

Bibliometric Analysis of Research on Process Optimisation in the Telecommunications Industry

Cătălina-Ileana RACHERU

0009-0000-8677-4477

Vodafone Intelligent Solutions

catalina.racheru@stud.etti.upb.ro

Andreea-Raluca DESPA

0009-0007-6861-7364

Vodafone Intelligent Solutions

andreea.despa@stud.etti.upb.ro

Gheorghe MILITARU

0000-0003-4650-8427

National University of Science and Technology POLITEHNICA Bucharest

gheorghe.militaru@upb.ro

Abstract. *The transition from 1G to 6G network architectures, backbone infrastructures, and sophisticated Quality of Service (QoS) requirements has contributed to the growing complexity of telecommunications services, increasing interest in process optimization among researchers. Emerging technologies are reshaping operational models, enhancing scalability, and redefining service delivery. Examples include artificial intelligence, big data analytics, robotic process automation (RPA), machine learning, and the convergence of 5G and IoT. Focusing on trends, leading authors, countries, and key research areas related to process optimization in telecommunications, this paper presents a bibliometric analysis of publications indexed by Scopus between 2005 and 2025. To map the field's collaborative and intellectual structures, citation patterns, co-authorship networks, and keyword co-occurrences were examined using VOSviewer and Scopus. The findings show that scientific output has increased steadily over the past decade, peaking in areas such as advanced network management, digital transformation strategies, AI-enabled predictive maintenance, and customer experience optimization. While collaboration networks reveal distinct clusters of expertise, the analysis also highlights the dominance of research output from the US, China, and the EU. By combining bibliometric evidence with insights into network evolution, KPI frameworks, and automation practices, this study provides researchers and practitioners with a comprehensive understanding of current trends, emerging directions, and key research gaps in telecom process optimization.*

Keywords: telecommunications, process optimisation, bibliometric analysis, artificial intelligence, 5G networks, digital transformation

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Introduction

One of the most active and quickly changing areas of the world economy is the telecommunications sector. Due to market competition, technological advancements, and increasingly complex customer demands, it has been at the forefront of the digital transformation for the past 20 years. Process optimization has emerged as a top strategic priority for telecom operators looking to boost productivity, cut expenses, and improve service quality in this fiercely competitive market. This transition has been accelerated by the broad adoption of disruptive technologies like

artificial intelligence (AI), big data analytics, robotic process automation (RPA), the Internet of Things (IoT), and 5G networks, which have changed operational models and redefined the creation and delivery of value.

A growing collection of literature on digitalization, automation, and service innovation in telecommunications has resulted from academic research that has closely followed these developments. Research emphasizes how 5G will enable new services and applications, AI will help with predictive maintenance, and Big Data will help predict loss of customers. However, research on process optimization in telecommunications is still dispersed despite the wealth of this literature.

By methodically mapping the collaborative and intellectual structures of research fields, bibliometric analysis offers a strong methodological framework to close this gap. Bibliometric techniques enable the identification of trends, significant contributors, thematic clusters, and knowledge gaps by examining publication patterns, co-authorship networks, and keyword co-occurrences. This method not only provides a look back at the evolution of knowledge production, but it also identifies possible avenues for further study.

In regard to this, the current study uses Scopus data from 2005 to 2025 to provide a thorough bibliometric analysis of research on process optimization in telecommunications. The following research question is the focus of the analysis: Over the past ten years, how has the scientific literature on process optimization in telecommunications changed, and what are the key themes and lines of inquiry impacting this area of study? Three research hypotheses are put forth in this study:

H1: Over the past ten years, there has been a significant increase in the number of publications on process optimization in the telecommunications industry;

H2: The industry's current priorities are reflected in the dominant research themes of digital transformation, operational automation, and predictive maintenance;

H3: The development and integration of emerging technologies in the telecommunications industry has led to a diversification of research topics on process optimization, creating new directions like real-time analytics, AI-based automation, and customer experience management.

By answering this question, the paper hopes to add to the body of knowledge by giving an evidence-based summary of the current research status and by giving practitioners advice on new avenues for collaboration, strategic priorities, and the use of process optimization in the telecom industry.

Literature review

A major shift toward software-based systems—more adaptable and easier to adjust to rapid market changes—has been driven by the expansion of the Internet and the rise of wireless technologies. Consequently, modular architectures and object-oriented development approaches have become the standard in the telecom software sector [1]. In such a dynamic environment, process management directs organizational systems to maximize efficiency and align operations with strategic goals. Effectiveness refers to completing planned tasks and objectives on time, whereas efficiency focuses on achieving them at lower cost and higher profitability; competent management integrates both dimensions [2].

In telecommunications, organizational procedures define how a company delivers services, maintains network operations, and responds quickly to market and technological changes [3]. Key Performance Indicators (KPIs) are vital for measuring performance, as they enable companies to evaluate progress toward strategic goals, streamline processes, increase productivity, and improve profitability [4].

Digitalization directly impacts the telecom sector by transforming business models, knowledge production, and management practices, while reflecting the social and economic effects of widespread digital platform adoption and new communication media [5]. Business Process Automation (BPA) further supports this transformation by automating data management, information handling, and execution logic to reduce costs, improve resource utilization, and accelerate workflows [6].

Key technologies driving telecom process digitalization include Robotic Process Automation (RPA) to eliminate repetitive tasks; Machine Learning and Big Data analytics for predictive maintenance and advanced operational insights; 5G and IoT networks for high-speed connectivity and scalability; and Business Process Model and Notation (BPMN) together with Kaizen principles for continuous process improvement. Furthermore, integrating

Artificial Intelligence for IT Operations (AIOps) and digital twins into network management enables real-

time monitoring and automatic parameter adjustments, enhancing infrastructure resilience and operational efficiency—critical factors for process optimization in telecommunications.

Methodology

One of the most rigorous techniques for mapping the collaborative and intellectual structure of a research field is the quantitative bibliometric approach used in this study. The quantification of scientific output, the identification of influential authors, and the visualization of emerging thematic clusters are all made possible by bibliometrics, which offers an impartial and thorough viewpoint. The selection of this approach shows a dedication to providing an evidence-based analysis that can document the development of research on telecommunications process optimization over the previous two decades.

A carefully designed search strategy was used to extract data from Scopus, one of the most prestigious scientific databases, using terms like "telecommunications," "process optimization," "artificial intelligence," "automation," "5G," "IoT," and "customer experience." etc. The period of 2005–2025 was chosen to represent the rapid adoption of disruptive technologies and the period of digital transformation. The final dataset consisted of 784 publications, containing only peer-reviewed journal articles, conference papers, and book chapters.

The query(*"process optimization" OR "process improvement" OR "workflow efficiency" OR "business process modeling" OR "business process model and notation" OR BPMN OR "robotic process automation" OR RPA OR "digital process transformation" OR "process automation" OR "intelligent automation" OR "AI-powered automation" OR "digital workflows" OR "process orchestration"*) AND (*"telecommunications" OR "telecommunication industry" OR "mobile telecommunications" OR "mobile network" OR "5G operations" OR "radio access network" OR "network automation" OR "OSS" OR "BSS" OR "network operations" OR "telecom infrastructure" OR "service provisioning" OR "network fault management"*) was organized into four primary directions and intended to cover a wide and pertinent thematic area. Concerns about enhancing organizational performance are reflected in terms such as process optimization, workflow efficiency, and process improvement. With a focus on digitalization and the automation of operational flows, the automation dimension encompasses robotic process automation, intelligent automation, AI-powered automation, digital workflows, and process orchestration. Terms that focus on the formal structuring and analysis of processes, like business process modeling and BPMN, are used in modeling. In order to identify studies on systemic changes in process architecture, digital process transformation was included as a representation of digital transformation.

R 4.4.2/Excel was used for descriptive statistics like annual publication trends and geographic distribution, and VOSviewer was used to create bibliometric maps and co-occurrence networks. This combination offered a thorough analysis of particular contributions as well as a broad perspective on research trends. Publication growth, the most cited authors, article distribution across sources, and trends in international collaboration were among the indicators examined.

Although reliance solely on Scopus may exclude some publications and bibliometric methods are inherently quantitative, these limitations do not diminish the study's value. On the contrary, they underscore the robustness and relevance of an analysis that offers a precise, panoramic, and systematic view of how research on telecommunications process optimisation has evolved globally.

The study's value is not diminished by these limitations, even though bibliometric methods are inherently quantitative and relying only on Scopus may exclude certain publications. Instead, they highlight the strength and applicability of an analysis that provides a clear, comprehensive, and methodical picture of the global evolution of telecommunications process optimization research.

Results and further discussions

One of the primary objectives in the telecom sector is process optimization. VOSviewer software was used to process bibliographic data (.csv format) that was taken from the Scopus database in order to create visual maps for sources or organizations, citation networks, co-authorship, and keyword co-occurrence in order to analyze research trends. In order to capture terminological variations, data collection used pertinent keywords like "process

optimization," "process improvement," "telecommunication industry," and "efficiency" in conjunction with Boolean operators (AND, OR). Included were only journal articles published in English between 2005 and 2025.

599,633 results were returned by the search for "process optimization," demonstrating the topic's interdisciplinary nature. The majority of publications come from the fields of engineering (268,652), computer science (178,548), materials science (85,853), mathematics (84,136), chemical engineering (70,564), physics and astronomy (70,257), and chemistry (69,181). The broad relevance and applicability of process optimization in the scientific literature is confirmed by additional contributions from disciplines like energy, environmental sciences, biochemistry, medicine, social sciences, and economics.

The interdisciplinary nature of the topic is reflected in the abundance of documents found by the query, which are primarily spread across technical and applied fields with a notable concentration in Computer Science (268 papers) and Engineering (202 papers), followed by Mathematics (71) and Business, Management, and Accounting (64). The scientific landscape is further enhanced by complementary disciplines like physics, astronomy, social sciences, medicine, and decision sciences, which emphasize the wide range of organizational, technological, and social viewpoints on process automation and optimization in telecommunications.

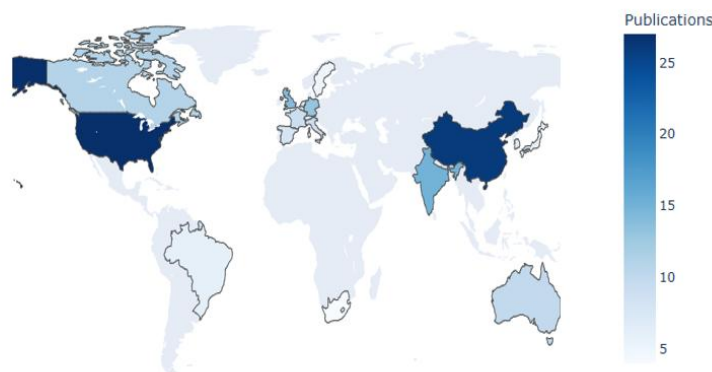


Figure 1: Annual scientific production (2005–2025)
Source: Author's own contribution

Evidently is a notable concentration of research around major global players in technology and telecommunications, according to an analysis of the geographical distribution of scientific publications. With the highest estimated number of publications, the United States (27 publications) and China (26 publications) are clearly involved in the exploration and development of automation and process optimization solutions. The top three countries—India (15), the UK (14), and Germany (13)—reflect significant contributions from sophisticated technological ecosystems. Leading economies' strategic interest in implementing digital transformation in the telecom sector, especially through technologies like RPA, BPMN, and process management in mobile networks, is confirmed by this distribution.

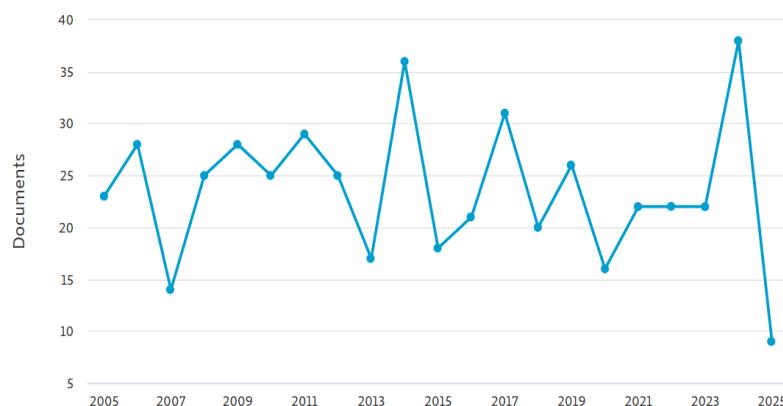


Figure 2: Country scientific production (2005-2025)

Source: Author's own contribution

The graph illustrates how the quantity of documents changed from 2005 to 2025, revealing notable variations from year to year. There are two years that stand out as having particularly high activity: 2014 and 2024, when the number of documents reached maximum values of about 36–38. The lowest values, with roughly 14 and 9 documents, respectively, are recorded in 2007 and 2025. This suggests a significant drop, particularly in 2025, which might be the result of insufficient data for that year. Relative stability is seen in some time periods, like 2021–2023 or 2008–2012, where there are consistently between 22 and 30 documents. These discrepancies could be the result of institutional activity levels, policy changes, or other outside factors.

Table 1: The main sources of the analyzed articles and their classification by quartile

<i>Source</i>	<i>Number of Articles</i>	<i>Quartile</i>
IEEE ACCESS	41	Q1
Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	36	Q2
Communications in Computer and Information Science	13	Q4
Lecture Notes in Business Information Processing	11	Q3
Lecture Notes of the Institute for Computer Sciences, Social- Informatics and Telecommunications Engineering	4	Q4
Information and Software Technology	3	Q1
IEEE Transactions on Industrial Informatics	2	Q1
Computer Networks	2	Q1
Journal of Geotechnical and Geoenvironmental Engineering - ASCE	1	Q1
International Journal of Mathematics	1	Q2
IEEE Transactions on Biomedical Engineering	1	Q1

Source: Author's own contribution

The journals in which the articles were published are highlighted in this list, along with their number and matching quartile based on the Scopus/SJR (SCImago Journal Rank) classification. A high degree of scientific quality is indicated by the notable presence in Q1-indexed journals like IEEE Access, Information and Software Technology, or IEEE Transactions on Industrial Informatics. In addition, the publications span a wide range of disciplines, including mathematics, biomedical engineering, and applied computer science. Many of them are part of the esteemed Lecture Notes series (Springer), which is known for disseminating research findings quickly. The influence and prominence of these journals in the global academic community are reflected in the quartile ranking.

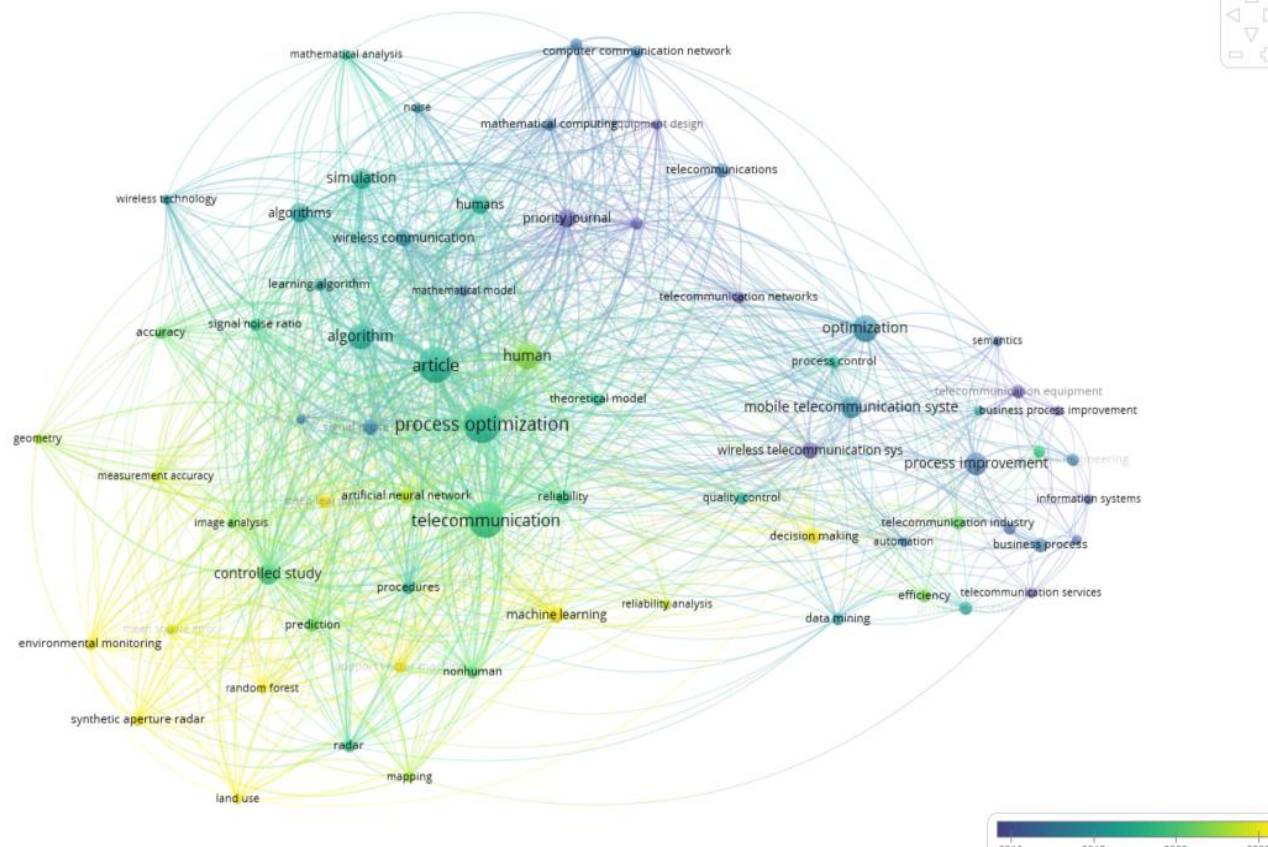


Figure 3: Keyword co-occurrence network analysis for a telecommunications network
Source: Author's own contribution

The colors in this VOSviewer-created visualization demonstrate the average year that the terms appeared in the scientific literature, ranging from violet (older, around 2016) to yellow-green (more recent, towards 2022). It depicts a temporal map of the network of terms related to process optimization. Practical and application-oriented terms like "process improvement," "automation," "efficiency," and "data mining," which are on the right side of the network and highlighted in green and yellow, readily move from theoretical and basic concepts like "simulation," "mathematical model," and "computer communication network," which are on the left side and colored in violet shades, to these terms.

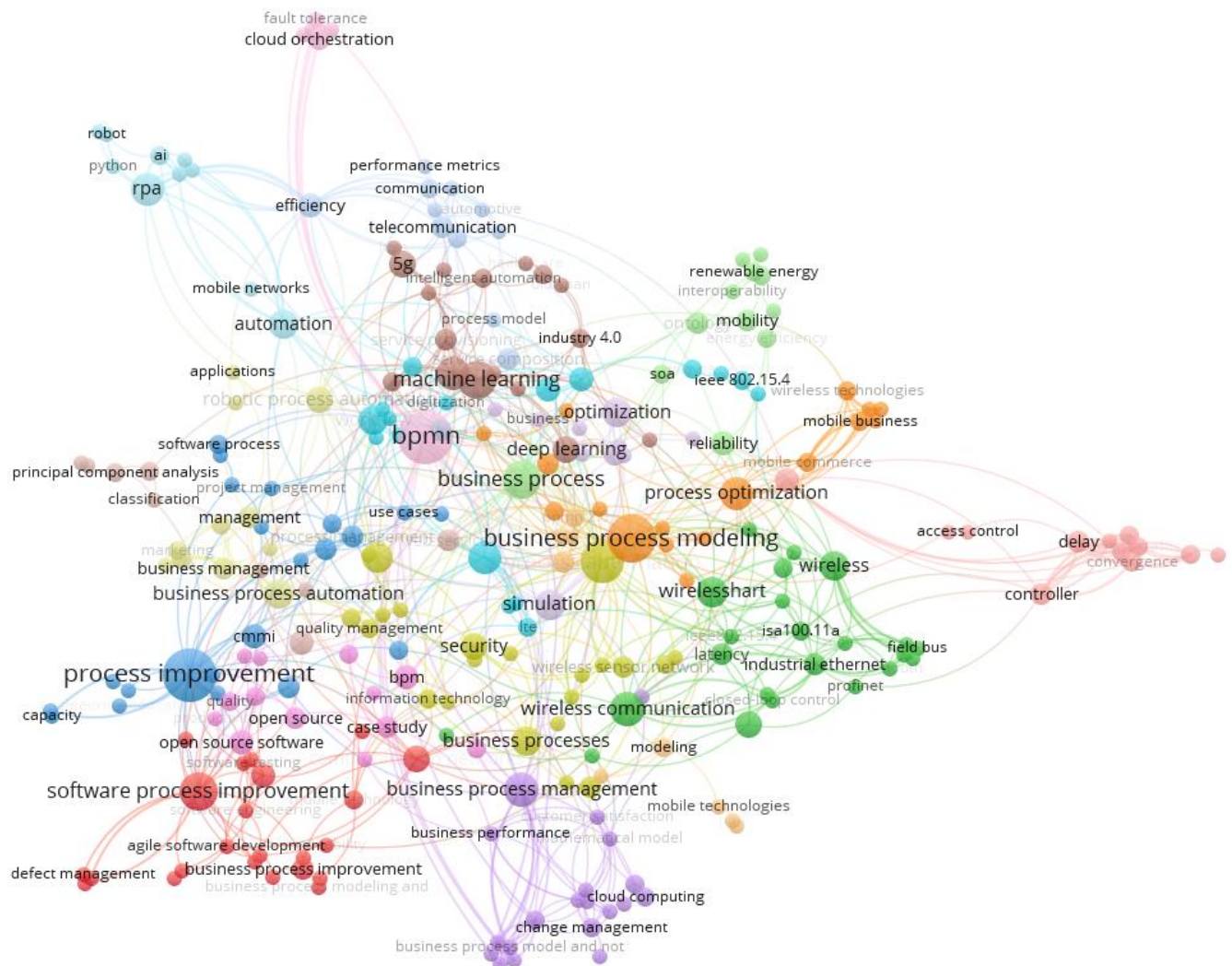


Figure 4: Keyword co-occurrence network analysis for a telecommunications network
Source: Author's own contribution

Using VOSviewer, a keyword co-occurrence analysis was conducted for looking at thematic structures and semantic relationships in the scientific literature on telecommunications process optimization. The query combined telecom-specific descriptors (mobile telecommunications, 5G operations, network automation, OSS/BSS, telecom infrastructure) with process-efficiency terms (process optimization, workflow efficiency, process automation, RPA, BPMN, digital transformation).

In the multi-cluster topology of the generated network, high-degree nodes like machine learning, business process modeling, process improvement, BPMN, telecommunications, and RPA hold central positions with dense interconnections, suggesting their function as bridging concepts and semantic hubs. The green cluster, which reflects research on mobile network automation and performance tuning, is dominated by wireless communication, network optimization, and fieldbus, while the blue cluster combines terms associated with open-source frameworks and software process improvement. Strong interdisciplinarity is indicated by high network density and cross-cluster links, as automation, artificial intelligence, and process modeling technologies converge more and more in telecom infrastructures. Thus, the co-occurrence map serves as a conceptual roadmap of current research advancements in this field as well as a visual knowledge graph.

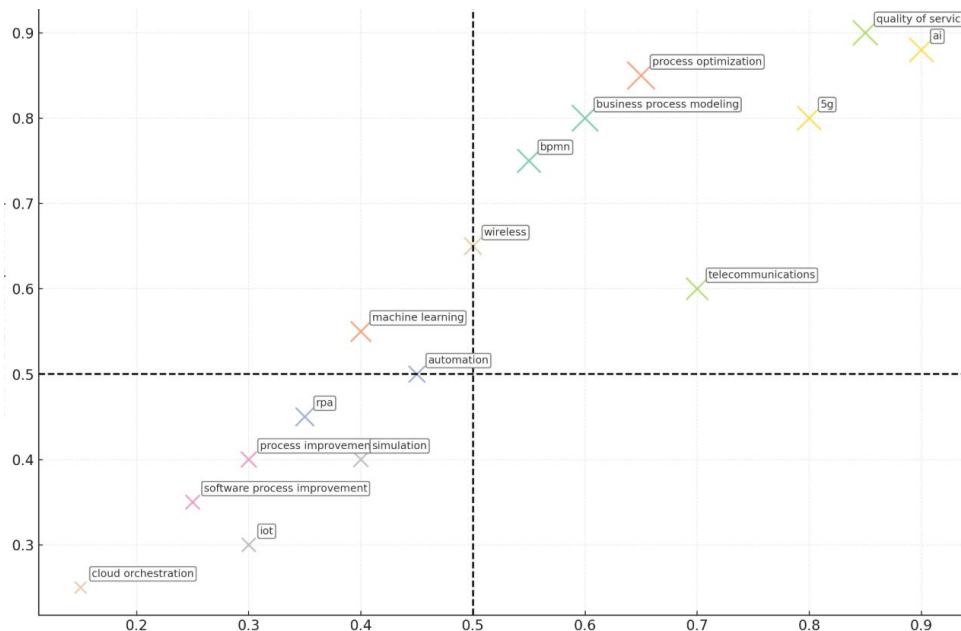


Figure 5: Thematic map

Source: Author's own contribution

Following Callon's model, the thematic map produced using the bibliometric network shows how the primary research themes are categorized based on their level of internal development (density) and their relevance within the field (centrality). The vertical axis represents the “Degree of Development (Density),” indicating the internal maturity and cohesion of a theme, while the horizontal axis illustrates the “Degree of Relevance (Centrality),” reflecting its connection and importance to the broader research domain. Concepts like business process modeling, process optimization, 5G, artificial intelligence, and quality of service are found in the upper-right quadrant (Motor Themes), suggesting that these are well-developed themes and crucial to the conceptual framework of the literature under analysis.

Conclusion

The conclusions of the study emphasize the scientific and practical relevance of the topic, positioned at the intersection between technological innovation and organizational optimization in the telecommunications industry. The research undertaken provides a structured overview of how telecom companies respond to market pressures through digitalization, automation, and the integration of emerging technologies such as artificial intelligence, robotic process automation (RPA), big data analytics, and cloud orchestration. The detailed analysis of network architectures (2G–6G), process models, and performance indicators contributes to a conceptual and operational framework for understanding efficiency and innovation in critical infrastructures.

A distinctive contribution of this paper lies in the integration of a complex bibliometric analysis that systematically maps the evolution of scientific knowledge on telecom process optimization over the past two decades. By combining quantitative bibliometric techniques with visual tools such as VOSviewer, the study identifies the most influential authors, journals, and thematic clusters, thus providing an evidence-based understanding of research trends. In this sense, the paper's originality resides in connecting bibliometric mapping with strategic insights for process optimization, offering both a theoretical and managerial perspective.

The results confirm all three research hypotheses (H1–H3). H1 is validated by the clear upward trend in publication output between 2005 and 2025, reflecting growing academic interest in process optimization. H2 is supported by the predominance of research themes such as digital transformation, operational automation, and predictive maintenance, which mirror the industry's current priorities. H3 is also confirmed, as emerging topics like AI-based automation, real-time analytics, and customer experience management demonstrate the diversification of research directions in this field.

Based on these findings, several future research directions emerge. First, the sample of analyzed documents can be expanded to include additional databases (e.g., Web of Science, IEEE Xplore) for broader coverage and improved representativeness. Second, the quantitative results may be complemented by qualitative methods—such as expert interviews or focus groups—to deepen the understanding of organizational and behavioral aspects of digital transformation. Finally, future studies could develop and empirically validate an integrated telecom process optimization model, combining BPMN, AI, and RPA frameworks to assess digital maturity and automation performance across different telecom operators. Overall, the study provides both a theoretical contribution—by mapping the evolution of telecom process optimization research—and a practical one, by outlining how emerging technologies can enhance process efficiency, adaptability, and strategic value creation in an increasingly competitive telecommunications landscape.

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