sales processes in companies. These fine-tuned search terms were ultimately used to run more specific and focused searches on the selected database, ensuring that the retrieved articles were directly relevant to our study objectives.

The search for relevant literature was carried out in the Web of Science academic database, one of the most recognized and widely used platforms for scientific research due to its comprehensive coverage of peer-reviewed journals and its ability to offer citation analysis (AlRyalat, Malkawi & Momani, 2019; Pranckuté, 2021). To ensure that the results were as accurate and relevant as possible, specific adjustments were applied that optimized the search, refining the terms and criteria used to filter the selected articles (Agarwal, etl al, 2016). Table 1 shows a summary of these criteria.

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[4] In Web of Science searches, the Boolean operators AND, OR, and NOT are used to combine search terms and refine the results. AND limits the search to results that contain all the specified terms; for example, "AI AND sales" will return items that mention both terms. OR expands the search to include results that contain any of the specified terms, such as "AI OR machine learning," which will retrieve articles that mention at least one of the two terms. NOT excludes terms from the search, so "AI NOT machine learning" will return results that mention "AI" but not "machine learning." These operators help control the accuracy and breadth of searches.

Table 1. *Stages and Descriptions of Item Selection*

Stage	Description
S1	Decomposition of the initial research question into keywords
S2	Formulating, testing, and adjusting search terms using keywords
S3	Execution of the search in the selected database, with the necessary specific settings
S4	Inclusion criterion 1: The result item has at least one of the selected search terms (Table A.1, annexes) in the title
S5	Inclusion criterion 2: The result item presents at least one of the search terms related to the use of AI and ML in companies.
S6	Inclusion Criterion 3: The result item features at least one of the search terms related to sales optimization.
S7	Exclusion Criteria 1: Non-Peer-Reviewed Articles
S8	Exclusion criteria 2: articles not related to the use of AI and ML in the sales process in companies based on the reading of titles and abstracts
S9	Access and registration of productions that meet the above criteria
S10	Exclusion Criterion 3: Duplicate Items
S11	Exclusion Criterion 4: Application of the ProKnow-C Method and Pareto Rule.
S12	Exclusion criterion 5: application of the Ordinatio method.

Note. Authors' development

Explanation of Inclusion Criteria

The inclusion criteria were designed to ensure that the selected articles were directly relevant to the study of the application of Artificial Intelligence (AI) and Machine Learning (ML) in the optimization of sales processes in companies. Included items that met the following requirements:

Presence of Keywords in the Title: The first inclusion criterion required that the title of the retrieved articles contain at least one of the selected search terms. This ensured that articles focused on specific topics of interest and did not simply mention search terms in a superficial or tangential manner. Table 2 provides a detailed list of the search terms used.

Relevance for AI and ML in Enterprise: The second inclusion criterion focused on ensuring that articles specifically addressed the utilization of AI and ML in a business context. This involved verifying that the search terms related to these technologies were clearly associated with applications in the business field, excluding studies that focused on theoretical aspects or applications in other sectors, such as health or education, that were not directly related to sales optimization.

Relationship to Sales Optimization: The third inclusion criterion required articles to include search terms related to sales optimization. This approach ensured that the selected studies not only focused on the implementation of AI and ML in enterprises, but also explored how these technologies are applied specifically to improve sales processes, increase efficiency, and maximize business outcomes.

Explanation of Exclusion Criteria

To avoid the inclusion of irrelevant or low-quality literature, rigorous exclusion criteria were applied:

Exclusion of Non-Peer-Reviewed Articles: Articles that had not undergone a peer-review process were excluded, as the review ensures the quality and scientific validity of the published studies. This included the exclusion of technical reports, unreviewed conference proceedings, and any other type of publication that did not meet this standard.

Exclusion Based on Titles and Abstracts: A preliminary review of the titles and abstracts of the retrieved articles was carried out to exclude those that, despite containing the keywords, were not really related to the use of AI and ML in the sales process in companies. This avoided the inclusion of articles whose relevance was superficial or that addressed other aspects not related to our topic of study.

To classify the articles according to their relationship with research in Machine Learning (ML) and Artificial Intelligence (AI) for sales in companies and businesses, the following criteria were used:

Use of ML or AI Techniques:

1: Whether the article directly applies ML or AI techniques, such as machine learning algorithms, neural networks, recommendation systems, data mining, predictive analytics, etc., in the context of sales, marketing, or business.

0: If the article does not apply ML or AI techniques, or if its primary focus is not related to improving sales or marketing processes using these technologies.

Focus on Sales or Marketing:

1: If the article focuses on improving or analyzing sales processes, marketing, or the efficiency of advertising campaigns using ML or AI.

0: If the article covers topics related to sales or marketing but does not use ML or AI, or if the main focus is on other aspects not related to direct sales improvement.

Practical Application in Business:

1: Whether the article provides practical ML or AI applications to optimize sales processes, such as recommendation systems, predictive sales analytics, customer segmentation, etc.

0: If the article does not offer practical applications or does not focus on sales and business problems through the use of ML or AI.

Advanced Methods or Models:

1: If the article uses advanced ML or AI methods or models that have a direct impact on sales and business practice.

0: If the article uses more traditional methods or does not directly address the implementation of ML or AI in the context of sales and business.

Elimination of Duplicate Articles: Duplicate articles, which often appear due to presence in multiple indexes or special editions, were identified and removed to avoid redundancies in the analysis and ensure that each study was considered only once.

Application of the ProKnow-C Method: The ProKnow-C (Knowledge Development Process–Constructivist) method was applied for the selection and evaluation of the relevance of the conforming articles used by Tasca, et al (2010) and Lacerda, Ensslin & Ensslin (2011). This method provides a systematic approach to building a bibliographic portfolio that is relevant and aligned with the objectives of the study, ensuring that the selected articles are the most suitable to answer the research question. This method finally allows you to select all the articles that respond positively to one of these three conditions: 1- Following the Pareto rule, it is one of the articles that add up to 80% of the total citations of the most to least cited. 2- It is a recent article, published in the last 2 years. 3- It is an article belonging to one of the most cited authors defined in the authors' bank.

Application of the Ordinatio Method: Finally, the Ordinatio method was used to prioritize and classify the selected articles (Pagiani, Novaleski & Resende, 2015). This method classifies articles according to their relevance, year of publication, and number of citations, allowing the identification of the most influential and recent studies in the field. The application of this method allowed the literature to be structured in such a way that the most significant articles for the study received adequate attention in the subsequent analysis. The calculation of the *Methodi Ordinatio* followed the following formula:

$$Ordinatio = JCR + Citations + \propto (10 - Publish\ Year) \qquad (1)$$

Where JCR is the impact factor; $\propto$ is a value that varies from 1 (values older items) to 10 (values more recent items) that can be attributed by the researcher and in our case was 8; Publish Year is the year in which the research was developed, and Citations is the number of times the article was cited in the database.

Table 2. Search Criteria in Web of Science

| Date	Search	Filters	n. papers
4/19/2024	TS=(("AI" OR "Artificial Intelligence" OR "Machine Learning" OR "ML" OR "deep learning" OR "neural network*" OR "predictive analytic*" OR "natural language processing" OR "NLP" OR "computer vision" OR "data mining" OR Salesforce Einstein" OR "HubSpot" OR "Marketo" OR "Pardot" OR "Zoho CRM"))		2,510,576
4/20/2024	TS=(("AI" OR "Artificial Intelligence" OR "Machine Learning" OR "ML" OR "deep learning" OR "neural network*" OR "predictive analytic*" OR "natural language processing" OR "NLP" OR "computer vision" OR "data mining" OR Salesforce Einstein" OR "HubSpot" OR "Marketo" OR "Pardot" OR "Zoho CRM"))	AND ("business*" OR "firm*" OR "enterprise*" OR "compan*" OR "organization*" OR "corporat*" OR "startup*" OR "SME*" OR "B2B" OR "B2C"))	86,627
4/20/2024	TS=(("AI" OR "Artificial Intelligence" OR "Machine Learning" OR "ML" OR "deep learning" OR "neural network*" OR "predictive analytic*" OR "natural language processing" OR "NLP" OR "computer vision" OR "data mining" OR Salesforce Einstein" OR "HubSpot" OR "Marketo" OR "Pardot" OR "Zoho CRM"))	AND ("business*" OR "firm*" OR "enterprise*" OR "compan*" OR "organization*" OR "corporat*" OR "startup*" OR "SME*" OR "B2B" OR "B2C") AND ("sales" OR "sale*" OR "sales process*" OR "sales optim*" OR "sales develop*" OR "sales implement*"))	1,864
4/20/2024	TS=(("AI" OR "Artificial Intelligence" OR "Machine Learning" OR "ML" OR "deep learning" OR "neural network*" OR "predictive analytic*" OR "natural language processing" OR "NLP" OR "computer vision" OR "data mining" OR Salesforce Einstein" OR "HubSpot" OR "Marketo" OR "Pardot" OR "Zoho CRM") AND ("business*" OR "firm*" OR "enterprise*" OR "compan*" OR "organization*" OR "corporat*" OR "startup*" OR "SME*" OR "B2B" OR "B2C") AND ("business*" OR "firm*" OR "enterprise*" OR "compan*" OR "organization*" OR "corporat*" OR "startup*" OR "SME*" OR "B2B" OR "B2C") AND ("sales" OR "sale*" OR "sales process*" OR "sales optim*" OR "sales develop*" OR "sales implement*"))	Paper Type: Article or Review	1,198
4/22/2024	TS=(("AI" OR "Artificial Intelligence" OR "Machine Learning" OR "ML" OR "deep learning" OR "neural network*" OR "predictive analytic*" OR "natural language processing" OR "NLP" OR "computer vision" OR "data mining" OR Salesforce Einstein" OR "HubSpot" OR "Marketo" OR "Pardot" OR "Zoho CRM") AND ("business*" OR "firm*" OR "enterprise*" OR "compan*" OR "organization*" OR "corporat*" OR "startup*" OR "SME*" OR "B2B" OR "B2C") AND ("business*" OR "firm*" OR "enterprise*" OR "compan*" OR "organization*" OR "corporat*" OR "startup*" OR "SME*" OR "B2B" OR "B2C") AND ("sales" OR "sale*" OR "sales process*" OR "sales optim*" OR "sales develop*" OR "sales implement*"))	Paper Type: Article or Review Theme-Aligned Title	931
4/24/2024	TS=(("AI" OR "Artificial Intelligence" OR "Machine Learning" OR "ML" OR "deep learning" OR "neural network*" OR "predictive analytic*" OR "natural language processing" OR "NLP" OR "computer vision" OR "data mining" OR Salesforce Einstein" OR "HubSpot" OR "Marketo" OR "Pardot" OR "Zoho CRM") AND ("business*" OR "firm*" OR "enterprise*" OR "compan*" OR "organization*" OR "corporat*" OR "startup*" OR "SME*" OR "B2B" OR "B2C") AND ("business*" OR "firm*" OR "enterprise*" OR "compan*" OR "organization*" OR "corporat*" OR "startup*" OR "SME*" OR "B2B" OR "B2C") AND ("sales" OR "sale*" OR "sales process*" OR "sales optim*" OR "sales develop*" OR "sales implement*"))	Paper Type: Article or Review Theme-Aligned Title Método ProKnow-C y Ordinatio	627

Note. Authors' development

Finally, with the data duly prepared and filtered, we proceeded to re-import the complete datasets, including detailed information on cocitations, bibliographic references and other elements necessary for an exhaustive analysis. This re-import was a crucial step in ensuring data integrity and consistency throughout the analysis process. We use VOSviewer Software to carry out advanced analysis of cocitation networks, allowing us to identify patterns of relationship between articles, authors and journals, as well as to map the predominant research structures in the field. At the same time, we used Excel to perform complementary analyses and visualize the data in a structured way, facilitating the interpretation of the results and the elaboration of graphs that clearly represented the trends and connections identified in the selected literature. This combination of tools enabled a multifaceted approach to bibliometric analysis, enriching the understanding of the impact and evolution of AI and Machine Learning in optimizing sales processes in companies.

RESULTS AND DISCUSSION

The analysis of the temporal evolution of scientific production on the use of Artificial Intelligence (AI) and Machine Learning (ML) in the optimization of sales processes in companies reveals a significant growth in the number of publications in recent years, which reflects the growing interest and relevance of these topics in the academic and business fields (Figure 1). Since the first studies recorded in 1996, where only one article with 168 citations was published, scientific production in this field has shown a gradual and constant increase. This initial growth was driven by early advances in AI and ML technologies, although technological limitations and reduced accessibility to large volumes of data restricted the wider adoption of these tools in business practice.

However, it is from 2018 onwards that a significant change in the trend is observed, with a notable increase in the number of publications. This accelerated rise coincides with several key factors, such as the proliferation of cloud computing platforms, improved machine learning algorithms, and the increased availability of Big Data, which have enabled companies to more effectively integrate AI and ML into their sales processes. This growth culminates in 2022, a year in which there was a drastic jump in the number of articles published, reaching a total of 165 publications. This peak not only signals a moment of high productivity in research, but also a period of intense development and application of these technologies in the business environment, reflecting the rapid expansion of their use and the importance it has gained in sales optimization.[5]

Figure 1. *Scientific Production and Citations of the Use of AI and ML for Sales Optimization*
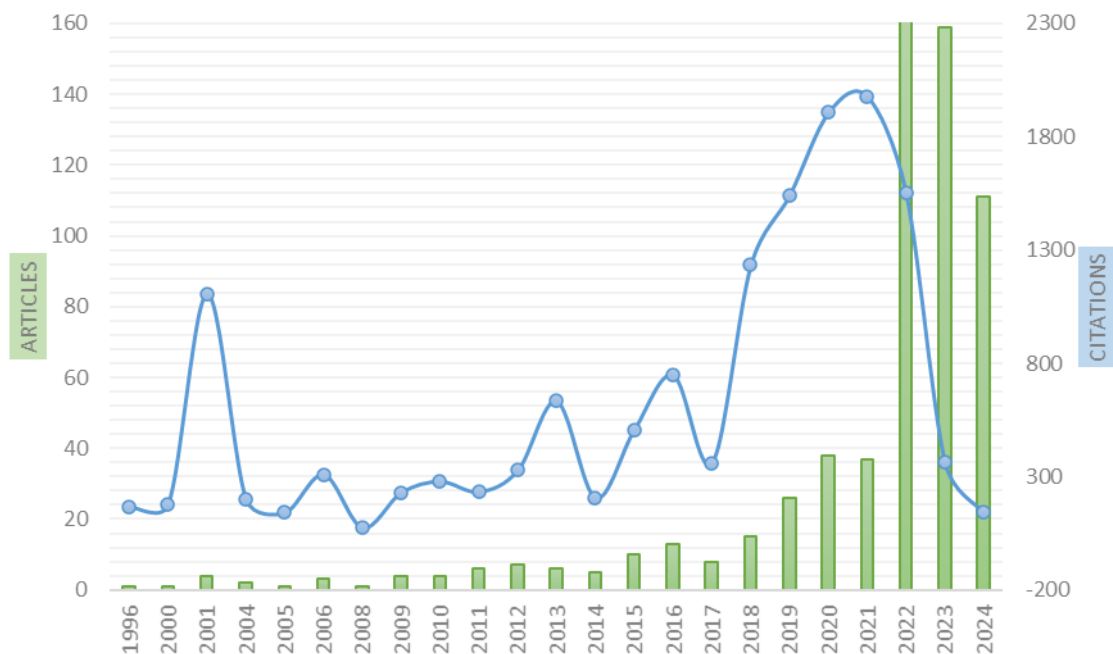
Note. Authors' development based on the results

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[5] In 2022, several AI and ML applications began to be widely adopted in sales, highlighting tools such as personalized recommendation systems that analyze customer behavior to suggest products in real-time. Advanced chatbots were also popular, capable of interacting in a natural and personalized way with customers, improving customer service and automating sales processes. In addition, ML-based predictive analytics platforms began to optimize sales strategies, allowing businesses to foresee market trends and adjust their tactics accordingly.

In 2016, there was notable progress in machine learning techniques, especially deep learning. The publication of frameworks such as TensorFlow by Google and PyTorch by Facebook facilitated the research and implementation of AI and ML, democratizing their access for researchers and companies (Auffarth, 2020; Chen, etl al, 2020). The expansion and accessibility of cloud computing platforms (AWS, Google Cloud, Azure) in that period allowed more companies and academics to use powerful AI and ML tools without the need for expensive infrastructure, likely spurring research into business applications, including sales.

The COVID-19 pandemic forced many companies to accelerate their digital transformation. With the massive shift to e-commerce and the need to optimize sales processes in an environment of uncertainty, the adoption of AI and ML technologies skyrocketed.[6] This, in turn, prompted research into how these technologies could be used to improve sales in times of crisis. With the rise of e-commerce and digital interactions, businesses began to generate large volumes of data, which created new opportunities for research into predictive analytics and sales personalization using AI and ML.

In 2022, the number of articles published experienced a notable jump, going from 37 in 2021 to 165 articles. This year marks a turning point in the field, reflecting a growing interest and the rapid expansion of research applied to AI and ML in sales. At this time, AI and ML technologies reached greater maturity, and their adoption had expanded significantly in various industries. Not only were companies exploring these technologies, but they were also beginning to implement them on a large scale, leading to a demand for more targeted and applied research. In 2022, there was also a growing focus on ethics and transparency in the use of AI and ML, leading to additional research on how to implement these technologies responsibly in the business context, including sales optimization. More sophisticated and accessible tools, such as AutoML and more integrated AI platforms, made it easier for researchers and companies to explore new applications of AI and ML, contributing to the increase in publications in this period.[7]

Despite the high number of publications in 2022, with a total of 165 articles, the number of citations accumulated during this year was 1,550. While this figure is considerable and reflects a growing interest in research on AI and ML applied to sales optimization, it also suggests that many of these articles are relatively recent and therefore have not had enough time to be widely cited. This is common in emerging research areas, where the volume of publications can increase rapidly, but citations usually follow a more gradual growth pattern as the papers are recognized and used by the scientific community in subsequent research. This time lag between publication and citation accumulation is an indicator that the relevance and impact of these studies will likely increase in the coming years as they become more established in the field.

This sustained increase in the volume of publications can be attributed to technological advancement, the increased availability of data and analytical tools, and the increasing adoption of AI and ML technologies by companies in various sectors. These innovations have facilitated the implementation of these technologies in the business environment, driving an increase in academic research exploring their applications and benefits.

The keyword co-occurrence analysis carried out with VOSviewer, in turn, reveals two main clusters that highlight different approaches in the research on the application of AI and ML in the optimization of sales processes. The first cluster, which includes terms such as machine learning, data mining, deep learning, demand, e-commerce, forecasting, model, neural-network, optimization, prediction, regression, and sales forecasting, suggests a technical and methodological approach. This cluster brings together research focused on the development and application of predictive models and advanced algorithms to improve the accuracy of sales prediction and demand optimization, particularly in e-commerce contexts. The prevalence of terms related to specific techniques such as deep learning and neural networks underscores the importance of innovations in machine learning to address complex challenges in sales prediction and management. These findings are represented in Figure 2.

The second cluster, composed of terms such as artificial intelligence, behavior, big data, impact, management, performance, sales, and social media, seems to focus on the strategic and behavioral aspects of the application of AI in sales (Figure 2). This group of keywords suggests that research in this area is more geared towards exploring how AI can influence consumer behavior and business performance. In addition, the presence of terms such as social media and big data indicates an interest in how big data platforms and social networks are being leveraged to improve sales management and decision-making. This cluster reflects a more holistic approach, integrating AI not only as a technical tool, but also as a key factor in sales strategy and interaction with consumers.

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[6] The pandemic forced many companies to accelerate digital transformation due to the urgent need to adapt to an environment where physical interactions and traditional operations were severely limited. With social distancing and restrictions, businesses had to quickly adopt digital technologies to continue operating, such as e-commerce, remote work, and virtual communication platforms. This led to a massive adoption of digital tools and the implementation of technologies such as AI and ML to optimize processes, improve efficiency, and maintain competitiveness in a suddenly digitized market.

[7] AutoML (Automated Machine Learning) is a technology that automates the process of creating, selecting, and tuning Machine Learning models. It aims to simplify and accelerate the development of predictive models by reducing the need for expert human intervention at every stage of the process, from feature and algorithm selection to hyperparameter optimization. AutoML enables users with limited knowledge of machine learning to develop effective models, democratizing access to AI and enabling more companies to harness the power of ML to solve complex problems.

Together, these clusters indicate a duality in research on AI and ML in sales: on the one hand, a focus on technical innovation and process optimization through the use of advanced models, and on the other, a focus on the management, behavior, and impact of these technologies in the business environment. This division suggests that the field is evolving towards an integration of technical knowledge with strategic perspectives, which will allow companies to not only improve the accuracy of their sales predictions, but also better understand and manage the impact of AI on their performance and customer experience.

Keyword co-occurrence analysis over time reveals that fundamental concepts such as neural networks, forecasting, and data mining have been present in the sales literature since before 2019. These terms reflect the early interest in techniques and methods that use advanced models for sales process optimization and trend prediction. The persistence of these themes in the literature suggests that, even before recent technological advances, there was significant recognition of the value of these techniques in improving accuracy in sales forecasting and in the analysis of complex data.

Figure 2. *Keyword Co-occurrence Analysis*
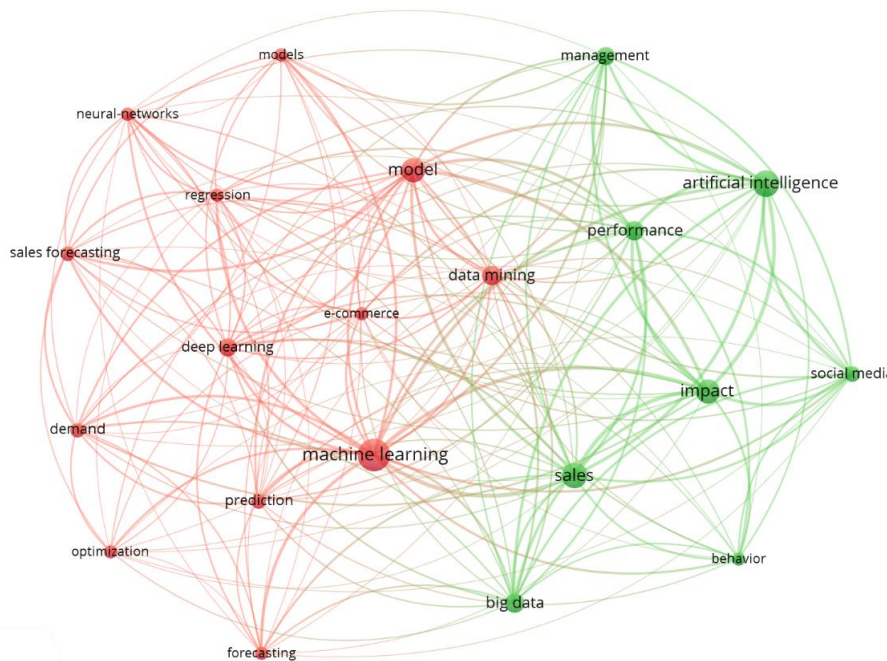
Note. Authors' development based on the results

**Figure 3.** *Analysis of Keyword Co-occurrences over Time*
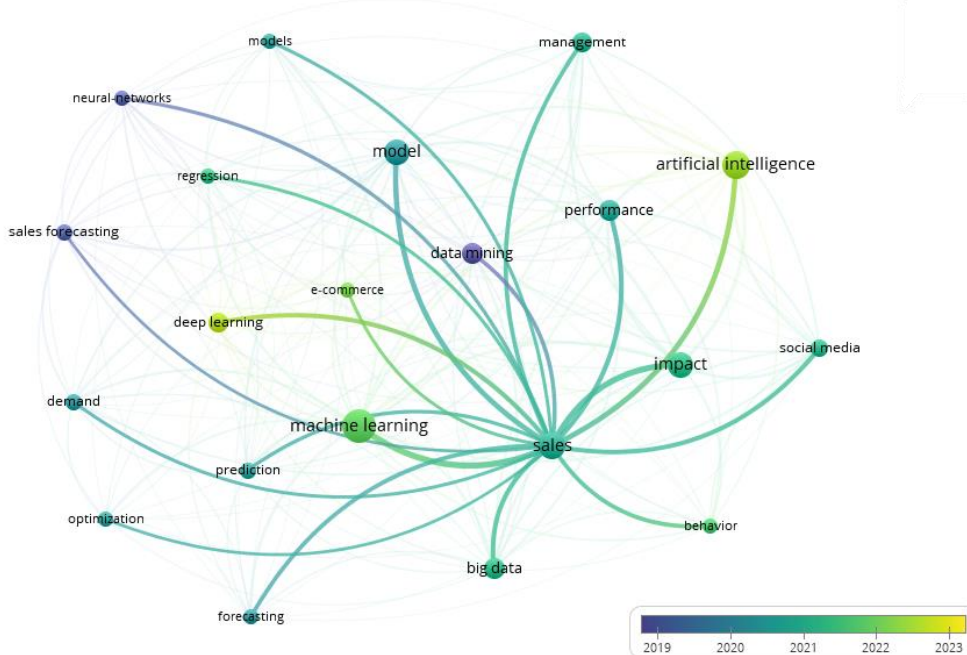
Note. Authors' development based on the results

However, it is from 2022 when the terms machine learning and artificial intelligence begin to gain prominence in the literature, indicating a shift towards more widespread adoption and deeper integration of these technologies in sales analytics. This increase in visibility and use of machine learning and artificial intelligence reflects the advancement in processing power and the development of new techniques that allow companies to address more complex problems and take advantage of emerging opportunities in sales optimization. More recently, the term deep learning has gained popularity in the literature, standing out as an emerging trend in research on the application of AI and ML in sales. The growing relevance of deep learning can be attributed to its advances in handling large volumes of data and its ability to model complex patterns with superior accuracy.

The analysis of the main research areas of the articles on the application of AI and ML in the optimization of sales processes reveals a remarkably concentrated distribution in two predominant fields: Computer Science (33.81%) and Business and Economics (33.49%). This concentration reflects the interdisciplinary nature of research in this field, where computer science provides the fundamental tools and techniques of AI and ML, while the business and economic context acts as the application scenario for these technologies. The combination of both areas underscores the importance of understanding not only the technical aspects of AI and ML, but also their impact and relevance on sales strategies and operational efficiency within companies. Figure 4 illustrate these findings.

Figure 4. *Main Subject Areas*
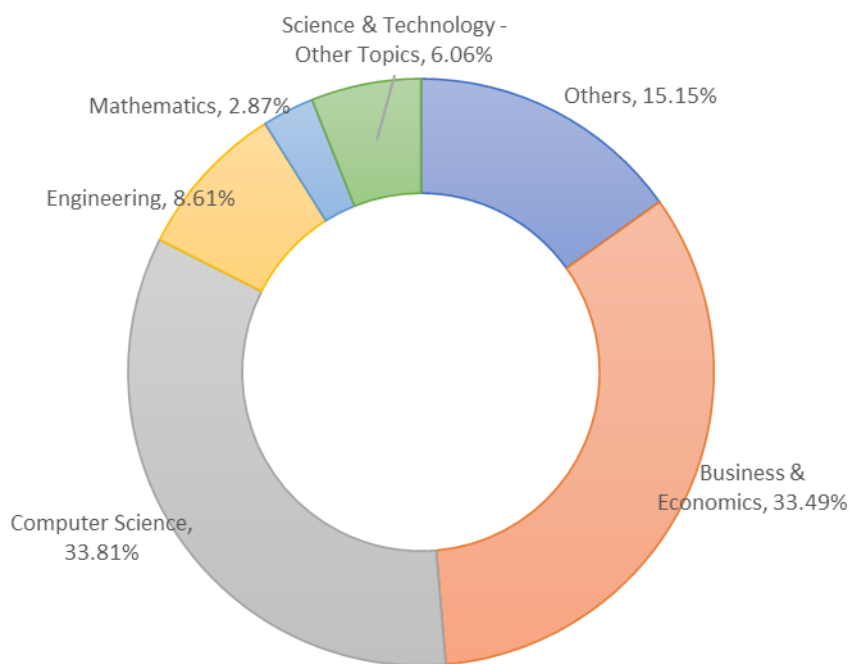
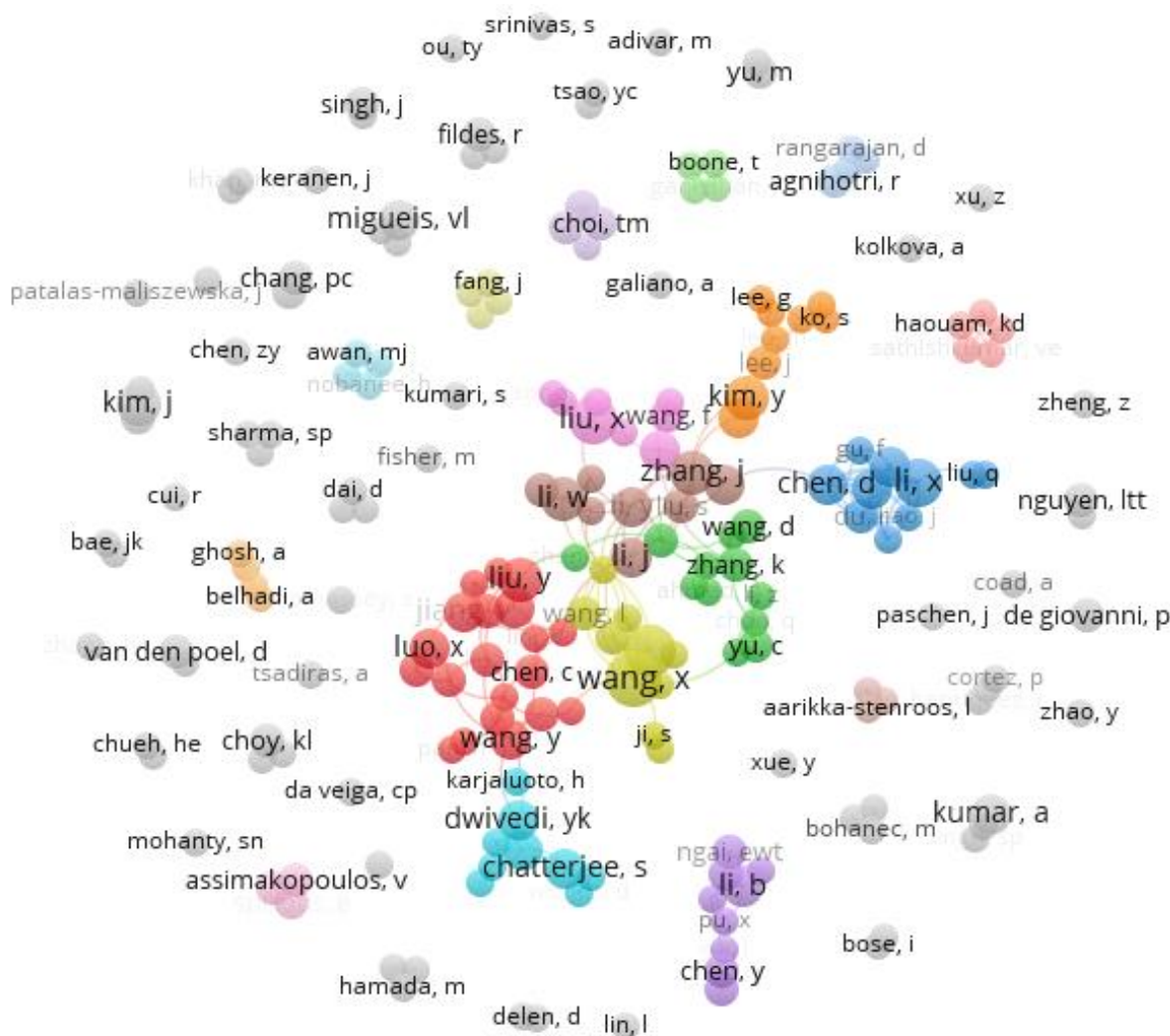**Note**. Authors' development based on the results

The next significant group of articles is in the field of Engineering, with 8.61% of the total, suggesting a focus on the practical implementation and development of technical solutions that facilitate the integration of AI and ML into specific business processes. This area of research is key to advancing the effective application of these technologies, addressing challenges such as scalability, reliability and system optimization. However, their lower representation compared to computer science and business could indicate that although engineering is crucial to execution, most research still focuses on methodologies and economic and business theory.

Finally, the areas of Mathematics (2.87%) and Science and Technology – Other Topics (6.06%) contribute more modestly to the body of research, suggesting that while mathematics provides the theoretical basis for AI and ML algorithms, its specific role in the context of sales optimization has not been as explored as in other, more technical applications. On the other hand, the percentage of "Other" (15.15%) highlights the diversity of approaches that can be found in the literature, ranging from applications in social sciences to interdisciplinary studies that do not fit a single category.

The co-authors' map reveals a complex structure in the scientific production on the application of AI and ML in the optimization of sales processes (Figure 5). A main group composed of at least eight clusters of authors who collaborate closely and whose works are interrelated is identified. This major group includes prominent Asian researchers such as Wang, Y., Luo, X., Kim, Y., and Wang, X., who have contributed significantly to the literature in this area. Also in this group are influential Western authors, such as Chatterjee, S., who have been widely cited and whose work has a considerable impact on

the field. The cohesion within this main cluster indicates a consolidated network of research that focuses on the development and expansion of fundamental theory related to the use of AI and ML in the context of sales.

Figure 5. *Co-Authors' Map*

Note. Authors' development based on the results

In addition to this core group, the analysis shows several smaller clusters of co-authors who, although less prominent, are also active in this area of research (Figure 6). These more dispersed clusters are involved in research that often focuses on the practical application of AI and ML techniques, rather than theoretical development. The presence of these smaller groups suggests a diversity in research approaches, with particular attention to implementing methods and solving specific problems in the sales arena.

The literature review indicates that while the core group is primarily engaged in the exploration and expansion of fundamental theories related to sales optimization using AI and ML, secondary clusters tend to address practical applications and concrete case studies. This differentiation in approach reflects a divide in research between the development of new theories and models, and the practical application of these methods in real business scenarios, providing a comprehensive view of the field that encompasses both theoretical innovation and practical implementation.

In the analysis of co-authorship by country, we observe an outstanding collaboration between authors from China and the United States, who lead scientific production in the field of optimization of sales processes using AI and ML. United States and China, as the two nations with the highest production in this area, show a strong interconnection in their research networks, suggesting significant cooperation and a constant exchange of ideas and resources between researchers from both countries. This close relationship may reflect the leadership of both countries in the development of advanced technologies and in applied research in AI and ML, as well as the influence of their academic institutions and cutting-edge research centers, which is complemented by the results of various studies that point to the close relationship between the level of development and the network of co-authors in indexed journals (Butt, Malik & Shahbaz, 2021).

Figure 6. *Co-Authorship Map by Country*
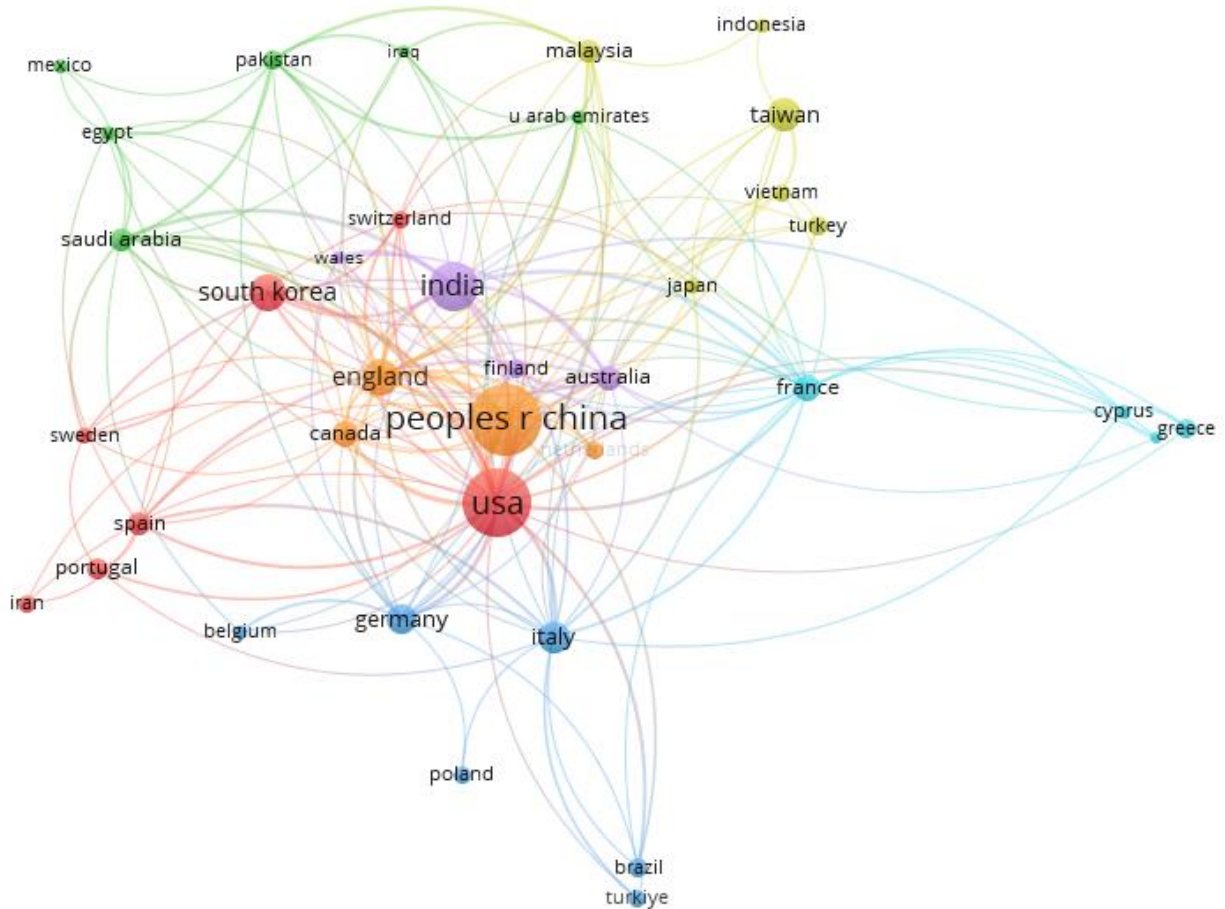
Note. Authors' development based on the results

In addition, the analysis highlights the important role of authors from India and South Korea in co-authorship, indicating a growing participation of these countries in the field of research. The significant presence of Indian and South Korean researchers suggests that, as AI and ML research expands globally, these countries are playing an increasingly relevant role in international scientific collaboration. India, with its robust technology sector and growing focus on AI innovation, and South Korea, with its advanced technology research ecosystem, contribute substantially to scientific production and the development of new approaches and applications in the field.[8]

Despite the global advancement in the field of sales process optimization using AI and ML, authors from developing countries show relatively low participation in this cutting-edge research area. This lack of participation can be attributed to several barriers, including limitations in financial resources, limited access to advanced technologies, and less research infrastructure compared to more developed nations.

The gap in developing countries' participation may reflect challenges such as a lack of specialized training in AI and ML, and a lack of international collaboration networks that could facilitate the sharing of knowledge and resources. In addition, research priorities in these countries may be more focused on local problems and urgent needs, which could limit the scope of their involvement in advanced technological areas.

Ordinatio's five highest-rated articles in the field of sales optimization using Artificial Intelligence (AI) and Machine Learning (ML) provide fundamental insights into how these technologies are transforming sales optimization, highlighting the evolution of technologies, the impact on marketing strategies, the importance of customer perception, and the need for continuous innovation. Through their analysis, we can understand what have been the foundations and main concerns of the authors who study these issues (Table 3).

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[8] Both South Korea and India have launched government initiatives to boost the development of artificial intelligence (AI) and machine learning (ML). South Korea has created a "regulatory sandbox" and is working on a legal framework to facilitate innovation in AI. India, for its part, has implemented the "AI for All" strategy to promote the adoption of AI in key sectors and is establishing centers of excellence in collaboration with academic institutions and industry. These efforts seek to accelerate technological advancement and research in both countries.

Table 3 *Top 5 Articles by Ordinatio Index*

Article Title	Authors	Publication Year	Contribution to the Researched Topic	Ordinatio
E-commerce recommendation applications	Ben Schafer, J; Konstan, JA; Riedl, J	2001	It examines how recommendation systems, which use AI techniques such as machine learning to analyze consumer behaviors, have evolved into key tools for e-commerce. Through the analysis of recommendation systems on market-leading sites, it explores how these systems optimize sales by personalizing product recommendations, highlighting the relationship between these techniques and traditional database analysis techniques. The study provides a taxonomy of recommendation models, identifying open issues and privacy considerations, which is essential to understanding how these technologies influence sales optimization.	690.8
Setting the future of digital and social media marketing research: Perspectives and research propositions	Dwivedi, YK; et. al.	2021	This article discusses how digital and social media marketing, influenced by AI and advanced technology, is transforming consumer behavior and business practices. The authors discuss the impact of emerging technologies such as artificial intelligence and augmented reality on marketing, highlighting both opportunities and challenges. Offering a comprehensive view on topics such as digital content management and ethics, the article provides crucial insight into how these technologies are reshaping marketing and, by extension, optimizing sales processes in the digital age.	679.1
Frontiers: Machines vs. Humans: The Impact of Artificial Intelligence Chatbot Disclosure on Customer Purchases	Luo, XM; Tong, SL; Fang, Z; Qu, Z	2019	Research the impact of AI-powered chatbots on customer purchases, comparing the effectiveness of chatbots and human workers on sales calls. The article reveals that although chatbots are effective, their prior disclosure significantly reduces purchase rates due to customers' negative perception of the machines. These findings offer important implications for the application of chatbots in sales, highlighting how customer insight and transparency can influence the effectiveness of AI technology in optimizing sales.	474
Waiting for a sales renaissance in the fourth industrial revolution: Machine learning and artificial intelligence in sales research and practice	Syam, N; Sharma, A	2018	Explore how the fourth industrial revolution, characterized by the integration of AI and machine learning, is transforming personal selling and sales management. The impact of these technologies on the sales process is analyzed and implications for both theory and practice are drawn. The study provides a framework for understanding how automation and artificial intelligence are redefining sales practices, offering a detailed analysis of how these changes can improve efficiency and effectiveness in sales optimization.	374.8
Spreading Social Media Messages on Facebook: An Analysis of Restaurant Business-to-Consumer Communications	Kwok, L; Yu, B	2013	Examine which types of Facebook posts are most effective for restaurants, analyzing how posts with different types of content (photos, videos, text) and messages (conversational vs. sales) affect user interaction. The findings suggest that conversational messages and photos receive more interactions than other types. These results are relevant to social media marketing, providing practical strategies to improve social media communication and optimize the influence of sales campaigns on digital platforms.	302.5

Note. Authors' development based on the results

The reviewed articles show that the application of AI and ML in sales optimization has evolved significantly. From the recommendation systems in e-commerce described by Schafer et al. (2001) to the use of chatbots in sales explored by Luo et al. (2019), there is a growing integration of advanced technologies to personalize and improve the customer experience. The evolution from simple recommendation algorithms to complex chatbots reflects progress in the ability of these technologies to influence consumer behavior and improve sales results. Small firms, especially, often find it difficult to innovate and acquire new technologies (Ramirez-Soto, et al., 2024). This reality is often more accentuated in the context of developing countries due to their currency foreign exchange dependence.

Emerging technologies such as AI and ML are revolutionizing marketing strategies, transforming the way businesses interact with consumers and manage their digital content. According to Dwivedi et al. (2021), one of the most comprehensive studies on this topic, these technologies offer a wide range of opportunities to personalize the customer experience, improve market segmentation, and optimize social media advertising campaigns.

However, along with these opportunities, significant challenges also arise, such as the need to address ethical and privacy issues in the handling of personal data. The analysis by Dwivedi et al. underscores that the transition to more data-driven marketing requires companies to not only adopt these technologies, but also to continuously adapt to rapid technological and regulatory changes. This dynamic approach is essential to staying competitive in an increasingly digitized

environment.

The perception that consumers have about technologies plays a crucial role in their effectiveness. The study by Luo et al. (2019) reveals that a negative perception towards chatbots, when their identity is revealed, can reduce purchase rates. This finding underscores the importance of managing customer perception when implementing AI technologies, highlighting that it is not only necessary to introduce technological innovations, but also to carefully manage how they are presented to users. In addition, research such as that by Syam and Sharma (2018) and Kwok and Yu (2013) demonstrates how the integration of AI and the optimization of messages in social networks can significantly improve sales and marketing strategies. This indicates that both technology and communication strategy are critical elements for success in sales optimization.

The articles also highlight the importance of innovation and future research. For example, the work of Syam and Sharma (2018) on the fourth industrial revolution and the study by Cui et al. (2016) on the use of social media information to improve the accuracy of sales forecasts, show a clear interest in exploring how new technologies and analytical methods can continue to revolutionize the field. Continuous research and development of new techniques and models is essential to stay ahead of the curve in sales optimization and adapt to an ever-changing environment.

FINAL REMARKS

This study has investigated the application of Artificial Intelligence (AI) and Machine Learning (ML) in the optimization of sales processes, highlighting how these emerging technologies are transforming consumer behavior and business strategies. Through a detailed analysis of the scientific literature and keyword co-occurrence, two main approaches have been identified: sales prediction using advanced machine learning models and managing consumer behavior through big data and social media.

The research carried out reveals a substantial growth in scientific production related to the use of Artificial Intelligence (AI) and Machine Learning (ML) in the optimization of sales processes, particularly in the last decade. This increase in the volume of publications can be linked to several factors, such as technological advances, increasing accessibility to large volumes of data, and the development of more sophisticated analytical tools. However, temporal citation analysis suggests that although there has been an increase in the number of articles, many of them have not yet had enough time to be widely cited, reflecting both the novelty of the topic and the speed with which the literature in this field is evolving. This trend is an indicator of the growing interest and relevance that AI and ML are acquiring in the business environment, with significant potential to continue transforming sales strategies in the near future.

The keyword co-occurrence analysis allowed us to identify two main clusters that reflect the predominant focus areas in the research. The first cluster focuses on terms such as "machine learning", "data mining", "deep learning" and "sales forecasting", indicating a strong focus on sales prediction and process optimization through advanced machine learning models. The second cluster includes terms such as "artificial intelligence", "behavior", "big data" and "social media", suggesting a growing interest in how AI is being applied to manage and understand consumer behaviour, as well as to improve performance and sales management through big data and social media. These results underline the duality in the application of AI and ML in sales, where on the one hand it focuses on predictive modelling and, on the other, on the management of behaviour and interaction with consumers.

Another significant finding of this research is the structure of collaboration between authors, highlighting a main group of co-authors, mostly Asian, who have led scientific production in this field. The connection between researchers from China and the United States highlights the close collaboration between these two countries, which dominate research in AI and ML applied to sales. Likewise, the growing participation of authors from India and South Korea is observed, which shows the globalization of research in this field. However, the limited participation of authors from developing countries suggests a gap in scientific output, reflecting challenges such as lack of resources, access to advanced technology, and funding for research in these regions. This presents an opportunity for future research and international collaboration to address these disparities and foster a more inclusive approach to the development of these technologies. Future research should include "grey literature" from regional academic journals in developing countries, institutional repositories, and peer-reviewed academic events with participants from other emergent countries to overcome limitations of scope and geographic diversity.

Finally, the results of this study not only contribute to theoretical and academic knowledge on the application of AI and ML in sales, but also offer important practical implications for companies. Identifying emerging trends, understanding global collaboration dynamics, and analyzing key research areas provide a valuable framework for implementing more effective and personalized sales strategies. In addition, the growing adoption of these technologies suggests that companies that integrate AI and ML into their sales processes will be better positioned to meet challenges and seize market opportunities in the digital age. This reinforces the relevance of continuing to research and develop new applications of AI

and ML in the business environment, ensuring that these tools are used effectively and ethically to maximize their positive impact on sales and society at large.

A relevant limitation of this work is the temporal restriction of the articles analyzed, which focused mainly on publications until 2024, which could influence the non-reliable capture of the number of citations and the influence of more recent articles in the field of sales optimization through AI and Machine Learning. As the rise of artificial intelligence (AI) and machine learning (ML) is a relatively recent phenomenon, some patterns and trends in scientometrics cannot yet be fully observed. This is because the scientific literature and bibliometric data need time to mature and fully reflect the evolution and impact of these technologies in different disciplines. In addition, the rapid expansion and adoption of AI and ML means that collaboration networks, citations, and knowledge dissemination are constantly changing, making it difficult to comprehensively capture their influence in the short term. Consequently, future studies will be necessary to continue monitoring and analyzing these phenomena as they develop, allowing for a deeper and more deeply understanding of how these technologies are reshaping the global scientific and academic landscape (Table 5). These studies could complement this research by looking at how AI and ML applications in sales have evolved after 2023, investigating the adaptability of these technologies in emerging markets and their ability to address ethical and privacy challenges. It would also be valuable to further explore the socio-economic implications of these innovations to provide a more comprehensive and robust view of the impact of these technologies on the global sales landscape.

Table 5. *Recommendations for future research*

No.	Method	Dependent Variables	Independent Variables	Research Proposal
1	Latent Topical Analysis (LDA)	Thematic Evolution in AI and ML Research	Year of publication, areas of application, technological advances, sources of funding	Research on thematic evolution in AI and ML literature, using latent topic models to identify how research approaches have changed and what are the emerging themes that could dominate the field in the coming years.
2	Multilevel Regression Models	Impact of AI and ML adoption on the industry	Scientific publications, patents, investments in R+D, academic training	A multilevel analysis examining how the adoption of AI and ML technologies in different industry sectors correlates with academic output, patent activity, and investments in research and development, assessing the transfer of knowledge from academia to industry.
3	Social Network Analysis (SNA)	Impact of international collaboration on scientific productivity	Co-authorship networks, international funding, research policies, scientific infrastructures	Assessing the impact of international collaboration on scientific productivity within the field of AI and ML, analyzing how co-authorship networks and global financial support influence knowledge production and the adoption of technological innovations.
4	Co-Citation Analysis	Influence of the most cited authors on the development of the field	Citation rate, institutional affiliations, technological contributions, age of publications	A study that explores how the most cited authors within AI and ML research have shaped the development of the field, identifying patterns of influence and the dissemination of key insights over time.

Note. Authors' development

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Contribution of each author to the manuscript:

Task	% of contribution of each author			
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A. theoretical and conceptual foundations and problematization:	25%	25%	25%	25%
B. data research and statistical analysis:	25%	25%	25%	25%
C. elaboration of figures and tables:	25%	25%	25%	25%
D. drafting, reviewing and writing of the text:	25%	25%	25%	25%
E. selection of bibliographical references	25%	25%	25%	25%
F. Other (please indicate)	25%	25%	25%	25%