

Toward Intelligent ERPs: A Bibliometric Perspective

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Abstract. *Enterprise Resource Planning (ERP) systems are undergoing a fundamental transformation that is fueled by the integration of artificial intelligence, machine learning, advanced analytics and other Industry 4.0 technologies. This shift has led to what is increasingly referred in the literature as intelligent ERP (iERP) systems. Despite the growing interest in both academic research and practice, the literature remains fragmented and dispersed across technological, organizational and managerial perspectives, reflecting its inherently complex and interdisciplinary nature. In this paper we present a PRISMA-guided bibliometric analysis that was applied to map the evolution of iERP research over the last decade (2015-2025). We performed a bibliometric analysis on a compiled dataset of publications from the Web of Science Core Collection. VOSviewer and the Bibliometrix R package were utilized to help us gain insights into the structure and latest developments of the field. Using this approach, we prevailed to identify major research thematic directions, key publication patterns, and top contributing regions and institutions. The paper also highlights the main technological and organizational dimensions of iERP systems. The study contributes to the existing literature by structuring a fragmented body of work, defining key research perspectives and providing a foundation for understanding current directions in iERP systems research.*

Keywords: Enterprise Resource Planning (ERP), Intelligent ERP (iERP), Artificial Intelligence (AI), Machine Learning, Bibliometric Analysis.

Introduction

Enterprise Resource Planning (ERP) systems have long been a key component of organizational digital infrastructures. They support functions across all core business areas, including finance, production, logistics, customer relations and human resources. Modern ERPs offers the potential to adopt standardized practices and enhance operational efficiency, accountability and overall organizational performance (Katuu, 2021).

Initially ERP systems were developed as transactional systems designed to manage basic operational and production activities. They have experienced complex technological and functional enhancements over time and have evolved into intelligent platforms that can analyze complex data, learn from accumulated experience and make strategic decisions autonomously.

In the current landscape, intelligent ERP systems are emerging as a result of the integration of artificial intelligence (AI), machine learning (ML), Internet of Things (IoT), big data analytics, digital twins and other advanced Industry 4.0 technologies. These systems are referred to in the literature under various terms, including “smart ERP,” “cognitive ERP,” “AI-enabled ERP,” “post-modern ERP,” “enhanced ERP,” or “next-generation ERP”. Although the terminology differs, the majority of definitions converge on the idea that intelligent ERPs extend traditional ERP functionalities by enabling predictive analytics, adaptive decision-making, workflow automation and turning operational data into actionable knowledge.

As interest in intelligent ERP systems continues to grow, its complex and interdisciplinary character has resulted in a fragmented body of research that spans multiple domains. We chose to perform a bibliometric analysis as an effective and rigorous method to map the evolution of the research field, identify emerging trends and highlight gaps in the literature.

In the first part of this study we carry out a detailed investigation of the current state of the art in the domain and identify the core perspectives and technologies that characterize intelligent ERP systems. Based on these findings, we propose a coherent definition for iERP. Then we perform a PRISMA-guided bibliometric analysis of research on intelligent ERP systems published over the past decade (2015–2025), combining quantitative bibliometric mapping with a review of related works. This approach allows us to provide a comprehensive overview of the field, identify key technological enablers and propose potential directions for future research in intelligent ERP systems.

The remainder of the paper is structured as follows: in the Literature Review section we trace the evolution of ERP systems, discuss technological enablers and examine current applications of intelligent ERP. In the Methodology section we present the PRISMA-guided bibliometric approach that we adopted in the study, the data collection process and the analytical tools that were employed. In the Results and Discussion section we present the main bibliometric findings, including publication trends, key countries and institutions, influential papers, keyword co-occurrence and thematic clusters. Finally, in the Conclusions section we summarize the key contributions, discuss limitations and outline directions for future research in the domain of intelligent ERP systems.

Literature review

ERP systems origins can be traced back to the 1960s, with the development of Material Requirements Planning (MRP). MRP systems were designed to ensure the planning of materials and components required for production processes (Sarferaz, 2024) based on Bills of Materials (BOM) and existing inventories. MRP systems were predominantly used in the manufacturing industry. During the 1970s-1980s, as their capabilities expanded to include production process optimization functionalities and simulation techniques that enabled predictive analysis, a new generation of MRP systems (MRP II) emerged. MRP II allowed organizations to manage cash flow, materials, inventories and human resource allocation more effectively (Al-Amin et al., 2023).

Building on the MRP advancements, ERP systems were introduced in the early 1990s. They managed to overcome previous limitations by integrating a broader range of organizational processes, including accounting, finance, human resources, production planning and distribution. The second generation of ERPs (ERP II) emerged in the early 2000s as an extension of existing systems through the addition of modules that connected external stakeholders (such as customers and suppliers) to the organization. This stage is also marked by the inclusion of Customer Relationship Management (CRM) and Supply Chain Management (SCM) modules, as well as by the facilitation of electronic commerce (Saxena & Verma, 2022).

The transition to ERP III systems is characterized by the addition of mobile access via smartphones and tablets (SZELAŁGOWSKI et al., 2023). Since 2010, ERP solutions are increasingly deployed through cloud-based platforms, breaking the previous entry barriers for SMEs generated by the cost of hardware acquisition and maintenance.

In recent years, a new generation of ERP systems has been developed through the integration of technologies such as artificial intelligence, the Internet of Things (IoT), big data and fog computing (Morawiec & Sołtysik-Piorunkiewicz, 2023). This new generation of ERP systems has the ability to transform large volumes of operational and strategic data into actionable information by leveraging advanced AI algorithms, ML mechanisms and predictive analytics.

Intelligent ERPs are described as a software solution that incorporates artificial intelligence, machine learning and advanced automation technologies to perform tasks, make decisions and

manage processes with minimal or no human intervention (Sarferaz, 2024). Some examples of key features of intelligent ERP are: advanced analytics and forecasting, intelligent automation, continuous improvement, enhanced security and personalization (Sarferaz, 2024).

The integration of Artificial Intelligence through adaptive and predictive models presents game-changing improvements in ERP responsiveness, accuracy and efficiency (Almahadin, 2025). (Zdravković et al., 2022) identified several applications of AI in inventory and logistics modules of ERP. According to the authors, AI techniques can be applied in demand forecasting, stock level optimization, backorder prediction and the dynamic selection of replenishment and ordering policies. Furthermore, among the AI applications in warehouse and internal logistics operations are (Zdravković et al., 2022) mentions: computer vision-based inventory counting, shelf monitoring and picking verification, which reduce manual workload and human error.

(Pohrib et al., 2025) highlighted practical manifestations of AI integration within ERP systems in audit and compliance areas. Their findings indicate that AI-driven automation reduces manual audit efforts, improves financial anomaly detection, automates document and email analysis and enhances audit quality and fraud detection.

Generative AI can be used, according to (Sarferaz, 2025) to enhance ERP core processes by automating content generation, enabling intelligent question answering, supporting conversational agents, performing text summarization and classification, providing real-time translation, data augmentation and information extraction and supporting personalization and creative processes.

ERP systems use machine learning techniques such as regression, clustering, anomaly detection, dimensionality reduction or prediction modelling to enhance decision-making, optimize operational processes and support strategic planning. In the context of Sales and Operations Planning (S&OP), these methods allow organizations to identify and correct errors or inconsistencies in historical data, detect patterns in past performance to improve future forecasts and demand plans, estimate the probability of future project outcomes, predict capacity utilization over time and identify potential bottlenecks (Ohlson et al., 2022). Furthermore, by leveraging big data and machine learning intelligent ERP systems can significantly improve manufacturing operation scheduling and resource allocation while preventing production stops and conferring reality awareness to resource maintenance (Morariu et al., 2020).

Digital twin (DT) is considered to be another technology of modern ERPs. It represents a virtual replica of a physical system that is synchronized through real-time data feeds (from IoT sensors). It features predictive analytics and simulation engines to simulate, analyze and refine real-world processes, driving enhanced organizational efficiency (Ziari & Taleizadeh, 2025). DT allows the alignment of machine-level intelligence with enterprise-level decision-making by leveraging real-time machine performance indicators, supporting automated maintenance scheduling and optimizing costs (Nozari & Szmelter-Jarosz, 2025).

Integration of blockchain in ERP systems has recently gained a lot of attention in the literature, particularly in supply chain management context. Blockchains rely on transparency, decentralization and security to transform the supply chain by sharing data across logistics, procurement, manufacturing, delivery, transport, maintenance, picking and packing processes. It links physical products to their digital representations, verifying product properties and recording the transfer of assets such as pallets and tools as they move throughout the supply chain (Hader et al., 2021). The synergy between blockchain and ERP systems helps organizations to achieve consistency between supply and demand, leading to decreased stockouts and lost sales (Košťál et al., 2024).

ERP systems can benefit from integration of IoT sensors to bridge the gap between physical assets and business logic. As demonstrated by (Mallieswari et al., 2022) the functionality of ERP through IoT has a significant impact on business process outcomes by connecting systems, allowing for real-time monitoring and raising performance figures.

Another critical dimension in the evolution of modern ERP systems is the shift toward cloud-based solutions. (Tongsuksai et al., 2023) presents benefits such as low costs of implementation, licensing and support, increased agility and reduced implementation times. Cloud services can be delivered in various formats such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) and offers the traditional ERP benefits at lower setup, maintenance and support costs (Prakash et al., 2022).

Defining iERP

Based on the synthesis of the literature, it is obvious that iERP systems represent the next step in ERP evolution.

We define intelligent ERP as a software ecosystem that extends traditional ERP functionalities with the infusion of advanced digital technologies, including AI, ML, IoT, cloud computing, digital twins, and blockchain, to enable process optimization and adaptive, predictive, and automated enterprise-wide decision-making. Figure 1 presents the technologies surrounding the iERP ecosystem.

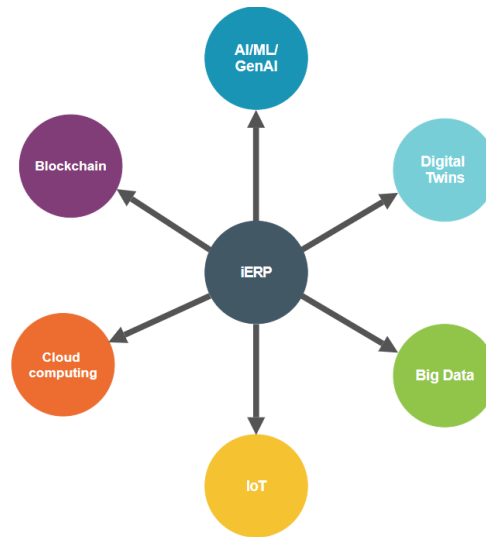


Figure 1. Intelligent ERP ecosystem

Source: Author's own research.

Methodology

In this study we carried out a PRISMA-guided bibliometric analysis of the literature on intelligent Enterprise Resource Planning systems, providing transparency and reproducibility. We conducted the search against the Web of Science Core Collection database with a time constraint for the last decade (2015-2025).

To identify relevant studies on intelligent ERP systems, we applied the search query: *"TS=(("intelligent ERP" OR "iERP" OR "smart ERP" OR "cognitive ERP" OR "AI-enabled ERP" OR "next-generation ERP" OR "post-modern ERP") OR ("Enterprise Resource Planning" OR "ERP")) NEAR/5 ("artificial intelligence" OR "AI" OR "machine learning" OR "deep learning" OR*

"generative AI" OR "predictive analytics" OR "intelligent automation" OR "smart" OR "cognitive" OR "post-modern"))".

The search was conducted against the topic field (TS) in the Web of Science Core Collection database, which includes titles, abstracts, keywords and author keywords. To ensure a comprehensive coverage, we proposed a search strategy made of two parts that are composed with the “OR” boolean operator. In the first part we included explicit terms referring to the concept of intelligent ERP. The second part was designed to capture the studies that discuss ERP systems in conjunction with advanced intelligent technologies, without explicitly using specific terminology. For this purpose, the proximity operator “NEAR/5” was applied between terms referring to Enterprise Resource Planning systems and terms related to advanced technologies. This approach is particularly relevant because in our case, the technological evolution precedes the consolidation of consistent academic terminology and authors use different expressions to describe novel concepts.

The final search and data extraction were performed on March 6, 2026 and returned a dataset of 566 papers with a publication date between January 01, 2015 and December 31, 2025.

We retained only the papers whose subject category matched the research topic. The included categories are: “Computer Science Artificial Intelligence”, “Computer Science Information Systems”, “Computer Science Interdisciplinary Applications”, “Management” and “Business”. Following this refinement, we were left with 82 results.

We screened the titles, abstracts, and bibliographic metadata to assess their relevance to the topic of intelligent ERP systems. We only included the studies that addressed ERP systems enhanced with intelligent capabilities, such as AI-enabled, smart, or cognitive ERP systems. Publications were excluded if ERP systems were not a central focus of the study. After the screening process, a dataset of 45 articles remained. The dataset was then exported in plain text format to serve as base for the bibliometric analysis.

The study rigorous selection process is summarized in the PRISMA flow diagram presented in Figure 2.

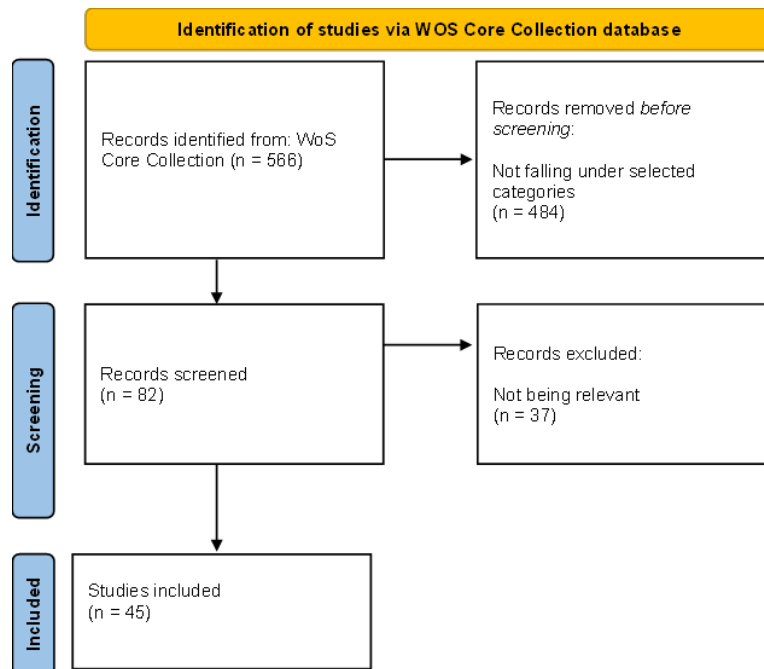


Figure 2. PRISMA flow diagram of the iERP literature selection process

Source: Author’s own research.

To support the quantitative examination of the dataset, we employed two complementary software tools: VOSviewer and the Biblioshiny web interface of the Bibliometrix R package. We used VOSviewer for the construction and visualization of bibliometric maps, such as keyword co-occurrence structures, facilitating the identification of thematic clusters within the research field. Biblioshiny was used for the exploration of descriptive indicators, such as annual scientific production, author's most relevant countries, author's most relevant affiliations, most cited papers, word cloud or keyword co-occurrence.

Results and discussions

Figure 3 illustrates the temporal evolution of research output related to intelligent ERPS systems over the last decade (2015-2025) based on publishing year. The results illustrate a clear upward trend in the number of publications, showing that the interest in the integration of intelligent technologies within ERP solutions is growing. While earlier years exhibit modest publication activity, a noticeable acceleration can be observed in more recent years, suggesting that intelligent ERP systems have gained increasing relevance in both academic research and practical applications as a response to advances in intelligent technologies and digitalization initiatives. The steep rise in publications since 2023 confirms that intelligent ERP systems represent an emerging and increasingly relevant research area, reflecting their growing importance in enterprise-wide decision-making.

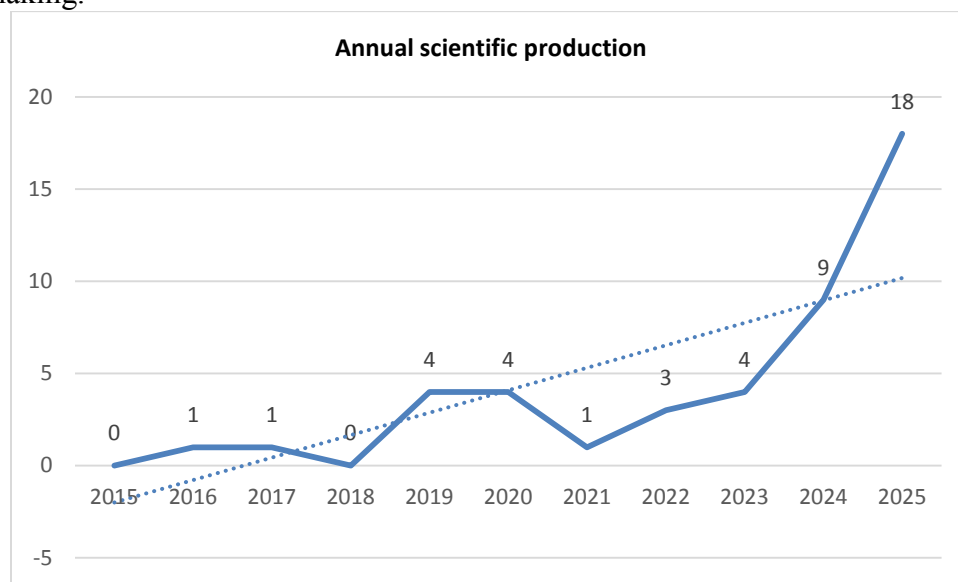


Figure 3. Annual scientific production on intelligent ERPs in 2015-2025

Source: Author's own research.

The corresponding author's countries plot was generated in bibliometrix, with a configuration to show the first ten countries by number of published papers.

Figure 4 presents the geographical distribution of research output. Romania is the leading country having the highest number of published articles. Other major contributions include China, Germany, USA, India and Australia. Romania's leadership highlights the growing role of Eastern European research institutions in digital transformation and enterprise systems research, particularly through applied and interdisciplinary studies.

The diversity of contributing countries reveals the global relevance of intelligent ERP systems and indicates that research efforts span both technologically advanced economies and emerging markets.

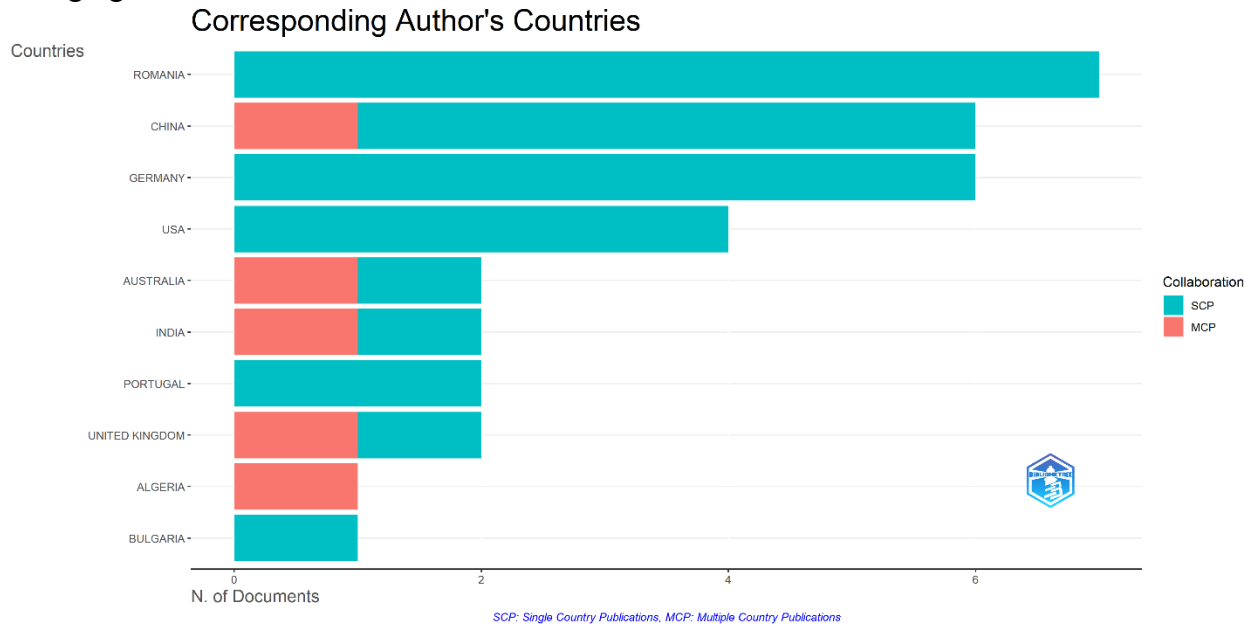


Figure 4. Global research contribution to intelligent ERPs by country of origin

Source: Author's own research.

The most relevant affiliations graph was generated in bibliometrix, using the affiliation name disambiguation configuration and a number of affiliations of ten.

As shown in Figure 5, research work on intelligent ERP systems is supported by a broad range of institutions. Institutional productivity rankings confirm the Bucharest University of Economic Studies as the leading research entity in the dataset, with a contribution of 6 articles. This is followed by the Guangdong University of Foreign Studies with 3 articles and the SAP Res and Dev department with 3 articles. The dispersion of research output across a wide range of universities, research institutes and governmental organizations underscores the interdisciplinary nature of intelligent ERPs. The presence of institutions from different geographical regions further confirms the international scope and collaborative character of the field.

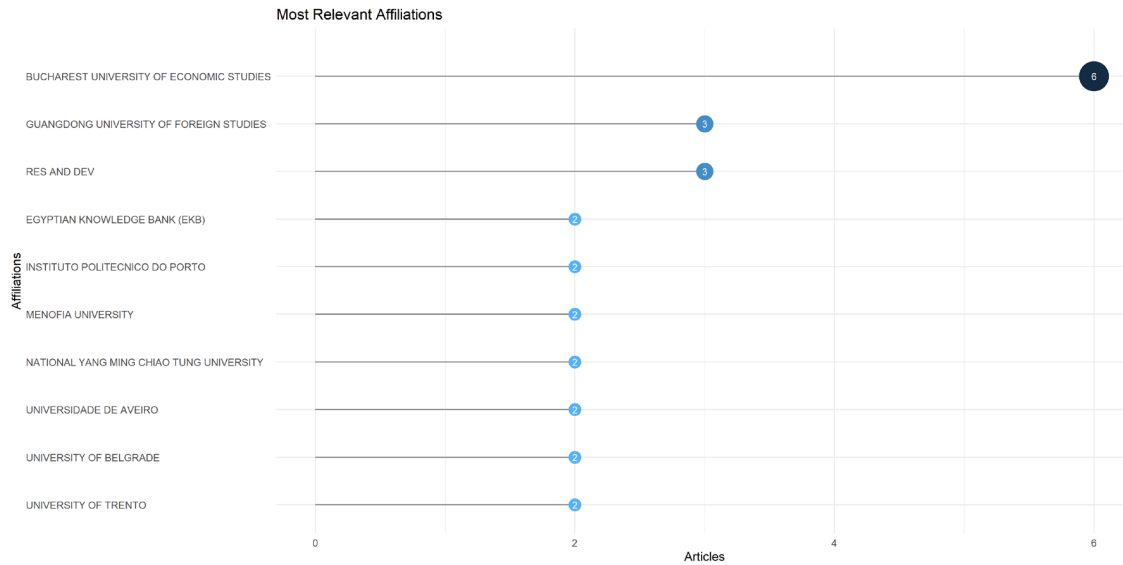


Figure 5. Most relevant affiliations in intelligent ERPs research

Source: Author's own research.

We generated the most global cited documents table in bibliometrix by selecting the “total citations” measure and configuring the number of documents value to ten.

Table 1 depicts the most influential publications within the field, by listing the top cited papers along with their citation metrics. The study by (Gupta et al., 2019) is the most cited work in the dataset, with 91 total citations, followed by (Gonçalves et al., 2022) with 44 total citations and (Ruhi, 2016) with 34 total citations. Although not exclusively focused on intelligent ERP systems, these highly cited studies tend to address foundational topics iERPs are built on top of, including Industry 4.0, predictive analytics, cloud systems, artificial intelligence. Rather than focusing on ERP functionalities in isolation, they examine the integration of advanced digital technologies that extend ERP capabilities toward real-time data processing, predictive analysis and system-wide coordination.

Table 1. Most cited papers in intelligent ERPs research

Paper	DOI	Total Citations	Norm. TC
Gupta S, 2019, Manage Decis	10.1108/MD-06-2018-0633	91	3.87
Gonçalves Mja, 2022, Informatics-Basel	10.3390/informatics9010019	44	2.49
Ruhi U, 2016, Int J Manag Educ-Oxf	10.1016/j.ijme.2016.04.006	34	1.00
Al Ghatrifi Mom, 2023, Comput Educ-Artif In	10.1016/j.caeai.2023.100144	21	3.82
Majstorovic V, 2020, Ifip Adv Inf Comm Te	10.1007/978-3-030-57993-7_33	12	3.69
Mahapatra Bs, 2025, Expert Syst Appl	10.1016/j.eswa.2024.125675	8	4.39
Hajipour V, 2025, Expert Syst Appl	10.1016/j.eswa.2024.125565	7	3.84
Akinbamini E, 2025, Logistics-Basel	10.3390/logistics9010008	6	3.29
Wang S, 2022, Enterp Inf Syst-Uk	10.1080/17517575.2020.1722254	5	0.28
Tortorella Gl, 2025, Total Qual Manag Bus	10.1080/14783363.2025.2498411	4	2.19

Source: Author's own research.

The word cloud visualization was produced using all keywords field and a number of 40 words. A list of synonyms was provided to avoid duplication caused by variations in terminology (e.g: ai = artificial intelligence, ERP = enterprise resource planning, IoT = internet of things).

The word cloud visualization in Figure 6 provides an overview of the most frequently occurring keywords within the dataset. The most prominent terms in the visualization: ERP, AI, business, industry 4.0, and digital transformation represent the foundational pillars of the literature.

Surrounding the core is a tier of keywords defining technological enablers of the intelligent ERPs: machine learning, IoT, deep learning, blockchain, conversational ai, cloud ERP, technology, software integration, generative ai. Business operational and strategic terms also have a central position in the word cloud: business, business applications, optimization, collaboration, organizational performance, accounting, scalability, operations, management.

The coexistence of data-driven technologies and business-related keywords points to a convergence between technical innovation and organizational decision-making. Rather than emphasizing one dimension over the other, the word cloud shows that intelligent ERP research consistently links technological advancement with business value creation.

The prominence of terms related to implementation, operations, performance and optimization further suggests that research interest extends beyond conceptual or architectural considerations toward practical deployment and use within organizations. Intelligent ERP systems are therefore examined in terms of how they are designed, integrated and managed across business processes.



Figure 6. Word cloud of keywords in intelligent ERPs research

Source: Author's own research.

A map was created in VOS Viewer based on bibliographic data. The co-occurrence analysis was selected, based on full counting of all keywords. A thesaurus file was provided to merge synonymous terms and normalize variations in terminology, thereby reducing fragmentation in the keyword network and improving the clarity of the visualization (e.g.: artificial intelligence = AI, enterprise resource planning = ERP, erp system = ERP). A minimum number of 2 occurrences was selected.

The thematic structure of the research field is explored through the keyword co-occurrence network map shown in Figure 7. As depicted in the figure, several well-defined thematic clusters can be identified, each corresponding to a major research area in the domain.

At the heart of the map, ERP and AI are the anchoring points of the graph. Their central placement and large size also indicate that they are the most frequently occurring and highly

connected concepts. The physical overlapping between these terms signifies that they are no longer separate entities, but the AI is embedded directly into the ERP core to drive automation.

The red cluster represents the foundational context and environmental catalysts that drives the adoption and implementation of intelligent ERP systems, particularly through themes such as digital transformation, Industry 4.0, algorithms, implementation, operations, optimization, and supply chain integration. The yellow cluster represents the core domain of ERP systems and their direct integration with artificial intelligence technologies. Key concepts within this cluster include erp, ai, deep learning, accounting, simulation, digital. This cluster emphasizes how AI techniques such as deep learning and simulation are increasingly being applied to enhance ERP functionalities. The green cluster represents the technical and business operational framework with topics such as: business ai, enterprise ai, decision support systems, ai development, ai operations. The pragmatic oriented purple cluster represents how the intelligent ERP adoption translate into actual business results. Within this group, the deployment of cloud ERP architectures delivers the high-availability infrastructure required to maintain data accuracy. This technical alignment ensures that generative AI layers can reliably process business data to optimize organizational performance through precise, automated outputs. The blue cluster represents the technological infrastructure that supports intelligent ERP ecosystems. Key concepts in this cluster include technology, systems, collaboration, scalability, stability.

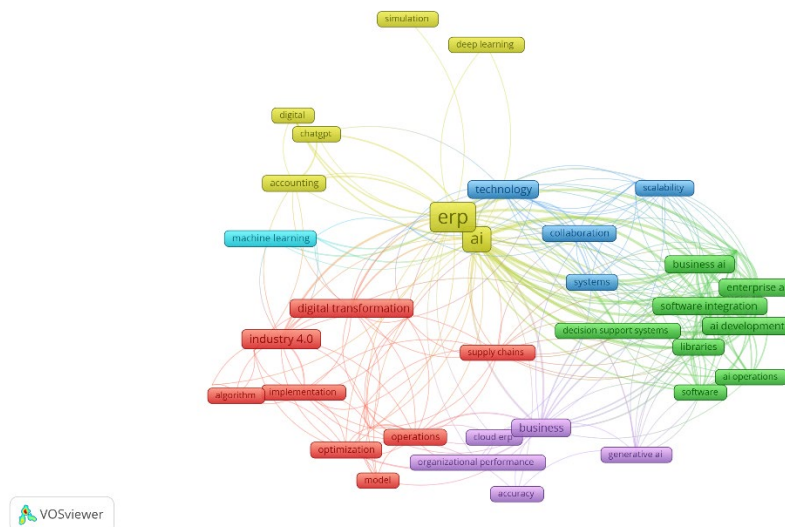


Figure 7. Keyword co-occurrence network in intelligent ERPs research

Source: Author's own research.

The interconnections among clusters show a high degree of thematic overlap. This adheres to the interdisciplinary nature of the research on intelligent ERP systems. The high degree of connectivity between the technical cluster, colored in green, and the foundational context cluster, colored in red, displays a link between the development of iERP and the strategic context of Industry 4.0. Similarly, the strong links between the yellow core and the blue infrastructure cluster show the reliance of advanced techniques like deep learning or simulation on the scalability and stability of the underlying system architecture. Ultimately, the network demonstrates that an intelligent ERP is an integrated environment where technical design and practical business needs are constantly influencing one another.

Prior studies frequently combine concepts from computer science, data engineering, organizational behavior and strategic management, reflecting the complex role of intelligent ERP systems as integrative platforms within modern organizations.

In table 2 we identify some of the most representative terms within each thematic cluster and relevant papers associated with them. By categorizing these representative terms alongside their relevant papers, Table 2 validates the study's earlier finding that intelligent ERP systems are not addressed as isolated solutions, but as enterprise-wide systems where advanced technical solutions meet practical business needs.

Table 2. Clusters' representative terms and relevant papers

Cluster	Representative terms	Relevant papers
Yellow	ERP, AI, Deep Learning	(Lin, 2020) (Sarferaz, 2025)
Blue	Technology, Systems, Collaboration, Scalability	(Akyuz & Ileri, 2025) (Akinbamini et al., 2025)
Green	Business AI, Enterprise AI, Decision support systems, AI operations	(Sarferaz, 2025) (Zhang, 2024)
Red	Digital transformation, Industry 4.0, Supply chain, Algorithms	(Gonçalves et al., 2022) (Majstorovic et al., 2020)
Purple	Cloud ERP, Generative AI, Organizational performance, Accuracy	(Basu & Jha, 2024) (Igna et al., 2020)

Source: Author's own research.

The combined analysis of keyword frequency and thematic clustering reveals a balanced distribution between technological and organizational research perspectives. A lot of research studies that explore how artificial intelligence, machine learning and Industry 4.0 related technologies are build and integrated in enterprise systems reveal the technical perspective of the iERP. Also, a substantial part of the studies focuses on organizational aspects such as system implementation, adoption, performance impact and managerial decision-making. Intelligent ERP systems deliver value through their inherently dual nature based on the advanced technological infrastructures and significant organizational transformation.

The bibliometric results point to a research field that is becoming increasingly structured and cohesive. We observed a strong positive publication trend, showing a rising academic interest, building on top of established work related to Industry 4.0 and data-driven technologies. In parallel, the keyword and cluster analyses reveal close connections between technological, organizational and strategic themes. Taken together, these findings indicate that intelligent ERP are enterprise-wide systems built on top of integrated modern technological solutions that can unlock clarity and agility for organizations.

Conclusion

This paper has presented a structured and comprehensive overview of the last decade of research in intelligent ERP systems. In response to the fragmented and interdisciplinary nature of existing research, we adopted a quantitative approach, using a PRISMA-guided bibliometric analysis. We extracted a dataset of 45 articles from the Web of Science Core Collection covering the period 2015–2025, and systematically mapped the intellectual structure, thematic evolution and research dynamics of intelligent ERP systems.

Based on the literature we found that research on intelligent ERP systems is primarily centered on the integration of traditional ERP architectures with advanced digital technologies that are associated with Industry 4.0, including Artificial Intelligence, Machine Learning, the Internet of Things and Cloud Computing. These technologies extend the capabilities of conventional ERP systems beyond transactional processing by enabling advanced analytics, predictive modeling, real-time data integration and adaptive process automation.

The evolution of scientific output in the given time window revealed consolidated academic interest in intelligent ERP systems and a sustained growth in recent years.

The analyzed research activity demonstrates a clear international scope, with significant contributions from Europe, Asia and North America, highlighting the global relevance of the topic. The analysis of keyword co-occurrence and thematic clustering confirmed the interdisciplinary character of the field, revealing clusters related to artificial intelligence, Industry 4.0 technologies, cloud-based ERP architectures and organizational aspects such as implementation, performance, optimization and digital transformation. The results of the bibliometric analysis are consistent with the main research directions identified in the literature review.

Despite its contributions, this study is subject to several limitations that we acknowledge. Specifically, our analysis was performed on publications exclusively indexed in the Web of Science Core Collection database, which may exclude relevant studies published in other academic databases. We propose that future research studies should address this limitation by extending the bibliometric analysis to additional databases, such as Scopus or IEEE Xplore, in order to capture a broader range of technical and applied studies. Future studies related to iERP can be undertaken. Using complementary review methodologies, including systematic literature reviews or meta-analyses, scholars could further strengthen the empirical grounding of the topic.

Acknowledgments

This paper was co-financed by The Bucharest University of Economic Studies during the PhD program.

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