THE EVOLUTION OF PROCESS INNOVATION RESEARCH: A BIBLIOMETRIC ANALYSIS OF A MATURE AND EXPANDING FIELD

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Abstract
Process innovation has been seen as a key determinant for organizational performance, contributing to productivity, efficiency, flexibility, and sustained competitive advantage. Despite its strategic relevance, research on process innovation remains conceptually dispersed and fragmented across multiple research areas, such as innovation studies, operations management, sustainability, or digital transformation. To understand how researchers addressed this topic, the level of maturity of the field, gaps and future trends, we conducted a bibliometric analysis of process innovation research using 1,093 peer reviewed articles published between 1977 and 2026 and indexed in the Web of Science Core Collection. Employing performance analysis and science mapping techniques, the study identifies publication trends, influential authors and journals, collaboration patterns, and the field's intellectual, conceptual, and social structures. The findings reveal a mature but still expanding research domain characterized by strong performance orientation and increasing attention to more recent trends such as sustainability, green innovation, and digitalization themes. By systematically mapping nearly five decades of research, this study provides an objective overview of the evolution of process innovation research. Although the domain approaches maturity, gaps and new trends especially related to artificial intelligence signal new opportunities for expansion.
Keywords: Process innovation, Product innovation, Organizational performance, Digitalization, Innovation.
DOI: https://doi.org/10.24818/beman/2026.S.I.6-08

1. INTRODUCTION

Process innovation is commonly conceptualized as a firm-specific capability embedded in organizational processes, routines and delivery systems, by which organizations pursue continuous improvements and learning (Chatterjee et al., 2024). Empirical evidence consistently shows that process innovation exerts a positive and statistically significant effect on a firm's performance, highlighting thus its strategic importance. However, across the innovation literature, there is a consistent observation: product innovation has received more attention than process innovation, despite process innovation's central role in productivity growth, cost reduction, and operational competitiveness. As such, improvements in production processes, delivery systems, and operational routines have often been treated as secondary or complementary (Hervas-Oliver et al., 2016, 2018; Frishammar et al., 2013). In contrast to product innovation which has an imitable character, the performance effects of process innovation are harder to copy, as they are deeply embedded in a firm's specific capabilities and routines. From a resource-based perspective, process innovation is a critical mechanism through which firms translate environmental strategies, operational improvements, and technological investments into sustained cost advantages (Christmann, 2000). Taken together, existing research demonstrates the strategic importance of process innovation while simultaneously revealing a field characterized by conceptual dispersion, methodological diversity, and growth. By integrating performance analysis and science mapping approaches, our study aims to provide a comprehensive overview of the field's development, intellectual foundations, and highlight future research opportunities that will close existing gaps and open new directions derived from scale application of artificial intelligence.

2. LITERATURE REVIEW OF PROCESS INNOVATION: ORGANIZATIONAL FOUNDATIONS AND COMPETITIVE IMPLICATIONS

Process innovation can be defined as the introduction of new or significantly improved elements into an organization's production or service operations with the primary objective of enhancing efficiency or improving the quality of the outputs (Reichstein & Salter, 2006). Through time, process innovation has been conceptualized as a distinct and capability intensive form of innovation that reshapes how organizations transform inputs into outputs through changes in technologies, workflows and routines primarily to enhance efficiency, quality and adaptability. Across diverse theoretical traditions and empirical contexts, the literature converges on the view that process innovation is less market visible than product innovation but more deeply embedded in the structures of an organization and with higher potential of creating hard to copy competitive advantage.

An important body of research was initiated from the studies of Ettlie & Reza (1992) who affirmed that firms capture value from process innovation through internal and external integrations mechanisms that embed new technologies into coordinated structures. Hatch & Mowery (1998) showed that process innovation performance depends on deliberate learning efforts and managerial allocation of engineering resources rather than on automatic learning by doing effects. Complementing these views Kim et al. (2012) demonstrated that structured process management routines simultaneously stabilize operations and enable both incremental and radical process innovation. Together these studies conclude that process innovation rests on the firm's ability to organize learning, routines and coordination around production process.

A second stream of research situates process innovation within broader innovation system and emphasizes complementarities and persistence. Product and process innovation are demonstrated to have strong complementarities and to mutually reinforce themselves (Reichstein & Salter, 2006), while overall innovation persistence within a firm is a strong driver of long term process innovation (Martínez-Ros & Labeaga, 2009). However, a later research done by Hullova et al. (2016) demonstrated that complementarities between product and process innovation are contingent rather than universal, varying across projects and depending on technological trajectories, supply-chain rigidity and absorbative capacity. Collectively, these studies conclude that process innovation follows a path – dependent and context – specific trajectories rather than a single optimal model.

So far, research on process innovation positions it strategically, but structurally as a complex phenomenon, shaped simultaneously by demand heterogeneity (Adner & Levinthal, 2001), cost based pricing dynamics (Chenavaz, 2012), and higher order managerial capabilities (Robertson et al., 2012) rather than by technological opportunity alone. Connected to the managerial capabilities, an important aspect of process innovation is highlighted by Frishammar et al. (2011) who demonstrate that process innovation is especially vulnerable in the early "fuzzy front end" where leadership needs to calibrate conflicting interpretations and shared understanding, as the success of the process innovation depends on the collective sense making and alignment.

Several other contributions explicitly distinguish process innovation from product innovation in terms of knowledge sources, capabilities and performance effects. Un & Asakawa (2015) demonstrated that upstream R&D collaborations with suppliers and universities support process innovation, while collaborations with customers (which is more central to product innovation) do not and collaborations with competitors even hinder it. Hervas-Oliver et al. (2020) consistently demonstrated that process innovation follows a fundamentally different strategic and capability logic from product innovation, particularly in SMEs. Across multiple studies they showed that process innovation is primarily production oriented, generating improvements in cost efficiency, production flexibility and manufacturing capacity rather than direct sales or market outcomes (Hervas-Oliver et al, 2014, 2018). Same authors point out that process innovation is a necessary but not sufficient condition for enhanced organizational outcomes which arise instead from specific combinations of process innovation with firm size, technological expenditures or product innovation (Hervas-Oliver et al., 2018). Piening & Salge (2015) further demonstrate that process innovation mediates the relationship between innovation activities and financial performance. Chatterjee et al. (2022, 2024) look at process innovation as a central mechanism through which data, knowledge and leadership translate into firm performance and competitive advantage. Their findings show that data driven cultures and ecosystem scanning capabilities stimulate both product and process innovation, with process innovation proving a slightly stronger effect on firm performance. Extending this logic to multinational firms, they further demonstrate that knowledge sharing across subsidiaries enhances dynamic capabilities which are critical for process innovation.

Our bibliometric analysis revealed Li Shoude as one of the authors that has brought a significant contribution to the research on process innovation. Across multiple studies, Li consistently conceptualized process innovation as cost-reduction effort embedded in dynamic systems of learning, knowledge accumulation and demand feedback, demonstrating that firms tend to underinvest in process innovation (Li, 2018; Guo & Li, 2023).

A significant stream of authors have taken a more niched approach and evaluated how green process innovation as a central mechanism deliver sustained organizational outcomes. Early evidence by Chen et al. (2006) pointed to the conclusion that both green product and green process innovation contribute positively to competitive advantage, suggesting that environmental innovation can simultaneously enhance efficiency, differentiation, and corporate image. However, subsequent studies revealed important asymmetries between the two types. Chang (2011) showed that while corporate environmental ethics stimulate both green product and process innovation, only product innovation mediates the ethics – competitive advantage relationship, indicating that market – visible outcomes dominate in translating environmental values into competitive gains. In contrast, Tang et al. (2018) argue that green process innovation represents a more robust and stable path to firm performance when managerial environmental concern is explicitly high. Government green subsidies also help firms gain a better environmental reputation but only when these firms use the subsidy to improve production process not as a reactive solution at the end of the process (Xie et al., 2019). From a resource based perspective, El-Kassar & Singh (2019) demonstrate that green process innovation exerts a direct positive impact on organizational performance, whereas green product innovation primarily affects environmental outcomes and does not directly generate competitive advantage. Regardless of a company's strategy, both green process and product innovation are activated through leadership, especially transformational leadership and employee creative involvement (Begum et al., 2022). Overall, studies on green process innovation do not contradict more general process innovation studies but rather extent it by showing that similar organizational and capability based mechanisms operate under additional environment, institutional and ethical constrains. While general process innovation research focuses on efficiency, learning and embedded routines, green process innovation studies highlight how the same mechanisms are selectively activated by managerial environmental commitments.

In sum, research on process innovation has evolved into a coherent yet multi – dimensional field: it exhibits strong agreement on what process innovation is and why it matters, but there is a large differentiation on how it operates, where it makes the most sense, where it has the most impact, and under which conditions it generates value. In our opinion, the challenge for future research is therefore not to resolve the contradictions, but to integrate these parallel streams into a framework that can explain when, why and how different process innovation mechanisms dominate.

3. RESEARCH METHODOLOGY

The study adopts a mixed review design that integrates bibliometric analysis with a qualitative literature review to provide both a structural and interpretative understanding of the evolution of process innovation research. Bibliometric analysis is a rigorous approach used to explore and analyse large volumes of scientific literature through quantitative mechanisms, with the purpose of revealing a field's structure and evolution also highlighting emerging areas that would be difficult to discern through manual reviewing (Donthu et al., 2021). Ball (2021) in his handbook's introductory framework, links bibliometrics to the contemporary impossibility of any scholar to read or even scan the full volume of outputs in and beyond a discipline. Therefore bibliometrics is introduced as a response to this scale problem. Across multiple investigated sources, bibliometric analysis is consistently framed as (i) data-intensive (often hundreds or thousands of records), (ii) dependent on specific methodology (using established techniques), and (iii) dependent on the interpretation of the researcher (quantitative results require informed sensemaking to become theoretical or practical insight) (Donthu et al., 2021; Passas, 2024). While bibliometric outputs are quantitative, value is realised when researchers move from describing patterns to interpreting them; sensemaking transforms "raw" bibliometric information into defensible insights and implications for review studies (Lim & Kumar, 2024). Öztürk et al. (2024) claim that bibliometric analysis enables systematic and comprehensive understanding of a field's existing structure, its evolutionary nuances, clusters, and emerging trends, especially where traditional review methods struggle to keep pace with the large volume of data.

The bibliometric analysis was complemented by a narrative literature review that focused on the most influential and theoretically significant authorship. The review concentrated on highly cited authors and recurrent thematic streams identified through bibliometric indicators, including organizational capabilities, learning mechanisms, complementarities with product innovation, sustainability-oriented process innovation and emerging digital perspectives. The literature review was conducted using a theory-driven and impact-oriented selection strategy, explicitly informed by the results of the bibliometric analysis. Rather than pursuing exhaustive coverage, the review focused on conceptually influential and structurally central contributions that have shaped the evolution of process innovation research. Authors and articles were selected based on 4 complementary criteria derived from bibliometric outputs: (i) historiographic positioning, identifying foundational works that initiated and structured early research trajectories; (ii) canonical status referring to authors whose contributions constitute theoretical cornerstones; (iii) citation impact; (iv) relevance within core bibliometric clusters as identified through co-citation. Following the identification of relevant authors and works through bibliometric indicators, the corresponding full text articles were identified in Web of Science and retrieved from their original journals. Each selected publication was read in full. The review process involved the systematic extraction of key elements including: (i) conceptual definition of process innovation; (ii) theoretical frameworks and lenses applied; (iii) core explanatory mechanisms; (iv) reported organizational and performance outcomes. Extracted findings were then organized chronologically and thematically, allowing for comparison across authors and research streams, but also chronological evolution. The synthesis was organized around dominant theoretical streams including organizational capabilities, learning routines, comparisons between product and process innovation and sustainability-oriented process innovation. In conclusion, the literature review and bibliometric analysis were designed as mutually reinforcing components of the research methodology. Integrating the bibliometric analysis with the literature review strengthens the methodological rigor of the study by combining quantitative field level mapping with qualitative theory level interpretation.

4. PROCESS INNOVATION: A BIBLIOMETRIC ANALYSIS

One of the key starting points in bibliometric research is the construction of the document corpus, as its robustness, interpretability, and reproducibility are directly contingent upon the applied selection procedures (Ball, 2021; Zupic & Čater, 2015). Following the widely adopted framework of Donthu et al. (2021) and the detailed procedural guidance of Öztürk et al. (2024), current bibliometric analysis is organized into two main approaches: (1) performance analysis and (2) science mapping. The bibliographic corpus was extracted from the Web of Science Core Collection on April 2nd, 2026 for a selected period between 1977 and 2026. We used Web of Science Core Collection as it is known to be a database widely recognised in bibliometric methodology for its rigorous journal selection criteria and structured citation data, which support reliable performance analysis and science mapping. The initial retrieval was conducted using the Search Topic field with the keyword "process innovation", thereby capturing occurrences in titles, abstracts, and author keywords. To align the dataset with the specific research design of the study, the Boolean operator NOT was applied to exclude records containing the term "artificial intelligence." This exclusion was theoretically motivated by the intention to address AI-driven process innovation as a distinct analytical stream in a separate bibliometric investigation. Scholars caution that the intersection with analytically separable research domains may affect thematic structures and distort trend interpretation, particularly in rapidly evolving domains such as artificial intelligence (Ball, 2021; Marzi et al., 2025). The initial query yielded 3,978 records.

The dataset was restricted to articles only, as articles are considered to offer stable contributions to scholarly knowledge. Furthermore, subject category filters were applied to delimit the disciplinary scope of the analysis retaining Management, Business, Operations Research & Management Science, Engineering Industrial, Engineering Manufacturing. This selection reflects the interdisciplinary yet management centred nature of process innovation research. Only records indexed in SSCI and SCI-Expanded were retained, as these citation indexes are commonly regarded as qualitative sources due to their journal inclusion standards. In addition, the analysis was limited to English language articles. After applying all filters, the final corpus consisted of 1,093 articles, which constitute the empirical basis of the bibliometric analysis. The records were exported from Web of Science in plain text format, in batches of 500 articles, including full records and cited references. The subsequent analysis was conducted using the bibliometrix package, which provides validated tools for descriptive performance analysis, science mapping, and conceptual structure identification (Donthu et al., 2021).

Covering a timespan from 1977 to 2026, the dataset of 1,093 documents extracted was published across 207 scientific sources and authored by 2,596 scholars. The sustained expansion of the field is further evidenced by an annual growth rate of 7.33%, indicating continuous scholarly interest and continuous consolidation of process innovation as a distinct research stream. The span of the literature is reinforced by a substantial reference base of 49,838 cited works. From a collaboration perspective only 135 documents are single-authored, while the average number of co-authors per document is 2.82, reflecting the interdisciplinary and collaborative nature of the field. Moreover, international co-authorship accounts for 38.61% of publications, reflecting the global relevance of process innovation and the increasing cross-national research efforts. The dataset contains 2,767 keywords used by authors, indicating a wide range of theoretical angles, empirical contexts and research objectives. At the same time, the literature demonstrates important scholarly impact, with an average of 60.07 citations per document and a document average age of 9.35 years. Together, these indicators point to a research field that is both well established and actively evolving.

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Business Excellence and Management
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5. RESULTS AND DISCUSSIONS

5.1 Performance analysis

Annual scientific production. The Annual scientific production (Figure 1) reveals 3 phases of evolution: Phase 1 (late 1970's - mid 1990's) is an emergent phase. Process innovation appears as a peripheral topic often embedded within broader innovation to uncover the direct link between managerial methods and successful innovation. Phase 2 (late 1990's - mid 2010's) is a growth phase. This reflects the conceptual consolidation of process innovation as a distinct research stream. And Phase 3 (late 2010's - 2020's) reveals a sharp rise, with a peak close to 100 articles per year, followed by a noticeable drop in the most recent year. This drop is not interpreted as a real decline in interest, but we believe it is attributed to database indexing delays, especially for the most recent publication year.

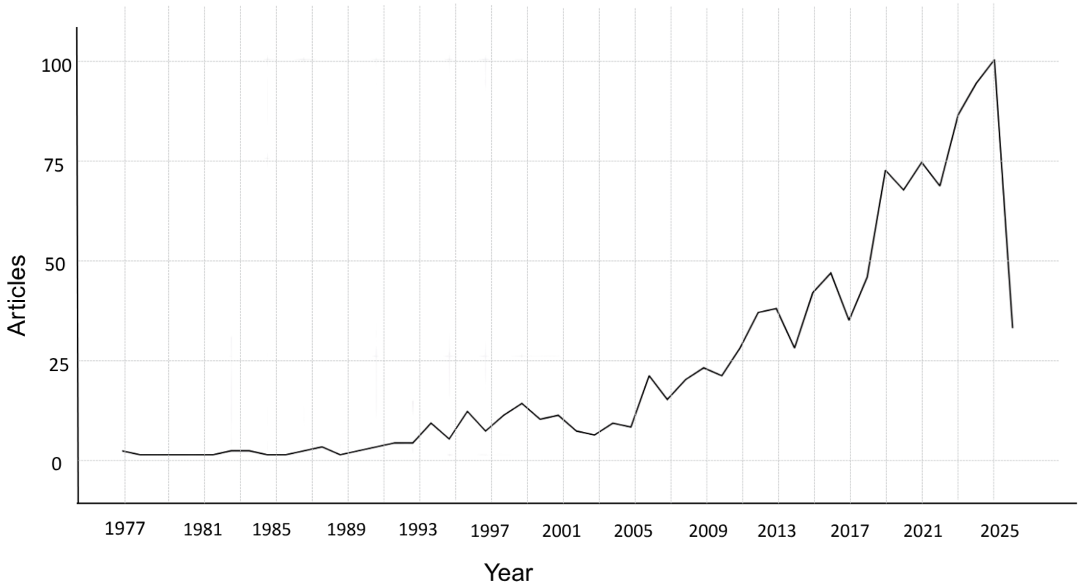

FIGURE 1. ANNUAL SCIENTIFIC PRODUCTION
Source: Adaptation from Biblioshiny.

Lifecycle of scientific production. The model achieves an R^2 of 0.875, indicating a good fit. The estimated peak year for annual publications is 2024. With a peak of approximately 76 publications per the fitted curve (the observed count in 2024 was higher, around 88–100, suggesting the field may have slightly exceeded the logistic prediction). The cumulative growth curve estimates a saturation point signaling that the growth phase is slowing. This life-cycle pattern is consistent with a maturing research field that is approaching saturation. However, the recent surge in publications (particularly in 2023–2024) exceeding the logistic curve suggests that emerging subtopics (such as green innovation, digital innovation) may be injecting new growth impulses.

Li Shoude is the most productive author in our dataset with 11 documents, focusing his research mainly on the evolution or adjustment over time of process innovation. The next group of clusters is much lower, around 5 – 6 documents each. Dominant authors here include Hervas Jose, Sempere-Ripoll Francisca, Frishammar Johan. This is also consistent with the Lotka pattern: a thin prolific core and a long tail.

The author productivity distribution was examined against Lotka's Law, which predicts that the number of authors making n contributions is about $1/n^2$ of those making one contribution. The distribution shows that approximately 85% of authors contribute only one document. This suggests a field where a small elite of scholars is responsible for a disproportionately large share of research papers, while most contributors are contextual.

Core Sources – Bradford's Law. Bradford's Law of scattering was applied to identify the core journals in the field. The top 10 journals, all classified in Zone 1 (the core zone), are presented in Table 1.

TABLE 1. BRADFORD'S LAW

Journal	Number of articles published
Technovation	44
Business Strategy and the Environment	39
Technological Forecasting and Social Change	38
Research Policy	36
Journal of Business Research	34
European Journal of Innovation Management	33
Technology Analysis and Strategic Management	31
International Journal of Technology Management	25
Small Business Economics	25
Business Process Management Journal	24

Source: Authors' conception.

Process innovation research constitutes a mature interdisciplinary field anchored at the intersection of innovation, strategy and technological change as evidenced by the dominance of leading journals.

The most frequent keywords reveal the conceptual core of the field (Figure 2). "Process innovation" leads with 380 occurrences (8%), followed by "performance" (311, 7%), "product innovation" (271, 6%), "research-and-development" (226, 5%), "innovation" (213, 5%), "management" (192, 4%), "impact" (184), "technology" (136, 3%), or "absorptive-capacity" (121, 3%). These frequencies confirm that the research field is centrally concerned with the innovation – performance relationship.

From the Tree Map analysis, we observe that the largest blocks are anchored in an operations and management core. This suggest that the field's conceptual backbone is a management and performance conversation rather than a purely technical one. Based on the Tree Map analysis we propose the following display of fields organized in 5 macro-themes (Table 2).

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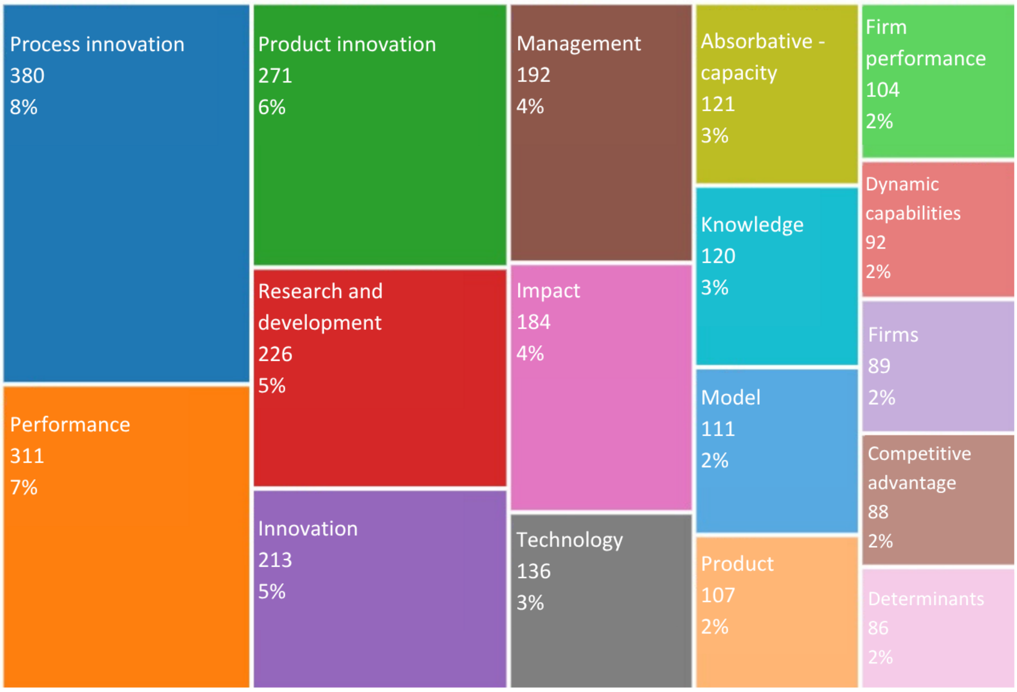

FIGURE 2. TREE MAP ANALYSIS (FIGURE CROPPED FOR MOST RELEVANT KEY WORDS)
Source: Biblioshiny.

TABLE 2. CONCEPTUAL FAMILIES

Conceptual families (macro-themes)	Explanation	Most relevant authors based on impact or number of citation
Core innovation + organizational or managerial framing	Dominance of process innovation alongside innovation and management suggests the field is framed as an organizational phenomenon (capabilities, practices, managerial levers).	(Teece, D. J., Pisano, G., & Shuen, A., 1997) (Gopalakrishnan, S., & Damanpour, F., 2000) (Frishammar, J., Florén, H., & Wincent, J., 2011) (Bennett, V. M., & Levinthal, D. A., 2017)
Performance and outcome orientation	Large presence of performance and nearby terms (e.g., financial/performance-related labels) implies a strong empirical tradition linking process innovation to firm outcomes.	(Adner, R., & Levinthal, D. A., 2001) (Ballot, G., Fakhfakh, F., Galia, F., & Salter, A., 2015)
Capabilities of knowledge-based explanation	Theory-building in this area often uses capability-based lenses to explain how and why process innovation happens and produces value	Un, C. A., & Asakawa, K., 2015) (Reichstein, T., & Salter, A., 2006)
Sustainability and green orientation	The presence of green process innovation, environmental sustainability, green product innovation indicates a prominent "sustainability turn".	(Christmann, P., 2000) (Chen, Y. S., Lai, S. B., & Wen, C. T., 2006) (Huang, J. W. & Li, Y. H., 2017) (Tang, M., Walsh, G., Lerner, D., Fitza, M. A., & Li, Q., 2018) (Xie, X., Huo, J., & Zou, H., 2019)
Digital or technology driven stream	Digital innovation and technology appear, suggesting a recent and rising stream	(Frishammar, J., Ericsson, K., & Patel, P. C., 2015) (Chatterjee, S., Chaudhuri, R., & Vrontis, D., 2024) (Chaudhuri, R., Chatterjee, S., Mariani, M. M., & Wamba, S. F., 2024)

Source: Authors' conception.

5.2 Science mapping

Science mapping goes beyond performance metrics to reveal the relational structure of the field. As Donthu et al. (2021, p. 288) explain, science mapping examines the relationships between research components through techniques including co-citation analysis, bibliographic coupling, co-word analysis and co-authorship analysis.

The co-citation network intellectual structure is presented in Figure 3. The Red Cluster is anchored by Cohen & Levinthal (1990) and it is the most central and largest node, alongside other foundational works including Damanpour (1991, 2000), and Utterback & Abernathy (1975). These works form the theoretical backbone of innovation economics and management, particularly absorbative capacity, innovation and product-process lifecycle. The presence of Nelson R. R. (2008), March J. G. (1991), Teece D. J. (1986) and Von Hippel E. (1988) reinforces that this cluster captures the core innovation theory canon. The Blue Cluster centers on Podsakoff et al. (2003), a widely cited methodological reference on common method bias and Barney (1991) referenced for his paper on resource based view. Other nodes include Teece et al. (1997) on dynamic capabilities or Fornell & Larcker (1981) on structural equation modelling. The Green Cluster is a small isolated one, containing authors Grant R. M. (1996) and Nonaka I. (1994) who represent the direction focused on knowledge based view.

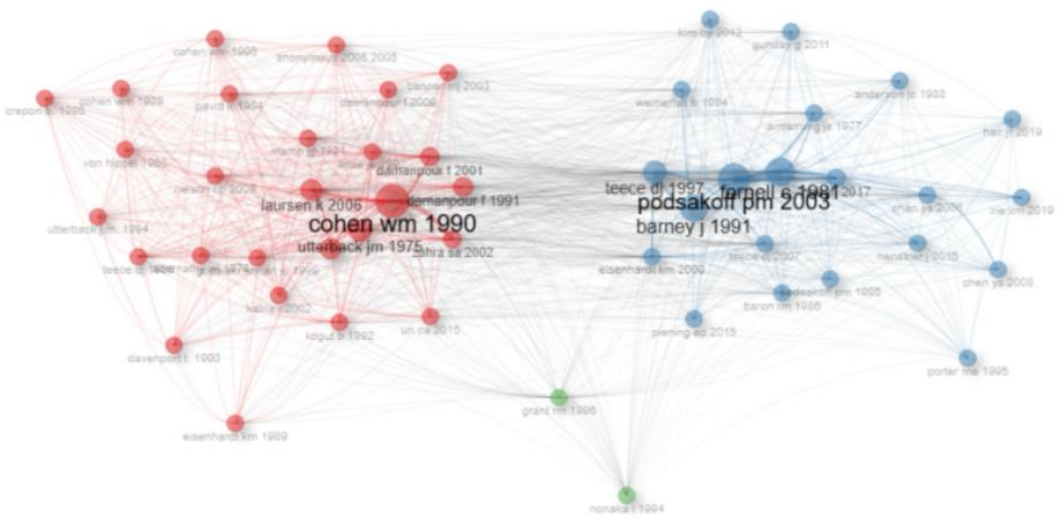

FIGURE 3. CO-CITATION NETWORK
Source: Biblioshiny.

Bibliographic coupling (Figure 4) groups documents that share common references, revealing current research fronts (Kessler, 1963). The coupling analysis of the dataset identified four clusters, visualized in both a strategic map (Impact × Centrality) and a network graph. Based on the centrality and density, clustering by coupling reveals four strategic positions.

Upper - right quadrant with high centrality and high density is the dominant core and is centred on process innovation, product innovation, and innovation in general. These topics are both internally consolidated and structurally central to the broader literature. Upper - left quadrant has low centrality and high density, reflecting a niche specialization in the fields of green innovation or green process innovation. This theme is relatively isolated and functions rather as a specialized sub-field. Lower - right quadrant with high centrality and low density includes transversal themes mixing process innovation, product innovation, and innovation. These are foundational concepts used across many studies, often as background variables or broad constructs rather than tightly theorized themes. Lower - left quadrant has low centrality and low density reflecting marginal or emerging themes. They may include either emerging research angles or weakly articulated research lines.

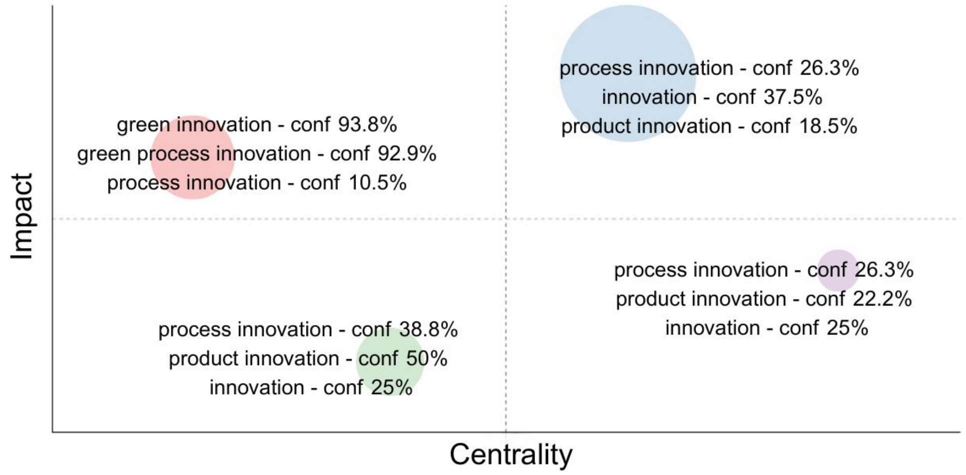

FIGURE 4. BIBLIOGRAPHIC COUPLING
Source: Adaptation from Biblioshiny.

The co-occurrence network (Figure 5) of keywords reveals three major conceptual clusters.

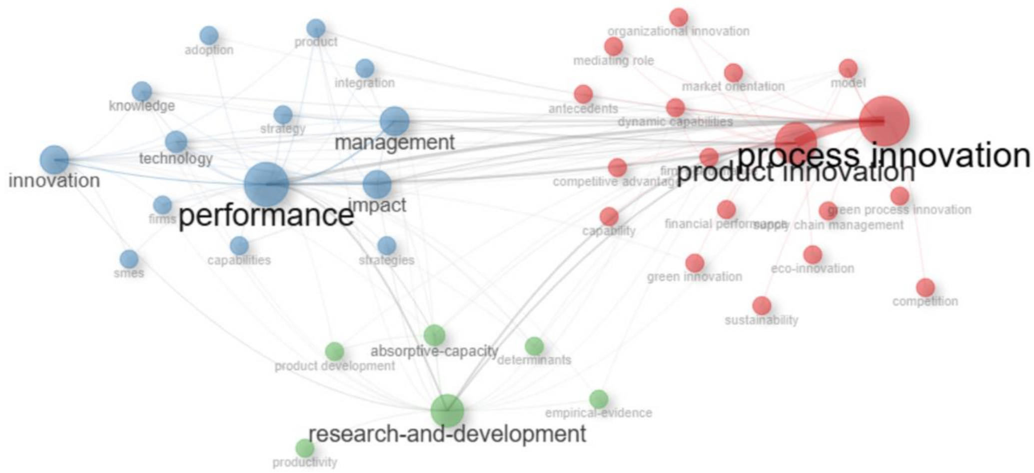

FIGURE 5. CO-OCCURRENCE NETWORK
Source: Biblioshiny.

The Blue upper left captures the traditional innovation perspective focusing on research and development inputs, knowledge absorption and their relationship to a firm's performance. The Green right-side cluster reflects the strategic management and sustainability perspectives, linking innovation types to competitive outcomes and environmental performance. Red lower center cluster represents the management-oriented stream focusing on how firms implement and manage different innovation types.

The thematic map (Figure 6) classifies keyword clusters by their centrality (relevance to the field) on the x-axis and density (development degree, internal cohesion) on the y-axis. This framework is originating from Callon et al. (1991) and is widely used in Bibliometrix, to position themes into four quadrants.

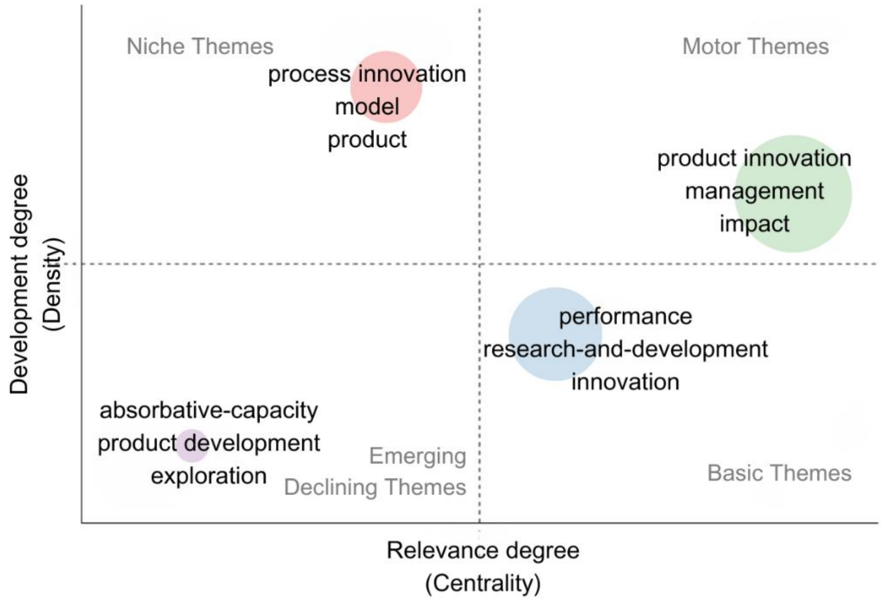

FIGURE 6. THEMATIC MAP
Source: Adaptation from Biblioshiny.

In our case the Motor theme (upper-right) consists of "Product innovation – management – impact", confirming that the intersection of product innovation with management practices and their performance impact is the most central and well-developed research stream. Although process innovation gained separate appreciation, it is still addressed mostly in comparison with product innovation performance. Our Niche theme (upper-left) including "Process innovation – model - product" is positioned as an internally well-developed research area but with less centrality to the broader field, suggesting a specialized sub-community. The Basic theme (lower-right) includes "Performance - research and development - innovation". Although highly central which means foundational to the field, it has lower internal density, meaning its internal connections are more dispersed. Emerging or Declining themes are shown in the lower-left and include "Absorptive-capacity - product development - exploration". Given the historical centrality of absorptive capacity in innovation research (as confirmed by the co-citation analysis), this positioning may indicate either that the theme is evolving into new sub-fields or that its explicit keyword usage is declining as the concept becomes absorbed into broader frameworks.

Scholars should take note of the most recent trend topics from 2022 to 2025 which include “digital innovation”, “strategic flexibility”, “environmental sustainability”, or “green innovation”. This temporal shift clearly illustrates the field’s evolution from classical technology management questions toward sustainability, digitalization, and advanced quantitative methodologies.

The historiographic analysis (Figure 7) confirms a cumulative, path-dependent evolution, not a disruptive or fragmented one. Each phase builds on the previous, reinforcing the field’s maturity and theoretical depth.

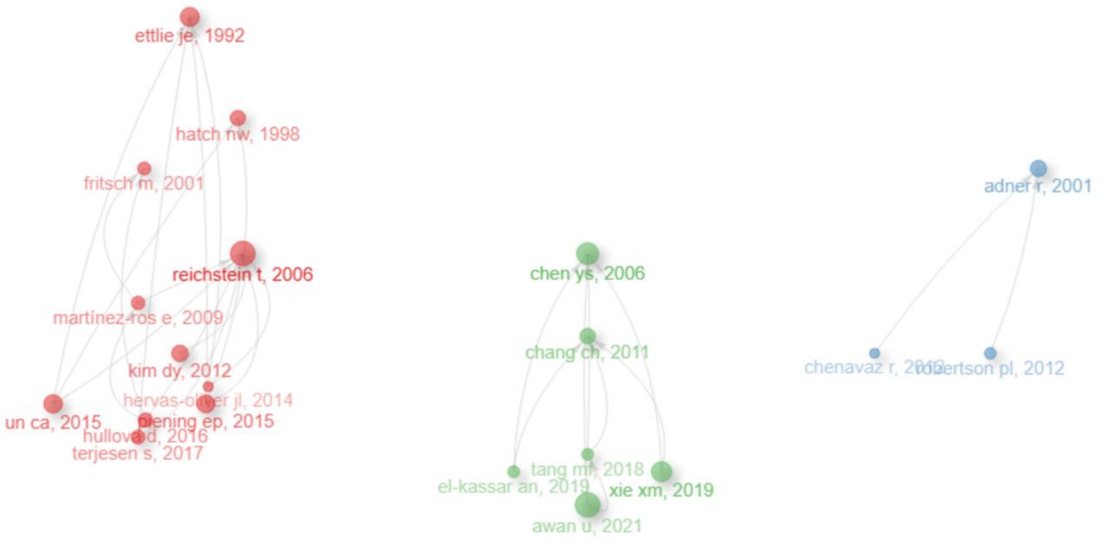

FIGURE 7. HISTORIOGRAPH
Source: Biblioshiny.

Phase (red) from the 1990’s reflects the early conceptualization with authors like Ettlie & Reza (1992) or Hatch & Mowery (1998) framing that process innovation should be treated as distinct from product innovation. Later contributions are generated by Kim D.-Y. (2012), Hervas-Oliver J. L. (2014), Un & Asakawa (2015), Hullova D. (2016), or Terjesen & Patel (2017). Hervas-Oliver et al. (2014-2018) expand the field into knowledge management, industry dynamics and process innovation beyond manufacturing. The green lineage traces the sustainability-oriented stream, beginning with Chen Y. S. (2006). A smaller third lineage (blue) includes Adner & Levinthal (2001) and Chenavaz R. (2012) representing a niche stream on innovation strategy and pricing.

The results from bibliometric analysis and literature review indicate that process innovation is a mature yet still expanding research domain. We see a significant interest for sustainability oriented and digitalization related topics which create momentum for another take off in the literature of process innovation.

Conceptually, process innovation is firmly anchored in management and performance - oriented research directions such as organizational capabilities, absorbative capacity and dynamic capabilities, often in comparison to product innovation. However, this persistent comparison can be interpreted not as a weakness of the field, but as an indication of its integrative role within innovation systems. Sustainability related concepts, such as green process innovation and eco innovation have evolved into a distinct and increasingly prominent research stream. Social network analysis shows a fragmented collaboration structure with several small and relatively isolated research clusters, reflecting the interdisciplinarity nature of the field but also signalling unrealized potential. This pattern corroborates earlier arguments that mature research fields do not necessarily stagnate but may evolve through thematic recombination and the emergence of adjacent fields (Donthu et al., 2021).

6. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

This study provides a thorough bibliometric assessment of process innovation research, based on 1,093 selected articles, published between 1977 and 2026, and indexed in the Web of Science Core Collection. It also includes a literature review of the most impactful and productive authors. By combining performance analysis with science mapping and literature review, the paper offers an objective overview of the field's evolution, intellectual foundations, conceptual structure, and collaboration patterns. Overall, this study contributes to the literature by demonstrating that process innovation should be understood as an independent strategic research domain, rather than a secondary dimension of product innovation, and scholars should be sensitive to trends that might bring new emerging research opportunities especially due to artificial intelligence and green practices. Based on our analysis we see that the primarily challenge for future research is not conceptual ambiguity but theoretical integration. The field exhibits strong agreements on foundational mechanisms such as learning, capabilities or performance, yet remains segmented across practical applications. An integrative research agenda should focus on explaining when, why and under which conditions different process innovation mechanisms dominate.

Limitations and future research directions. Despite its contributions, this study is subject to several limitations. First, the analysis relies exclusively on the Web of Science Core Collection. Although highly recommended for bibliographic analysis, this choice may omit relevant publications indexed in other databases. Second, only English-language journal articles were included, potentially excluding high value articles published in other languages. Although this paper includes a literature review of the most cited and productive authors, scholars are encouraged to do a systematic or integrative literature reviews. Second, a particularly promising direction concerns the systematic investigation of artificial intelligence in process

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innovation. Third, further research could focus on the intersection of process innovation and sustainability, or process innovation and digital transformation.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the Bucharest University of Economic Studies for its support in the development of this research, including access to scientific databases and academic knowledge facilitated through dedicated courses and scholarly literature. This paper was co-financed by the Bucharest University of Economic Studies during the PhD program.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work the authors used Microsoft 365 Copilot, based on the GPT-5 chat model and Opus 4.6 (Claude) in order to do deep search in selected articles, rephrase authors' ideas or improve English writing. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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