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INTELLECTUAL CAPITAL AND ARTIFICIAL INTELLIGENCE AS DRIVERS OF COMPANY PERFORMANCE AND INNOVATION: A BIBLIOMETRIC ANALYSIS

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Purpose: This paper focuses on the intersection of intellectual capital (IC), artificial intelligence (AI), and company performance and innovation, which together constitute the dual dimensions of value creation (VC). It aims to map and interpret the scientific literature on these relationships and to identify dominant and emerging research directions.
Design/methodology/approach: The study applies quantitative bibliometric methods combined with qualitative literature synthesis. A systematic search of the Scopus database yielded 448 records, which were screened and refined to 129 peer-reviewed articles. Qualitative synthesis was then applied to identify key mechanisms linking IC, AI, and VC.
Findings: The results reveal a strong and rapidly growing scientific interest in the IC-AI-VC nexus. The literature most frequently co-evolves with research themes related to innovation and sustainability, digital transformation, knowledge management, organizational performance, environmental and green development, and managerial decision-making. The qualitative synthesis suggests that the interaction between IC and AI supports VC, primarily through learning processes, capability development and adaptive processes.
Research limitations/implications: Future research should develop empirical models testing causal mechanisms between IC, AI, and VC. Context-specific analyses examining firm-specific and institutional effects would enhance understanding of these relationships.
Practical implications: The findings highlight the importance for organizations to integrate investments in human capital, knowledge management systems, and artificial intelligence as mutually reinforcing elements of competitive strategy.
Social implications: Human capital is critical for successful AI adoption, highlighting workforce needs. As AI reshapes firms, policies for continuous learning, skills upgrading, and sustainable innovation are essential for societal adaptation.
Originality/value: This paper offers one of the first comprehensive bibliometric mappings combined with qualitative synthesis of the IC-AI-VC research domain, providing an integrated perspective for researchers, practitioners, and policymakers.
Keywords: corporate finance; value creation; intellectual capital; artificial intelligence; company performance and innovation.
Category of the paper: Research paper; Literature review.

1. Introduction

In the contemporary knowledge-based economy, the sources of sustainable competitive advantage are undergoing a profound transformation (Barney, 2010). Traditional tangible resources are no longer sufficient to explain differences in firm performance, market valuation, and innovation capacity. Instead, intangible resources, particularly intellectual capital, and advanced digital technologies have become central drivers of enterprise value creation (Inkinen, 2015; Madhani, 2012). At the same time, the rapid diffusion of artificial intelligence is fundamentally reshaping how knowledge is generated, processed, and converted into economic outcomes (Cockburn et al., 2019; Dwivedi et al., 2021). Recent empirical studies further indicate that artificial intelligence and digitally oriented organizational capabilities increasingly shape managerial decision-making and firms' innovation-related outcomes (Hofman, Wawak, 2025; Żukowska et al., 2025).

Although both intellectual capital and artificial intelligence have been extensively studied as separate research domains, their joint impact on firm performance and innovation remains conceptually fragmented and empirically under-systematized (Mention, 2012). Existing studies are dispersed across disciplines, employ heterogeneous methodologies, and frequently focus on isolated components of intellectual capital or specific technological applications, making it difficult to derive an integrated understanding of how intellectual capital and artificial intelligence jointly influence measurable firm outcomes (Inkinen, 2015; Van de Vrande et al., 2010).

This article addresses this gap by providing a comprehensive bibliometric mapping and qualitative synthesis of the scientific literature at the intersection of intellectual capital (IC), artificial intelligence (AI), and firm performance and innovation, which together constitute the dual dimensions of value creation (VC). To guide the analysis, the following research questions were formulated:

RQ1. What are the quantitative publication trends, citation patterns, and geographical characteristics that define the temporal and spatial evolution of scientific research on the Intellectual Capital, Artificial Intelligence, and Value Creation triad?

RQ2. Which journals constitute the most influential publication outlets within this research field, and what is the structure of the core scientific knowledge base supporting this domain?

RQ3. What dominant and emerging thematic clusters structure the current research landscape, and how do they differentiate the intellectual capital and artificial intelligence configuration from traditional intellectual capital theory?

RQ4. What are the key conceptual relationships, mediating mechanisms, and research gaps regarding how intellectual capital and artificial intelligence jointly shape value creation (encompassing performance and innovation)?

The study contributes to the literature in three principal ways. First, it reconstructs the conceptual structure and evolution of research on the intellectual capital, artificial intelligence, and value creation triad using advanced bibliometric techniques. Second, it identifies the dominant thematic clusters and emerging research fronts shaping this field. Third, it develops a qualitative synthesis that reveals key conceptual linkages, limitations of existing approaches, and under-explored research directions.

The article is structured as follows. Section 2 describes the data sources and bibliometric methodology. Sections 3 and 4 present the quantitative bibliometric results. Section 5 provides a qualitative synthesis of the literature focused on conceptual development, and identification of critical research gaps. The article concludes with a summary of key findings, limitations, and directions for further research.

2. Data and methodology

Bibliometric analysis was employed as a quantitative approach to examine a body of scholarly literature, map the intellectual structure of the field, identify influential works, and trace the evolution of themes over time (Broadus, 1987; Pritchard, 1969). In social sciences, bibliometrics helps reveal patterns such as keyword co-occurrence, detect research fronts and knowledge bases, and diagnose gaps that require further investigation (Donthu et al., 2021; Zupic, Čater, 2015). This study focused on a thematic synthesis of intellectual capital, artificial intelligence, and firm performance and innovation in order to highlight dominant and emerging topics and to identify underexplored links within the analyzed triad.

Table 1.
Literature selection and filtering process

Database	**Scopus**
Search	("intellectual capital" OR "human capital" OR "structural capital" OR "relational capital") AND ("AI" or "artificial intelligence" OR "machine learning") AND ("profitability" OR "market value" OR "value creation" OR "performance" or “innovation”)
Records generated after the search	448 records
Selection	Limit to: articles, final, English
Records generated after applying filters	224 articles
Title, abstract and keywords analysis	Articles excluded: AI/ML used as an analytical method, macro-level or educational perspective with no link to company perspective, no connection between the analyzed factors
Final record of articles for quantity and quality analysis	129 articles

Source: own study.

Table 1**.** summarizes the literature selection and filtering procedure, providing an overview of the search strategy, applied criteria, and the construction of the final dataset used in the bibliometric analysis. To conduct the study and identify relevant literature on the analyzed topics, the Scopus database was selected. It is considered the largest abstract and citation database of research literature in the world (Schotten et al., 2017). Scopus is also a valuable resource in the social sciences especially in the areas of business and management. Content is published according to rigorous selection rules overseen by an independent board of scientists, ensuring that only the highest quality sources are indexed. Scopus also offers advanced functionalities, and analysis tools with built-in bibliometric indicators, making it a high-quality source of bibliometric data for academic research, significantly facilitating literature reviews in particular (Baas et al., 2020).

The search query was performed on 16th September 2025. As the three analyzed concepts represent relatively recent and evolving research domains, the search query was intentionally formulated in a broader manner to capture diverse terminological variations and conceptual perspectives present in the literature. The search phrase was formed as follows: ("intellectual capital" OR "human capital" OR "structural capital" OR "relational capital") AND ("AI" or "artificial intelligence" OR "machine learning") AND ("performance" OR "innovation" OR "profitability" OR "market value" OR "value creation").

The term "intellectual capital" has been expanded in the search to include its main components: human, structural and relational capital. The reason for this expansion was that these three aspects are closely related to the topic of analysis and should be considered complementary. In many articles, the phrase "intellectual capital" itself did not appear in the keywords, titles, and abstracts, but its components were mentioned. Therefore, it was decided to expand this phrase, as all these IC elements should be included in this analysis as important. The concept of artificial intelligence was also expanded to include "machine learning", which can be treated as a practical synonym in the technological sense in the processes used by companies. The third aspect of the analysis was formulated as broadly understood performance and innovation and supplemented with phrases related to the profitability and market value of the company as a financial aspect.

The search string was applied to article titles, abstracts, and keywords and 448 records were identified. The dataset was then restricted to document type “article”, resulting in 257 records. Subsequently, non-final publications were excluded, resulting in the removal of 20 records. Finally the language filter was applied, selecting only English-language articles to enable content comparison and analysis. This resulted in a total of 224 articles, which were then exported for further processing.

Microsoft Excel was used for content analysis of titles, abstracts, and keywords to initially clean the data and refine the sample of analyzed articles. To select only topic-relevant articles, these elements were reviewed to verify thematic appropriateness. This thorough screening led to the exclusion of 95 irrelevant articles due to poor thematic fit. Such a substantial number of

articles eliminated from the research sample was determined by the following main factors: (1) use of AI or ML as a method of analysis and not the subject of the research itself; (2) a macroeconomic or educational perspective on the analyzed factors without any connection with firm operations; and (3) a lack of connection between the analyzed factors, specifically simple occurrence of keywords without a visible analysis of influences and dependencies. The exclusion decisions were made by applying these criteria independently to each article's title, abstract, and keywords. To ensure consistency of application, a random sample of 20 articles (approximately 9% of the screened dataset) was cross-checked, confirming full agreement with the applied protocol. The screening was conducted by a single researcher, which constitutes a methodological limitation acknowledged in this study. After applying these exclusion criteria, the final dataset comprised 129 thematically relevant articles.

The bibliometric study was conducted in RStudio with the Bibliometrix package and its web interface Biblioshiny. The analysis generated a comprehensive set of performance indicators and science mapping visualizations. Specifically, the study produced descriptive statistics on annual scientific production, citation structures, and source impact, including the identification of core journals based on Bradford's Law and leading publication outlets. Science mapping techniques were applied to construct keyword frequency distributions, keyword co-occurrence networks, thematic maps, and thematic evolution diagrams in order to identify dominant, emerging, and declining research themes. Additional analyses included trending topics visualization and the quantitative characterization of thematic clusters with respect to their centrality, density, and frequency. These outputs provided the empirical basis for both the quantitative mapping of the field and the subsequent qualitative literature synthesis.

3. Preliminary quantitative bibliometric analysis

This section presents the bibliometric results for the Scopus corpus on intellectual capital in the era of technology and artificial intelligence with a focus on links to firm performance and innovation. The analysis proceeds from global production dynamics to structural features of the knowledge base. First, publication trends over time are examined to situate the temporal evolution of the field. Next, the geographical distribution of research output is analyzed to highlight leading regions contributing to this research stream. The section then explores the structure of publication outlets through the identification of core journals and source concentration based on Bradford's Law.

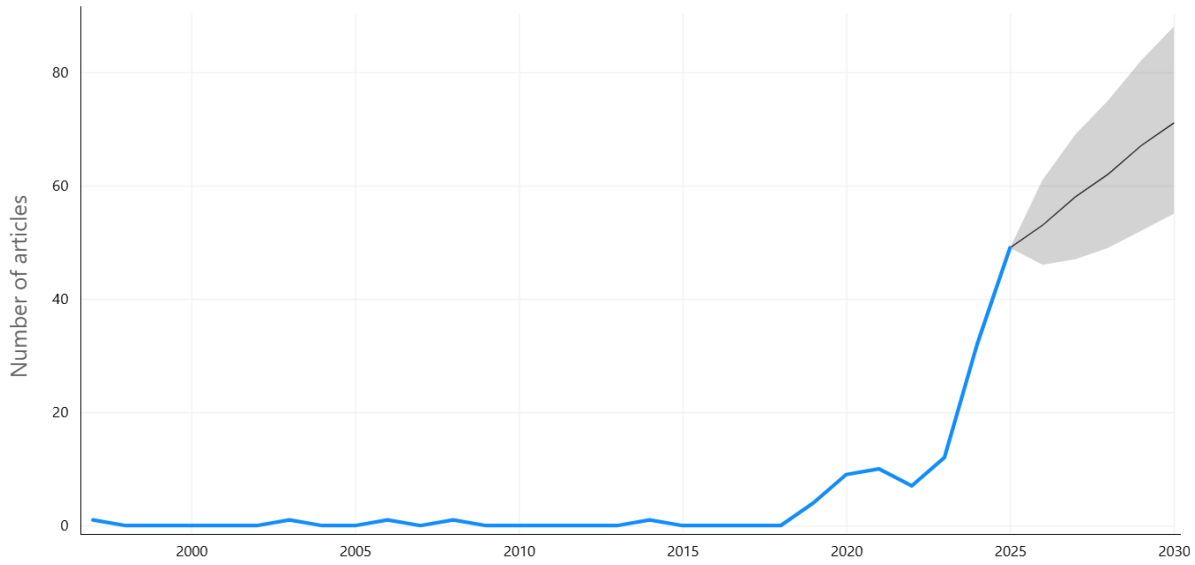

Figure 1. Annual publication output with 5 year forecast.

Source: own study based on Scopus data.

Research on the IC-AI-VC nexus was minimal before 2018, with many years in the 1990s and 2000s recording zero or one article (Figure 1). The first consistent growth begins in 2019 (4 articles), showing dedicated academic interest. This volume sharply increased from 2020 onward, rising from 9 articles in 2020 to 12 in 2023, and then dramatically peaking at 32 in 2024 and 49 in 2025. This surge corresponds with the massive adoption of AI technologies in business, confirming the relevance of this topic. Overall, the production figures emphasize the rapidly growing significance of the field. Projections for 2026–2030 indicate continued growth in annual publication volume, reflecting sustained and expanding scientific interest in the IC-AI-VC nexus. However, such forecasts should be interpreted cautiously, as they assume the persistence of recent trends and do not account for potential disruptions or shifts in research priorities.

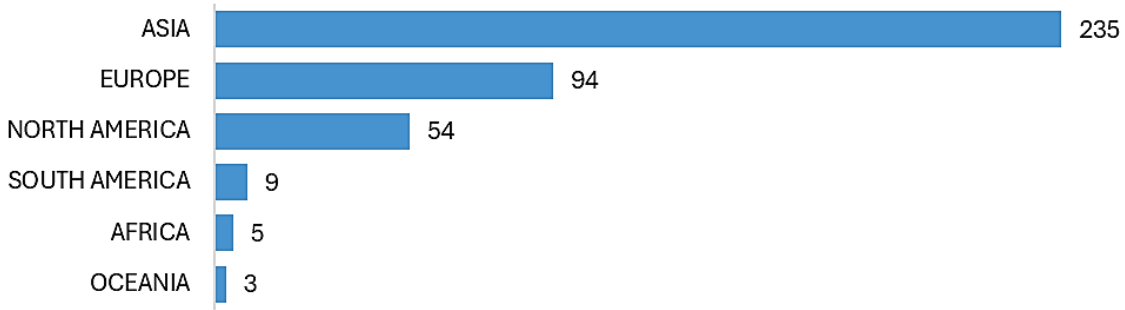

Figure 2. Continents' scientific production.

Source: own study (based on Scopus data, Bibliometrix package).

The geographical distribution of research (Figure 2) reveals a clear dominance of Asia in terms of scientific production within the analyzed field. This region substantially exceeds the contributions of Europe and North America, which occupy the second and third positions, respectively.

A closer examination of country-level contributions helps to explain this continental pattern. China emerges as the most productive contributor with a scientific output of 147, followed by the United States (39), India (26), and Romania (20). The concentration in China and India largely explains Asia's continental dominance. Within Asia, Malaysia (15), Indonesia (9), and Saudi Arabia (8) provide additional contributions, while outside the region, Canada (10) and Italy (8) represent the most active contributors in their respective continents.

Despite ranking second at the continental level, Europe's scientific production remains approximately 2.5 times lower Asia's. Moreover, the European research landscape appears more dispersed, with output distributed across a relatively large number of countries rather than concentrated in a small group of dominant research hubs. Notably, Poland does not appear in the Scopus dataset, which points to a clear gap in the existing literature and limits empirical and conceptual insights into the situation of Polish companies within the IC-AI-VC framework. The remaining continents exhibit only niche levels of participation in scientific production.

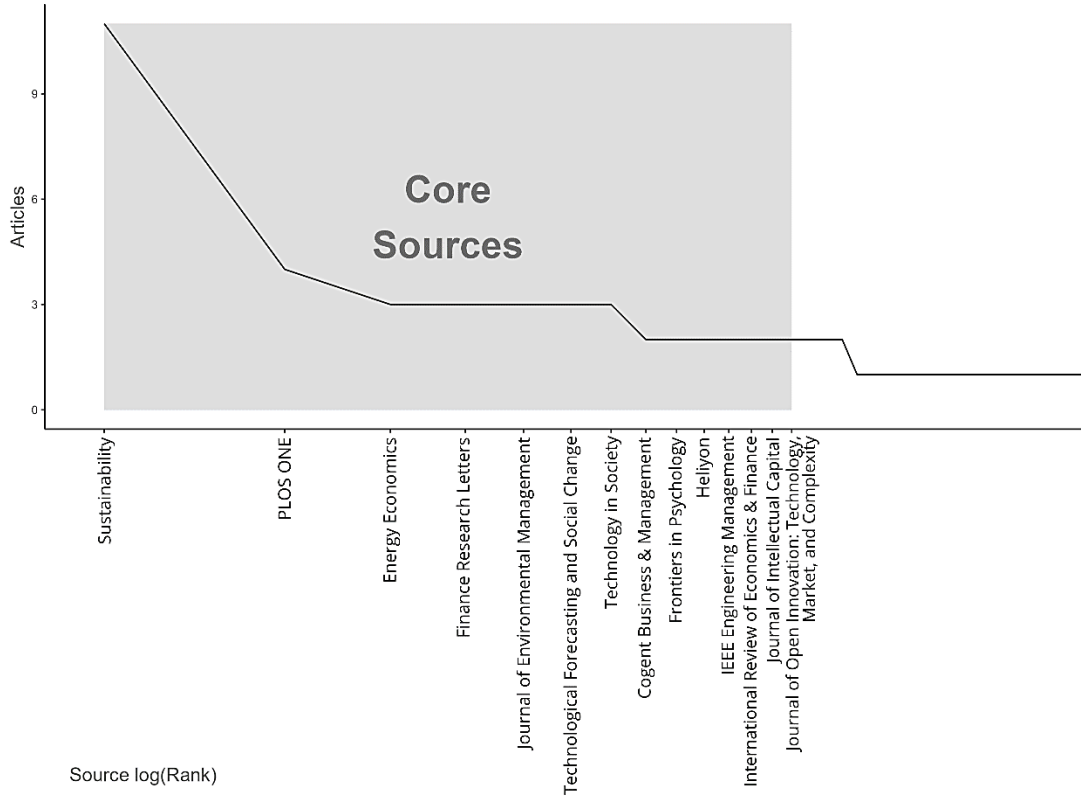

Figure 3. Bradford's Law - core sources.

Source: own study (based on Scopus data, Bibliometrix package).

Figure 3 presents the distribution of research output across journals according to Bradford's Law. The core sources zone (marked grey) identifies journals that contribute the most to the analyzed topic. Results show that there is a high concentration of scientific output within a limited number of journals. This pattern is consistent with the classical interpretation of Bradford's Law. A small group of leading sources accounts for a disproportionately high share of published articles and shapes both the research and communication in this field. These core

sources constitute the primary knowledge base for scholars and practitioners. Beyond the core zone, the number of published articles decreases while the number of contributing journals increases, creating a long tail of occasional publications.

4. Advanced quantitative bibliometric analysis

This section extends the preliminary results by providing a deeper quantitative examination of the intellectual structure of the research field. Specifically, the in-depth analysis explores key concepts, themes, and research streams to reveal the underlying organization and evolution of the literature.

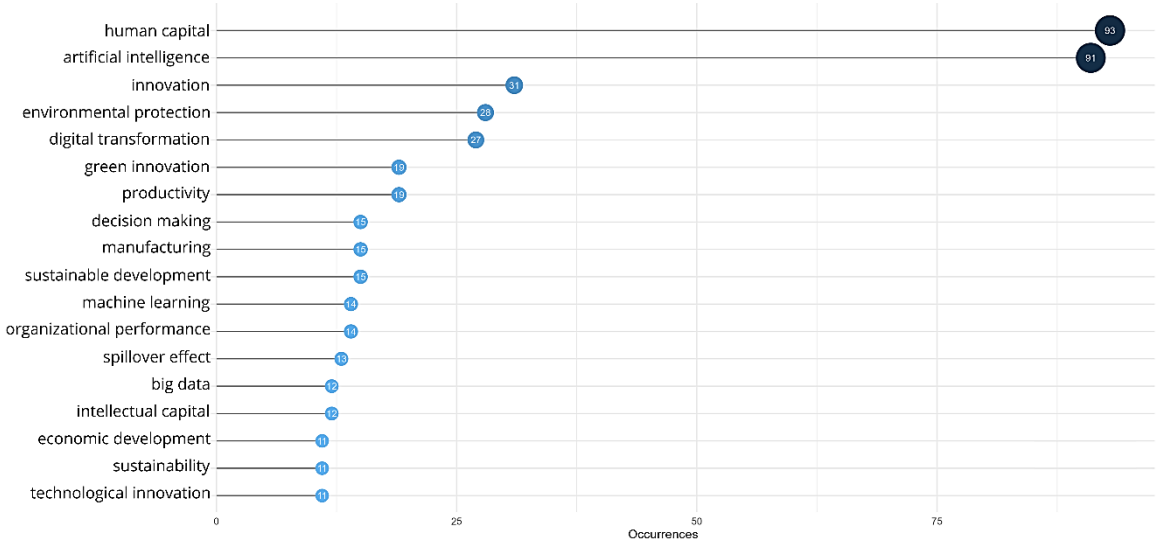

Figure 4. Most relevant words.

Source: own study (based on Scopus data, Bibliometrix package).

Keyword frequency analysis allows us to unveil the most significant conceptual elements which shape the intellectual focus of a research field. By showing the terms that are used most frequently across publications, it reveals the dominant research orientations and provides a preliminary basis for investigating the evolution and clustering of prevailing and emerging research themes. To enhance the interpretability and consistency of the results, a synonym list was used in the analysis to avoid fragmentation of key concepts due to closely related terms or different grammatical forms. Additionally, a standard keyword list was used to eliminate terms that were not substantively relevant to the thematic focus of this study.

Figure 4 shows the keywords that were the most significant in the analyzed corpus and are ranked according to their frequency of occurrence. The overwhelming dominance of human capital (93 occurrences) and artificial intelligence (91 occurrences) - substantially exceeding all other terms - reveals a clear human-centric orientation in the literature. This pattern suggests

that AI is most often conceptualized not as an autonomous technological factor, but as a mechanism that interacts closely with employee skills, knowledge, and competencies.

Beyond the dominant dyad of human capital and AI, the keyword distribution reveals three distinct thematic clusters. First, innovation-related terms (innovation: 31, green innovation: 19, technological innovation: 9) and sustainability concepts (environmental protection: 28, sustainable development: 15, sustainability: 9) form a coherent stream linking AI adoption to broader societal and environmental outcomes. Second, operational and performance-oriented keywords (productivity: 19, decision making: 16, manufacturing: 16, organizational performance: 13) emphasize efficiency gains and strategic decision-making processes. Third, the emergence of digital transformation (27), machine learning (13), and big data (12) signals growing attention to the broader technological ecosystem surrounding AI implementation. In general, the keyword distribution reveals the existing research on the IC-AI-VC triad is conceptually rooted in human capital and innovation outcomes, while more integrative or financially explicit perspectives remain underexplored.

Identifying the frequency of keywords is a way of showing the importance of one concept over the others. Yet, it does not bring out the connections between these concepts within the field's intellectual structure. Accordingly, the next analysis looks for patterns of co-occurrence and thematic structures of keywords to identify dominant research clusters. This co-occurrence approach also allows us to reveal the interdependencies between these clusters, providing deeper insight into the conceptual structure of the research field.

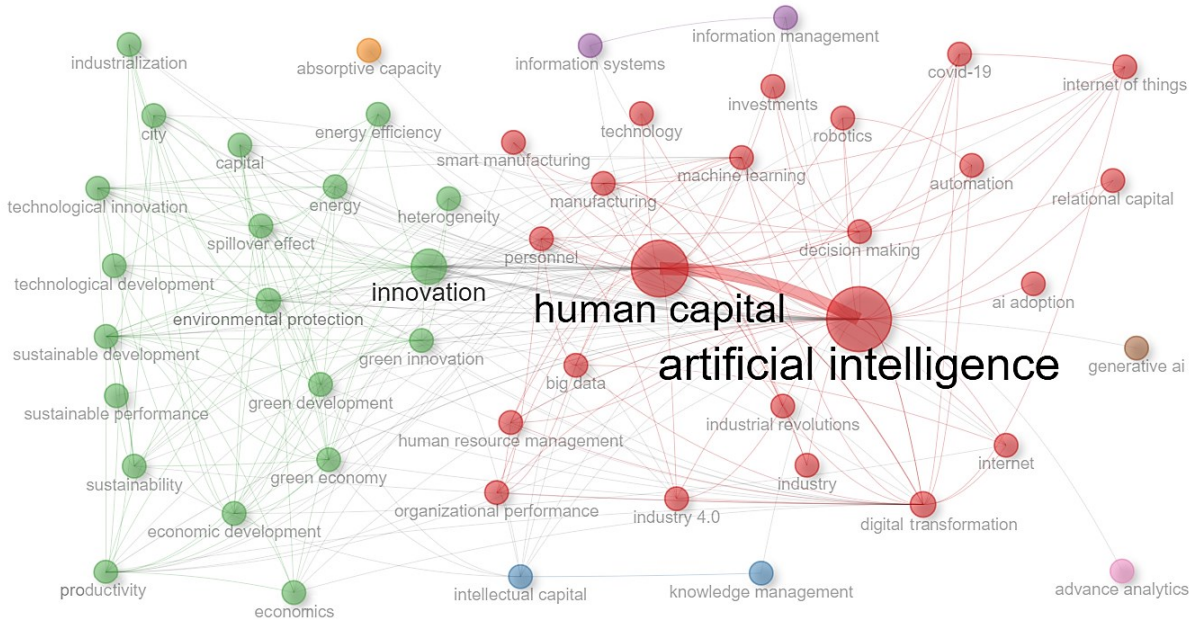

Figure 5. Keyword co-occurrence network.

Source: own study (based on Scopus data, Bibliometrix package).

Figure 5 reveals two main thematic clusters concentrating the majority of co-occurring keywords, alongside five smaller peripheral groups. The largest cluster (red) centers on the human capital-artificial intelligence nexus. Their central position confirms that research predominantly frames AI-driven transformation through the lens of human-related intangible resources. Notably, this cluster incorporates a broader technological ecosystem - including big data, Internet of Things, machine learning, smart manufacturing, robotics, and Industry 4.0, suggesting that AI is conceptualized not in isolation but as part of an interconnected digital infrastructure. Human resource management terms (personnel, decision making) further reinforce the cluster's human-centric orientation. The appearance of relational capital (one of the three main components of intellectual capital) within this cluster is noteworthy, as it co-occurs with both human capital and artificial intelligence. The co-occurrence with organizational performance suggests that authors attempt to link these factors with firm outcomes.

The second main cluster (green) is anchored by innovation and exhibits strong alignment with the sustainability discourse. Keywords such as green innovation, green economy, green development, and environmental protection, as well as sustainable development and sustainable performance, form a coherent thematic stream. In the context of measuring progress, terms such as productivity, economic development, and technological development emphasize the focus on measurable progress and firm-level outcomes.

Among the smaller clusters, the blue cluster containing intellectual capital appears relatively peripheral compared to the dominant human capital cluster. The co-occurrence of intellectual capital with knowledge management suggests that holistic IC constructs are present but play a less central role in current research. The remaining minor clusters exhibit limited connectivity, pointing to niche or emerging research directions that are not yet fully integrated into the core thematic structure.

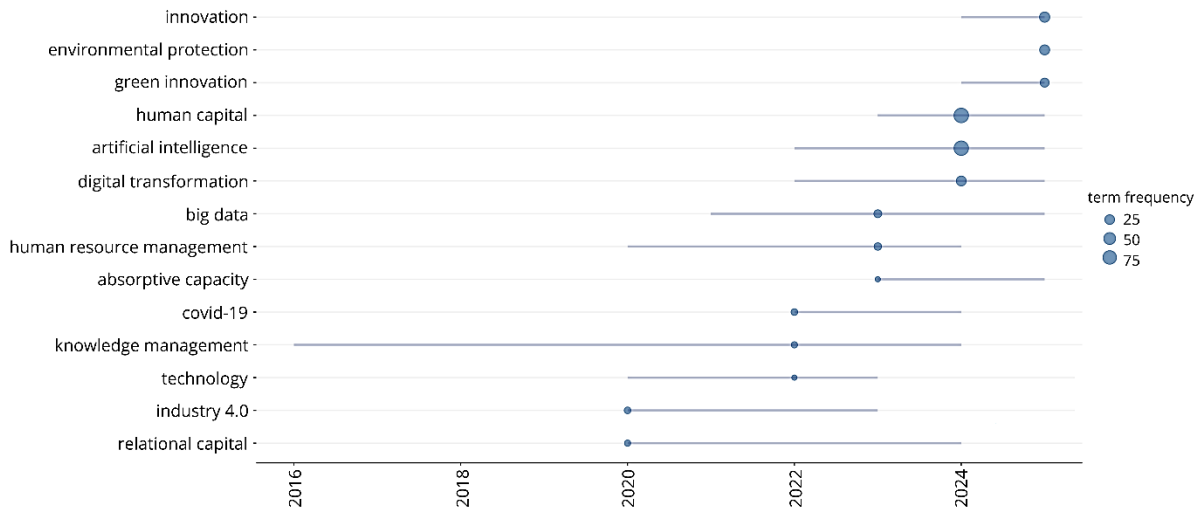

Figure 6. Thematic trends.

Source: own study (based on Scopus data, Bibliometrix package).

The analysis of trending topics reveals the research focus over time, allowing to identify what concepts have emerged in recent years. Figure 6 illustrates current importance of selected keywords highlighting research directions withing the analyzed literature.

The two core concepts, human capital and artificial intelligence, display sustained and increasing relevance over recent years, confirming their role as central and enduring elements of the evolving research landscape. A prominent position is also occupied by innovation, which represents a relatively recent focus within the analyzed literature and emerges primarily in the most recent years of the studied period. Among the reviewed articles, environmental protection and green innovation appear as new yet significant concepts, indicating the growing strength of ecological and sustainability-related trends.

A strong and consistently maintained trend is observed for knowledge management, which suggests that attention is directed not only toward the adoption of advanced technologies and the availability of employees with relevant skills, but also toward processes related to organizing, accumulating, and effectively using organizational knowledge. This reflects a rational approach that supports innovation and organizational efficiency through knowledge management within firms. In this context, the presence of human resource management further emphasizes that, beyond possessing human capital, increasing attention is paid to its management.

Among the remaining trend topics, concepts related to technological progress emerge. The most important are digital transformation and big data, alongside more general terms such as technology and Industry 4.0. Given the rapid pace of technological development, these specific topics may evolve quickly, reflecting ongoing innovations in the field.

An interesting trend is absorptive capacity, which underlines that companies must remain agile in a fast-changing environment and be able to recognize new external information and apply it in practice. It also points to a rising interest in organizational mechanisms that support the effective integration of AI technologies. This may serve as an important indication for those managing organizations that it is not only currently available resources that matter, but also the ability to monitor the environment in order to gain a competitive advantage.

The COVID-19 trend, although present for only a few years, is unlikely to remain a broadly discussed topic in the academic literature. However, it demonstrates that scholarly research responds to short-term external shocks. The final trending concept identified is relational capital, which, although less prominent, signals recent interest in the relational dimension of intellectual capital.

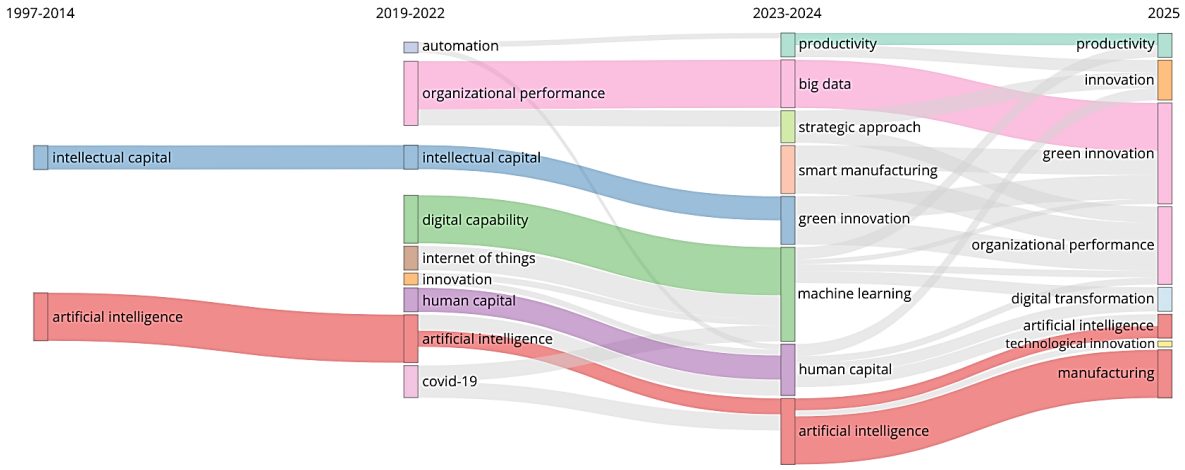

Figure 7. Thematic evolution.

Source: own study (based on Scopus data, Bibliometrix package).

Thematic evolution analysis (Figure 7) illustrates changes in the intellectual structure of the literature over different periods of time examining both continuity and shifts in research focus. The periodization reflects observed publication patterns: the pre-2014 period represents the emergence phase with sporadic publications, followed by a 4-year gap. The 2019-2022 period marks accelerated growth and thematic stabilization, while the subsequent shorter periods (2023-2024 and 2025) capture rapid thematic diversification driven by technological development. The accelerating publication rate in recent years may have contributed to greater thematic variability.

In the initial period (1997-2014), thematic activity is concentrated around two main concepts, namely intellectual capital and artificial intelligence. This reflects the relative novelty of the topic, as authors were only beginning to introduce these concepts into academic publications. Thematic diversity increases markedly in the period 2019-2022, during which thematic expansion and diversification can be observed. New topics emerge from a technology- and capability-based perspective. Beyond intellectual capital, its component human capital gains importance. Authors also introduce topics related to organizational performance and innovation. Moreover, technology-related themes gain prominence, including digital capability, artificial intelligence, Internet of Things, and automation. In the years 2023-2024, the thematic structure becomes more technologically specialized. The themes evolve toward machine learning, big data, and smart manufacturing, while at the same time sustainability-related concepts, such as green innovation, gain importance. The most recent publications emphasize an outcome-oriented approach through terms such as organizational performance and productivity. Alongside this, there is a growing focus on new ideas and innovations, including green innovation, technological innovation, and digital transformation.

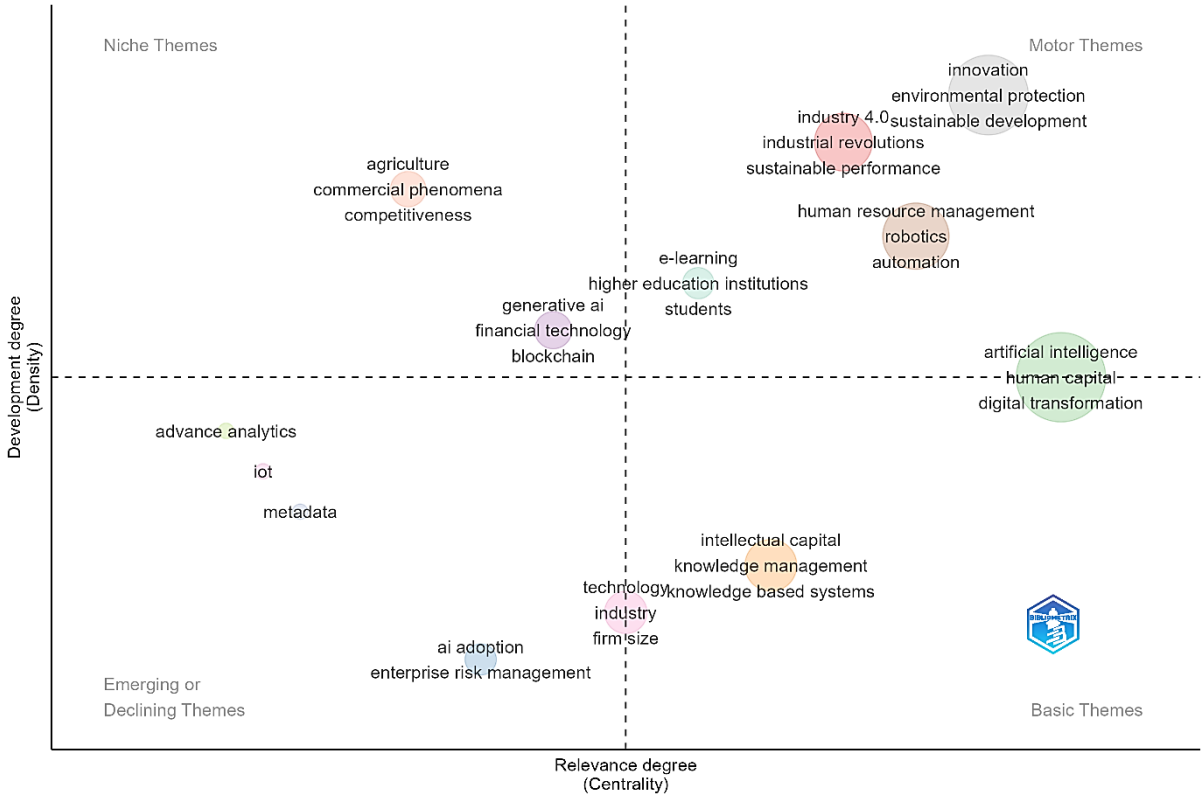

Figure 8. Thematic map of research themes.

Source: own study (based on Scopus data, Bibliometrix package).

Figure 8 presents the thematic map of the analyzed literature. These results allow us to assess the structural position and the relative importance of individual themes within the research field. The basic themes quadrant includes artificial intelligence, human capital, and digital transformation, which exhibit high centrality and medium density. This classification confirms their role as fundamental elements and reinforces their position as core concepts within the literature. Themes such as intellectual capital and knowledge management occupy a position of moderate density and lower centrality, indicating their continued presence in the research field, but a decreasing dominance as independent areas of investigation.

Within the motor themes quadrant, authors frequently refer to currently popular and topical issues, which can be described as trend-driven themes, such as environmental protection, sustainable development, and sustainable performance. In the short term these topics may act as key drivers of publication activity. However, themes that are widely discussed at present often tend to lose momentum over time as their novelty diminishes and research attention shifts to new areas. A second stream within the motor themes relates to technological transformation, including Industry 4.0, industrial revolutions, and innovation. In addition, the presence of robotics and automation in combination with human resource management may indicate growing scholarly interest in the substitutability of human resources by automated systems.

Emerging or declining themes such as AI adoption, advanced analytics, Internet of Things, and metadata display low centrality and density, pointing to research areas that are either at an early stage of development or losing prominence. In this case, these themes appear to have greater potential for emergence, as they reflect current technological aspects that may be further explored and analyzed by a broader group of researchers.

Finally, niche topics such as agriculture and competitiveness are characterized by high density but low centrality, suggesting specialized and internally coherent research streams with limited integration with the broader field. Overall, the combined data from the thematic map and quantitative cluster characterization indicate a growing focus of the research area on integrated, technology-driven, and performance-oriented topics, with innovation and sustainability being key drivers of thematic consolidation within the IC-AI-VC framework.

5. Qualitative literature synthesis

Following the quantitative mapping of the scientific field, this section provides a qualitative synthesis of the literature aimed at interpreting the main thematic structures identified by the bibliometric analysis, with particular emphasis on highly cited and thematically relevant contributions.

5.1. Intellectual capital, company performance and innovation

The qualitative analysis of the literature reveals a strong and consistent consensus that intellectual capital constitutes a fundamental driver of firm performance and innovation. Across diverse empirical contexts, intellectual capital is conceptualized as a multidimensional strategic resource whose economic value emerges primarily through its ability to enhance organizational capabilities, competitive positioning, and long-term value creation (Chen et al., 2005; Inkinen, 2015; Tan et al., 2007). Rather than functioning as an isolated asset, intellectual capital operates through complex internal mechanisms that shape how firms generate, apply, and renew knowledge in dynamic competitive environments.

The reviewed studies indicate that the relationship between intellectual capital and firm performance is rarely linear or purely direct. Instead, its impact is typically mediated through organizational learning, capability development, and innovation processes (Clarke et al., 2011; Hsu, Fang, 2009). Human capital emerges as the most influential component, as employee knowledge, skills, and competencies represent the primary source of knowledge creation and strategic flexibility. Empirical evidence further suggests that investments in human capital exhibit delayed effects on financial outcomes, implying that the value of intellectual capital unfolds over time rather than producing immediate performance gains (Clarke et al., 2011; Maditinos et al., 2011; Tan et al., 2007).

In contrast, the contributions of structural and relational capital display greater variability across studies and contexts. While structural capital provides the institutional infrastructure required to codify knowledge and stabilize organizational routines, its direct association with short-term financial performance is often weak or statistically insignificant, particularly when significant implementation costs are involved (Clarke et al., 2011; Hsu, Fang, 2009). Relational capital, by facilitating access to external knowledge, partners, and markets, strengthens innovation performance and new product development, yet its financial impact remains highly contingent on industry characteristics and market maturity (Chen et al., 2005; Tan et al., 2007).

A particularly robust finding across the literature is the central role of intellectual capital in driving innovation outcomes. Both human and relational capital enhance innovation performance primarily through the mediating influence of organizational learning capability, which converts dispersed knowledge resources into commercially viable outputs (Hsu, Fang, 2009). This evidence underscores that intellectual capital does not create value automatically, but requires deliberate managerial coordination and strategic integration to translate intangible resources into sustainable competitive advantage.

Despite the extensive body of empirical evidence, the literature remains fragmented regarding the precise mechanisms through which different components of intellectual capital interact to influence both financial performance and innovation. Many studies focus on isolated components or short-term performance indicators, leaving unresolved questions concerning the long-term dynamics of intellectual capital accumulation, cross-component complementarities, and contextual moderators.

5.2. Intellectual capital and artificial intelligence

The reviewed literature consistently portrays the relationship between intellectual capital and artificial intelligence as both interdependent and mutually reinforcing. Intellectual capital is widely recognized as a foundational resource that enables firms to successfully develop and implement artificial intelligence technologies, particularly in the form of advanced data analytics and AI-driven systems. At the same time, artificial intelligence reshapes the structure and economic role of intellectual capital by transforming how organizational knowledge is created, codified, and exploited for competitive purposes (Abdelfattah et al., 2024; Chen, Chen, 2022).

Empirical evidence indicates that high-quality human capital is a critical prerequisite for the effective development and use of AI capabilities. Skilled employees are essential for designing, interpreting, and strategically applying AI solutions, while continuous learning and upskilling determine the firm's ability to absorb and exploit new technological opportunities (Abdelfattah et al., 2024; Chen, Chen, 2022). As a result, the deployment of artificial intelligence does not reduce the importance of human capital but instead shifts its role toward more advanced cognitive, analytical, and decision-oriented functions (Shaffer et al., 2020).

Structural capital plays a complementary role by providing the organizational infrastructure necessary for AI integration. Flexible systems, knowledge codification mechanisms, and efficient internal processes facilitate the diffusion and scalability of AI-based tools within the firm. Without adequate structural capital, the benefits of AI adoption remain fragmented and difficult to sustain. Relational capital further strengthens this process by enabling firms to access external expertise, technological partners, and market knowledge that support AI development and commercialization (Abdelfattah et al., 2024; Chen, Chen, 2022).

The interaction between intellectual capital and artificial intelligence is dynamic rather than static and recursive. Investments in human capital lead to the creation of AI-based solutions, which are subsequently embedded into the organization as elements of structural capital. This transformation, in turn, generates new demands for skills and competencies, reinforcing the continuous evolution of human capital within the firm (Dal Mas et al., 2019; Popkova, Sergi, 2020). In this sense, artificial intelligence both depends on and reshapes intellectual capital, forming a feedback loop that progressively alters organizational structures and strategic capabilities.

Collectively, the literature suggests that intellectual capital and artificial intelligence should not be treated as separate drivers of firm performance, but rather as an integrated system of intangible resources and technological mechanisms that co-evolve in response to competitive and environmental pressures.

5.3. Artificial intelligence, company performance and innovation

Artificial intelligence is widely perceived as a major driver of firm performance and innovation, although the nature of this relationship is frequently described as complex and mediated rather than direct. Empirical studies consistently show that the adoption of artificial intelligence contributes to productivity growth, operational efficiency, and cost reduction by automating routine processes and enhancing the quality and speed of managerial decision-making (Dubey et al., 2020; Wamba-Taguimdje et al., 2020).

Rather than functioning solely as a technological tool, artificial intelligence is conceptualized as an organizational capability that strengthens firms' dynamic capabilities and their ability to adapt to volatile market environments. The reviewed evidence suggests that AI-based analytical capabilities improve internal integration, coordination between functional units, and the effectiveness of organizational processes, which in turn translate into superior performance outcomes (Bag et al., 2021; Chen, Chen, 2022). In this sense, artificial intelligence operates as a catalyst that transforms data into actionable knowledge, supporting more rational and informed strategic decisions.

Beyond operational efficiency, artificial intelligence is increasingly associated with innovation performance. The literature highlights that AI facilitates the generation of new ideas, accelerates product development, and enhances firms' capacity to recognize and exploit emerging opportunities. Recent studies further indicate that advanced AI applications

contribute to organizational resilience by strengthening knowledge bases and supporting firms in navigating uncertainty and external disruptions (Abbas et al., 2025; Kanbach et al., 2024). These effects suggest that the innovation-related benefits of artificial intelligence extend beyond immediate performance improvements and influence the long-term strategic positioning of the firm.

At the same time, the reviewed research emphasizes that the impact of artificial intelligence on performance is contingent upon organizational context. Without adequate managerial coordination, complementary resources, and employee competencies, AI investments may fail to generate the expected economic returns (Dubey et al., 2020). This reinforces the interpretation that artificial intelligence does not automatically produce value but requires alignment with organizational structures, skills, and strategic objectives.

Overall, the qualitative evidence portrays artificial intelligence as a transformative force that reshapes both performance mechanisms and innovation processes within firms. However, the literature offers limited insight into how these benefits unfold over time and how artificial intelligence interacts with other intangible resources in different organizational and industry settings.

5.4. Integrated conceptualization of the IC-AI-VC triad

The qualitative synthesis of the literature establishes strong, synergistic linkages across the core triad examined in this study. Intellectual capital functions as the fundamental enabling asset that determines a firm's capacity to adopt and leverage AI technologies. Simultaneously, AI serves as the transformative mechanism, converting existing human knowledge into codified structural assets, automating processes for efficiency, and demanding a shift in human skills toward high-value, interpretive functions (Popkova, Sergi, 2020; Shaffer et al., 2020). Ultimately, this interplay generates superior firm outcomes in the form of competitive advantage, enhanced profitability, accelerated innovation, and increased organizational resilience.

Despite these insights, the literature reveals that the precise nature of these relationships is complex, often relying on indirect mediating pathways, such as organizational learning capability (Hsu, Fang, 2009) or resilience (Abbas et al., 2025), rather than simple direct links. Moreover, empirical findings vary considerably across different economic and geographic contexts, while the rapid emergence of new AI tools continuously reshapes the research landscape. This complexity necessitates further research to clarify these dynamics.

6. Conclusions

The growing strategic importance of intellectual capital and artificial intelligence reflects a fundamental transformation of contemporary enterprises toward knowledge-driven and technology-enabled value creation. As firms increasingly compete through intangible resources and advanced digital capabilities, understanding how intellectual capital and artificial intelligence jointly shape performance and innovation becomes essential for both theory and managerial practice. This study responds to this need by offering a comprehensive mapping and qualitative synthesis of the rapidly expanding body of scientific research at the intersection of these domains, addressing four interconnected research questions.

The bibliometric results demonstrate a rapidly accelerating growth of scientific interest in the relationship between intellectual capital, artificial intelligence, and firm performance since 2019. This development corresponds with the large-scale adoption of artificial intelligence technologies in business practice. The qualitative synthesis further indicates that intellectual capital functions as a fundamental enabling resource for artificial intelligence adoption, while artificial intelligence operates as a transformative mechanism that reshapes knowledge utilization and organizational capabilities, ultimately influencing firm performance primarily through indirect and mediated pathways. The following sections address each research question in detail.

Regarding publication trends and geographical patterns (RQ1), the bibliometric results provide quantitative evidence that the IC-AI-VC research stream is undergoing rapid expansion and structural consolidation. After 2019, scientific output in this field increased sharply, reflecting a strong and growing scholarly interest in the analyzed problem. However, this expansion is geographically concentrated, with research output dominated by a small number of leading countries, particularly in Asia, Europe, and North America, while many economic regions and emerging markets remain relatively underexplored in this context.

With respect to publication outlets and core knowledge structures (RQ2), the publication activity is concentrated within a relatively small group of leading academic journals, which indicates the specialized and high-impact character of this research domain. This concentration follows Bradford's Law, with a distinct core zone of journals contributing disproportionately to the field's development.

Concerning thematic clusters and intellectual structure (RQ3), this expansion was accompanied by the formation of stable thematic directions that now structure the core of the literature. Beyond the central focus of the analyzed triad, the research is most frequently discussed in conjunction with broader thematic domains related to innovation and sustainability, digital transformation and technological change, knowledge management and decision-making processes, as well as environmental and green development perspectives. The identified thematic clusters reveal a clear internal organization of the field, with dominant

research streams focused on human-centered technological transformation, innovation performance, and sustainability-driven value creation, alongside emerging topics that continue to reshape the intellectual landscape. Notably, while human capital dominates the discourse, structural and relational capital dimensions remain underrepresented, indicating a conceptual imbalance relative to traditional intellectual capital frameworks.

Addressing the conceptual relationships and mediating mechanisms (RQ4), the qualitative synthesis indicates that the interaction between intellectual capital and artificial intelligence is widely interpreted as a central mechanism of organizational transformation and value creation, operating mainly through learning processes, capability development, and organizational adaptation rather than through simple direct effects on performance. Intellectual capital enables AI adoption while AI transforms intellectual capital through a dynamic and recursive relationship, converting human knowledge into structural assets and generating outcomes in innovation and competitive advantage. However, this relationship exhibits complexity and contextual variability, with empirical findings differing across industries, geographic contexts, and technological maturity levels, necessitating further integrative research.

Several methodological considerations should be taken into account when interpreting these findings. First, bibliometric techniques are designed to identify structural and thematic patterns in scientific knowledge rather than to test causal relationships. Moreover, such techniques reveal publication trends and conceptual structures but do not evaluate the quality of theoretical arguments or empirical evidence within individual studies. Second, the reliance on explicit keyword matching may exclude studies that examine IC-AI dynamics under different conceptual frameworks or employ domain-specific terminology that does not align with standard intellectual capital or artificial intelligence vocabulary. Third, the analyzed literature exhibits significant heterogeneity in how intellectual capital and artificial intelligence are operationalized, making cross-study comparisons complex and limiting the generalizability of findings. Furthermore, the study does not provide a systematic categorization of measurement approaches employed across the 129 analyzed articles. It could be developed to benefit from a structured coding of methodological designs.

Future studies should develop integrative empirical models that explicitly incorporate artificial intelligence into frameworks of intellectual capital and firm value creation. Improved measurement tools are essential to capture the contribution of AI to company value creation, particularly in financial terms. Comparative analyses across industries, institutional contexts, and countries would help clarify contextual differences in how intellectual capital and artificial intelligence jointly influence performance and innovation. Finally, increasing attention should be paid to ethical and social implications, including workforce transformation, skill displacement, and the long-term consequences of organizational transformation driven by AI adoption.

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