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Cloud Computing Adoption in SMEs: Exploring IaaS, PaaS and SaaS through a Bibliometric Study

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Abstract

This study offers a bibliometric analysis to explore the evolving trends and emerging patterns in the adoption and use of cloud computing and its service models IaaS, PaaS and SaaS among small and medium-sized enterprises. By identifying key themes, influential authors and leading journals the research provides valuable insights into this rapidly growing field. Data was collected from the Scopus database, covering the period of 10 years from 2015 to 2024. The initial dataset consisted of 1,882 documents from Scopus which was refined to 662 relevant articles. Using VOSviewer and Biblioshiny, the study analyzed publication trends, citation patterns, authorship networks, collaborative efforts, and thematic clusters. Findings indicate a significant surge in publications, reaching a peak of 140 articles in 2024. Notable contributors include Kumar V, Raut R and Eze S C, with India emerging as a leading country in research output. Prominent journals such as “International Journal of Business Information Systems” and “Technological Forecasting and Social Change” have played a pivotal role in disseminating research on this topic. The study highlights the importance of stakeholders focusing on the adoption of cloud computing in SMEs, with particular attention to its service models IaaS, PaaS, and SaaS to drive improved operational efficiency and strengthen competitiveness.

Keywords: Bibliometric analysis, Cloud Computing, IaaS, PaaS, SaaS, SMEs

Introduction

The Information Technology sector has witnessed unprecedented growth and has become a cornerstone of modern business operations (Ciulli & Kolk, 2023). Organizations are embracing digital transformation at a breakneck speed as advancements in telecommunications and computing revolutionize global commerce and offer businesses substantial competitive edges (Kao et al., 2024; Sevak & George, 2023). In this dynamic landscape SMEs are turning to cloud computing to modernize operations and boost efficiency by moving away from traditional software models designed for individual users (Khayer et al., 2021; Yaseen et al., 2023). This shift to cloud-based solutions is transforming the way SMEs conduct business and is driving

operational efficiency and streamlining processes (Bajdor, 2024). Cloud technology empowers SMEs to manage data more effectively and enhances flexibility, accuracy and responsiveness in daily operations (Alasady et al., 2023; Jain, 2024). The scalability offered by cloud platforms enables enterprises to handle data processing storage and management efficiently and adapt quickly to evolving business demands (Zakutynskyi et al., 2023).

Cloud computing fosters innovation by providing SMEs access to advanced tools and resources on demand and eliminates the need for significant upfront investments (Musarat et al., 2024). This accessibility supports growth and positions SMEs to remain competitive in an increasingly digital and fast-paced business environment (Basu et al., 2023; Huang et al., 2022). With the rising importance of cloud computing in the business world SMEs are increasingly embracing cloud-based solutions through its diverse service models including IaaS, PaaS and SaaS (Odukoya, 2024; Wen et al., 2024). These cloud service models collectively empower SMEs to enhance their operational capabilities innovate in their service delivery and scale their operations without the constraints of traditional IT infrastructure (Homan & Beránek, 2023). Unlike conventional software that requires substantial upfront investments and regular maintenance cloud computing offers a flexible cost-effective and scalable alternative that aligns seamlessly with the dynamic needs of SMEs (Li & Kumar, 2022).

SaaS has emerged as a popular choice for SMEs due to its user-friendly interface minimal installation requirements and ability to provide seamless access to software applications (Ongowarsito et al., 2022). On the other hand, PaaS enables enterprises to develop test and deploy custom applications without needing to manage the underlying infrastructure thus fostering innovation and agility (Wen et al., 2024). IaaS with its on-demand computing power and storage solutions allows SMEs to efficiently handle data-intensive processes and rapidly respond to evolving business demands. Together these service models not only reduce operational costs but also enhance the technological competitiveness of SMEs in the global market (Kondo et al., 2022; Wen et al., 2024).

Despite its transformative potential the adoption and usage of cloud computing among SMEs face several challenges and barriers such as concerns over data security lack of technical expertise and resistance to change within organizational structures (A. Mjlae, 2024; Khayer et al., 2020). Furthermore, research on the adoption and implementation of IaaS, PaaS and SaaS in SMEs is fragmented with limited insights into the evolving trends and patterns of adoption (Alqahtani et al., 2022; Homan & Beránek, 2023). Understanding these dynamics is crucial for identifying the factors driving or hindering cloud adoption and for developing strategies to support SMEs in leveraging the full potential of cloud computing.

This bibliometric analysis aims to address these gaps by uncovering the key themes research trends and emerging patterns in cloud computing adoption among SMEs. By analyzing scholarly literature this study provides a comprehensive understanding of how SMEs are embracing cloud technologies and highlights the critical factors influencing their adoption. The findings will serve as a foundation for future research offering actionable insights into the role of cloud computing in shaping the digital transformation of SMEs. This analysis not only bridges existing knowledge gaps but also positions cloud computing and its service models as a vital enabler of growth and innovation in the SME sector.
The following research questions can be formulated based on the stated objectives.

***RQ1**. What is the yearly trend in scientific publications related to the adoption and use of cloud computing and its service models* IaaS, PaaS, and SaaS *within SMEs?*
***RQ2**. Which researchers have contributed most significantly to this area of study?*
***RQ3.** Which countries and academic journals have been instrumental in shaping and advancing research on this topic?*
***RQ4**. What are the major trends and developments that can inform and shape future research in this field?*

The structure of the paper is organized as follows: Section 2 explores the conceptual background, focusing on emerging patterns connected to adoption and use of Cloud Computing and its service models in SMEs. Section 3 outlines the research methodology in detail. Section 4 presents the findings, analysis, and discussion of the study. Finally, Section 5 concludes the paper by summarizing the key insights and main conclusions.

Conceptual Background

In the fast-changing SME landscape, adopting and integrating cloud computing services like SaaS PaaS and IaaS has transformed traditional business practices (Yaseen et al., 2023). These technologies act as key enablers in enhancing business process, optimizing operations and ensuring seamless workflow continuity (Jayeola et al., 2022). Cloud computing provides SMEs with flexible and scalable tools to handle data storage, processing and management allowing them to optimize their operations while significantly reducing infrastructure expenses (Kumar & Sharma, 2024). The strength of cloud systems combined with the quality of information and services plays a vital role in enhancing these processes (Gammelgaard & Nowicka, 2023). Reliable access to resources and the protection of sensitive data are essential for the effective use of cloud technologies (Wang & Yongchareon, 2020).

The flexibility of cloud computing enables SMEs to scale their IT resources up or down according to changing demands and operational requirements (Khayer et al., 2021). PaaS offers a structured environment for the development, testing, and deployment of applications, enabling SMEs to streamline software creation and improve collaboration (Bharany et al., 2022; Nadeem, 2022). Common examples of PaaS applications include load balancers, firewalls, middleware, application servers, HTTP servers, software libraries, and integrated development environments (IDEs) (Saraswat & Tripathi, 2020). Meanwhile, IaaS delivers essential computing resources like virtual machines, storage, and networking on a pay-as-you-go model, giving SMEs the flexibility to scale their infrastructure resources based on evolving business needs (Homan & Beránek, 2023; Saraswat & Tripathi, 2020). SaaS allows businesses to access and use software applications over the internet without requiring significant internal infrastructure. This approach minimizes upfront costs and reduces the effort needed for maintenance (Li & Kumar, 2022; Z. Zhang, 2020). Common examples of SaaS applications include industry-specific tools like business process automation systems, customer relationship management (CRM) platforms, enterprise resource planning (ERP) solutions and email services (Rahman & Subriadi, 2022).

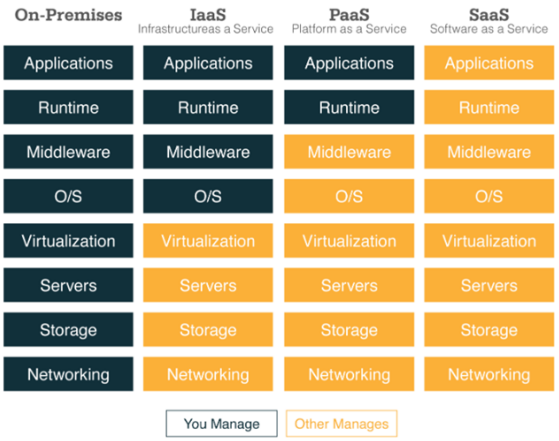

Figure 1. Cloud Computing Service Models

In essence, cloud computing adoption not only enhances operational efficiency and cost-effectiveness for SMEs but also fosters a more agile and responsive business environment (Mohammed & Trzcielinski, 2021). By utilizing scalable, reliable, and cost-effective cloud services, SMEs can enhance their market position and dedicate greater attention to innovation, customer engagement, and business growth in an ever-changing market environment (Abusaimeh et al., 2023). The adoption of cloud computing transforms how SMEs manage and optimize their business processes by utilizing advanced tools and resources available within cloud environments. Tools such as Microsoft Azure, AWS (Amazon Web Services), Google Cloud Platform, Salesforce, and Oracle Cloud can be integrated into these environments to enhance operational capabilities (Alnaimat et al., 2024; Rajput et al., 2023). These platforms provide a range of services like data storage, business intelligence, customer relationship management (CRM), enterprise resource planning (ERP) and machine learning tools that enable SMEs to streamline processes improve decision-making and adapt to evolving market demands (Balabanov, 2022; Baritto et al., 2020).

Cloud-based systems streamline operations by automating routine tasks and providing actionable insights that enhance efficiency (Chaising & Haasis, 2021). Data analytics capabilities in cloud platforms enable SMEs to process and analyze complex data sets to uncover meaningful patterns supporting strategic decision-making and improving business processes (Liu et al., 2020). Cloud solutions also empower SMEs to forecast trends and adapt to market changes to deliver personalized services that enhance customer satisfaction and retention (Forootani et al., 2022).

Study Methodology

Figure 2 provides a flowchart that follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Asif & Fazel, 2024; Riaz et al., 2023). This flowchart offers a visual representation of the systematic approach used to select studies for this research and effectively maps out the entire process from the initial search to the final selection of relevant studies (Asif et al., 2024). It explains the main steps followed in the selection process which involved identifying potential articles conducting a detailed screening to exclude irrelevant studies and assessing article eligibility using a predefined set of inclusion and exclusion criteria.

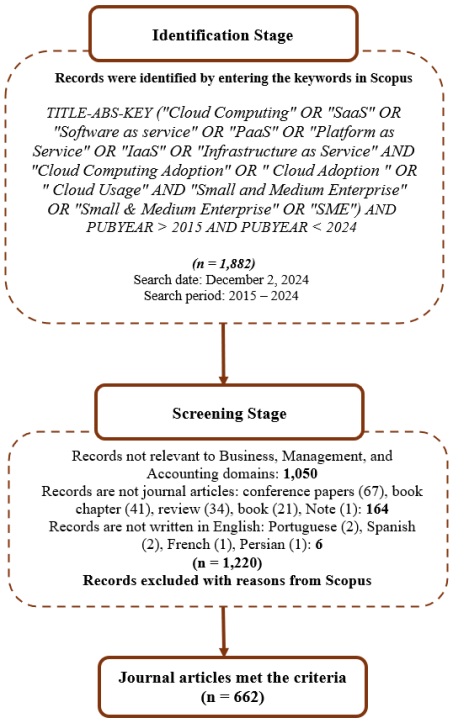

Figure 2. PRISMA Chart

Bibliometric Methodologies for Research

Bibliometric analysis is a trusted method for evaluating and ranking extensive collections of scientific literature. It provides a comprehensive overview of recent developments in active or emerging research areas helping to identify the connections and relationships between references within academic publications (Donthu et al., 2021). Bibliometric data benefits researchers and practitioners by highlighting how different topics are interconnected and explored within the scientific literature (Almeida et al., 2022; Morshidi et al., 2024). A bibliometric analysis uses various statistical techniques to evaluate a scientific subject by examining bibliographic data (Mahmood et al., 2023). Bibliometrics provides a quick and visual way to explore a large volume of articles, enabling the simultaneous analysis of various aspects. This includes tracking publication trends over time, identifying highly cited papers, recognizing prolific authors, pinpointing top institutions, highlighting contributing countries and uncovering prevalent research patterns (Saadouli et al., 2024; G. Sharma & Kulshreshtha, 2023).

Charting the Tool Framework

This study employed VOSviewer (version 1.6.20), a popular software for bibliometric analysis (Jairoun et al., 2024). To address RQ1, RQ2, and RQ3 through descriptive analysis, we utilized "Biblioshiny" (Ibrahim & Kumar, 2023), while VOSviewer was utilized for network analysis to answer RQ4 (Asif & Fazel, 2024). Microsoft Excel was extensively used for data visualization, including generating graphs and charts, as well as for data management tasks such as formatting, table creation, and statistical calculations (Hassan et al., 2023).

Database Selection

Bibliometric research in business, management, accounting and related fields is on the rise as scholars aim to structure and synthesize the expanding body of literature. Researchers often rely on databases like Scopus to access relevant publications and datasets (Ibrahim & Kumar, 2023; Latukismo et al., 2024). This study collected all relevant publications from Scopus which is a well-known academic database managed by Elsevier and highly regarded for its reliability. Scopus is a common data source for most bibliometric analyses due to its credibility and comprehensive coverage of scholarly literature (Baas et al., 2020). The objective of this data collection was to compile a robust and comprehensive dataset that captures the latest academic contributions in the field. Although bibliometric studies often utilize databases like Google Scholar, Scopus, or Web of Science (Bakhmat et al., 2022; Guerrero-Bote et al., 2021), Scopus was selected for this research due to the following reasons:

Scopus introduced by Elsevier in 2004 is known for its reliable bibliographic data in research analysis (Al-Khoury et al., 2022). It initially covered articles from 1996 onward but expanded its archive in 2015 by adding four million pre-2004 articles to enhance its historical data scope (Pranckutė, 2021; Thelwall & Sud, 2022). Unlike Web of Science or some other databases, Scopus provides full access to its content through a single subscription. Additionally, it integrates data from various specialized databases such as Biobase, Embase, Medline, World Textile Index, Fluidex, Compendex, and Geobase, ensuring that all resources are uniformly available (Pranckutė, 2021; Sarjidan & Kasim, 2023).

Unpacking Key Terms

This study aimed on examining the evolving trends and emerging research patterns in cloud computing and its service models IaaS, PaaS and SaaS with an emphasis on their adoption and usage within SMEs. To capture the most recent advancements in this rapidly evolving area, we conducted a comprehensive systematic review of academic literature sourced from the Scopus database. Our search targeted publications from 2015 to 2024, focusing on key terms related to management and business including *"Cloud Computing" OR "SaaS" OR "Software as service" OR "PaaS" OR "Platform as Service" OR "IaaS" OR "Infrastructure as Service" AND "Cloud Computing Adoption" OR " Cloud Adoption " OR " Cloud Usage" AND "Small and Medium Enterprise" OR "Small & Medium Enterprise" OR "SME"*. The key terms were thoughtfully chosen to identify articles closely related to the focus of our study. This search query was conducted in Scopus to ensure thorough coverage. By leveraging the Scopus academic database, we sought to gather a broad spectrum of relevant literature, establishing a strong foundation for our research.

Data Harvesting Approaches

The first step of the study involved collecting academic publications from the Scopus database, spanning from 2015 to 2024, with data extraction taking place on December 2, 2024. This process resulted in a total of 1,882 documents. A careful selection process was then applied to filter out irrelevant or low-quality publications, ensuring that only the most relevant and high-quality documents were included in the dataset.

Publications that did not meet the established criteria were excluded from the study. The focus was maintained on specific categories central to the research including Cloud Computing, Cloud Service Models, Cloud Computing Adoption and Small and Medium

Enterprises. Publications outside these key areas were not considered ensuring the study remained concentrated on its core objectives. Additionally, non-English papers were excluded to ensure consistency and facilitate a thorough analysis. This filtering process was essential in creating a high-quality dataset (see Figure 2), enabling researchers to concentrate on the most relevant and significant studies for detailed examination (Han et al., 2024; Mahmood et al., 2023).

Analytical Practices

Several measures were taken to substantially improve the quality and reliability of the dataset, establishing a strong base for the analysis and ensuring the credibility of the research outcomes (Caputo & Kargina, 2022; Yıldız & Yılmaz, 2023). For this study data in BibTeX format was obtained from Scopus and R-Studio along with Biblioshiny was used to streamline data management and analysis (Hasnan et al., 2024; Ibrahim & Kumar, 2023; Mahmood et al., 2023). R-Studio and Biblioshiny were employed to analyze RQ1, RQ2, and RQ3, while Microsoft Excel was used to generate tables and bar charts for RQ1 and RQ3. For RQ4, VOSviewer was utilized to generate the co-occurrence keyword network, which was visualized in four distinct color-coded clusters. Additionally, Microsoft Excel was used to create the cluster tables.

Findings

The findings of the bibliometric analysis are organized around the four research questions outlined in this study.

Answer to Research Question 1

Figure 3 demonstrates a significant rise in research related to Cloud Computing and its adoption by SMEs. The number of scholarly articles has steadily increased over the past ten years, starting with just 14 publications in 2015 and reaching a peak of 140 in 2024. This sharp growth particularly since 2020 reflects the growing academic focus on how digital advancements are influencing SMEs. The transformation of the global SME landscape through cloud adoption is clearly mirrored in the literature, as shown in Figure 3. This upward trend emphasizes the growing recognition of cloud computing's role in SMEs and highlights the need for ongoing research in this field.

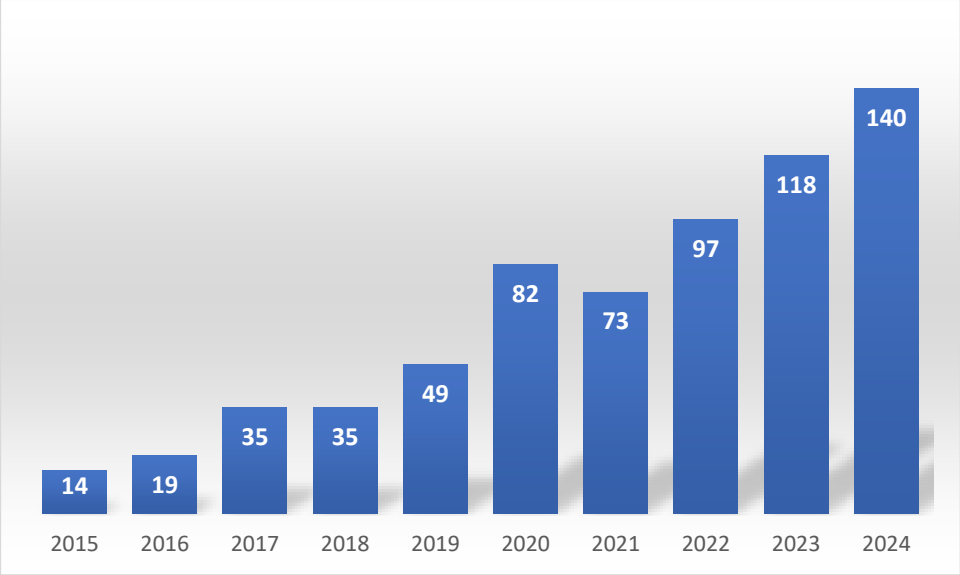

Figure 3. Answer to RQ1: annual scientific production

Answer to Research Question 2

Figure 4 highlights the contributions of prominent researchers with Vikas Kumar standing out as a leading figure in the field. He has an impressive track record of publications including 10 articles relevant to this study that were published between 2016 and 2023 and indexed in the Scopus database. His work covers a wide range of topics, particularly focusing on Cloud Computing adoption in SMEs. He explores the critical factors for successful cloud integration, such as organizational readiness and technological infrastructure and examines how cloud technologies enhance business performance, streamline operations and foster growth. Notably, his publication output increased significantly in 2023, with three articles published that year. Rakesh D. Raut has also made significant contributions by publishing 10 articles between 2017 and 2022. His research links Cloud Computing and its service models like SaaS, PaaS and IaaS adoption to enhanced efficiency across various sectors including manufacturing and e-commerce. He highlights the importance of leadership, resource management and external pressures in successfully implementing cloud technologies in SMEs.

Researchers such as Sunday Chinedu Eze, Bhaskar B. Gardas, and Pragati Priyadarshinee have each published nine articles in the last decade, contributing valuable insights into the integration of innovative technologies within small business firms. Their work covers cloud computing, cloud sourcing decisions and frameworks like IaaS, PaaS and SaaS addressing success factors and challenges. They also emphasize the adoption benefits including scalability, cost savings and innovation. Additionally, researchers like Adenike O. Bello, Vera C. Chinedu-Eze and Tiago Oliveira have explored emerging technologies including Cloud Computing, Industry 4.0, and Cloud ERP thus contributing significantly to the literature on technological usage in the industry.

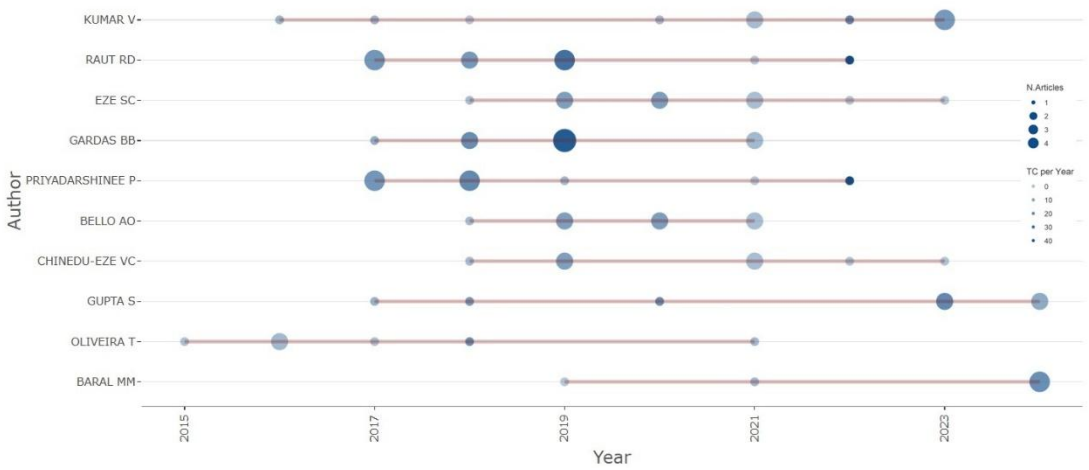

Figure 4. Answer to RQ2 : Prominent Research Contributors

Answer to Research Question 3

Table 1

Answer to RQ3 : Countries Driving Major Contributions

Country	Articles	Articles %	SCP	MCP	MCP %
INDIA	104	15.7	93	11	10.6
MALAYSIA	54	8.2	34	20	37
CHINA	46	6.9	27	19	41.3
UNITED KINGDOM	34	5.1	12	22	64.7
INDONESIA	19	2.9	16	3	15.8
AUSTRALIA	18	2.7	12	6	33.3
JORDAN	18	2.7	14	4	22.2
USA	18	2.7	7	11	61.1
IRAN	17	2.6	15	2	11.8
ITALY	17	2.6	11	6	35.3

The table presents an analysis of publications by various countries, highlighting their total contributions, proportions, and categorization into Single Country Publications (SCP) and Multiple Country Publications (MCP). India leads with 104 articles, accounting for (15.7%) of the total, with 93 articles as SCP and 11 as MCP, reflecting a (10.6%) share of MCPs. Malaysia follows with 54 articles, representing (8.2%) of the total, where 34 are SCP and 20 are MCP, indicating a significant (37%) collaboration rate. China has published 46 articles, contributing (6.9%) overall, with 27 as SCP and 19 as MCP, achieving a (41.3%) MCP rate. The United Kingdom shows notable collaboration with 34 articles, (5.1%) of the total, of which only 12 are SCP while 22 are MCP, resulting in the highest MCP percentage of (64.7%). Indonesia has 19 articles, comprising (2.9%) of the total, with 16 as SCP and 3 as MCP, giving it a (15.8%) MCP share. Other notable contributors are Australia, Jordan and the USA each publishing 18 articles (2.7%) along with Iran and Italy each contributing 17 articles (2.6%), demonstrating varying levels of international collaboration reflected in their MCP ratios.

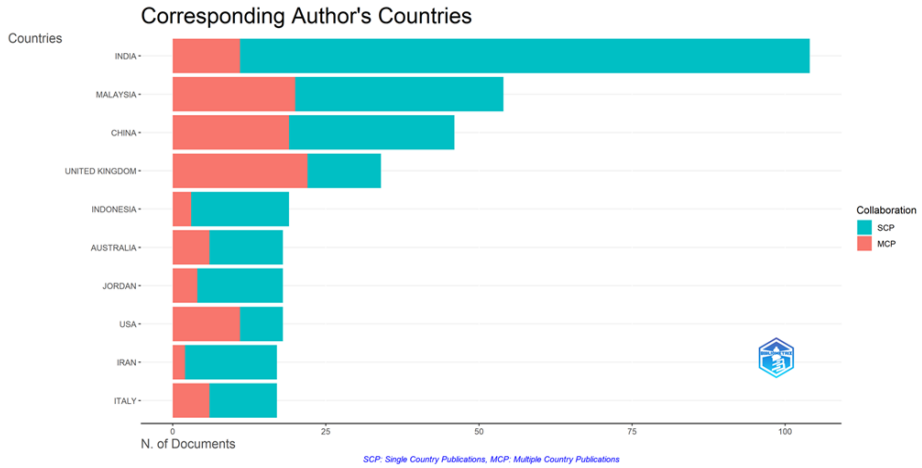

Figure 5. Answer to RQ3 : Countries Driving Major Contributions

Figure 6 addresses Research Question 3 by identifying the most prominent academic journals in the field and highlighting their influence on ongoing discussions. Leading the list is the *"International Journal of Business Information Systems"*, with 28 articles underscoring its substantial impact and contribution to the field. It is followed by "*Technological Forecasting and Social Change"* with 20 papers and the *"Journal of Science and Technology Policy Management"* which has 16 articles, each significantly advancing scholarly discourse. *"Technology in Society"* follows closely with 14 published papers further solidifying its importance. Both *"Industrial Management"* and *"Data Systems and Journal of Enterprise Information Management"* have contributed 13 articles each showcasing their relevance and influence. *"Benchmarking"* has 12 papers while *"IEEE Transactions on Engineering Management*", *"International Journal of Information Management"* and *"International Journal of Innovation and Technology Management"* each feature 11 articles, cementing their roles as key contributors to the academic conversation.

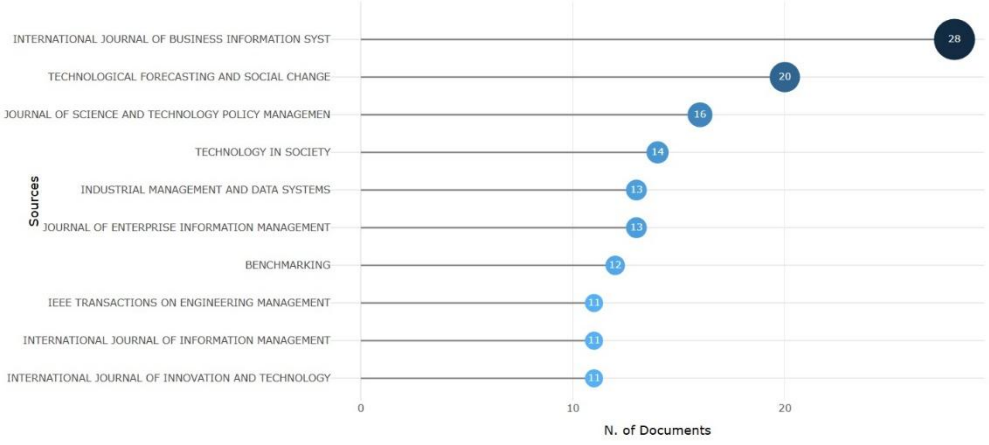

Figure 6. Answer to RQ3 : Top Journals by Contribution

Answer to Research Question 4

To answer RQ4, we performed a keyword co-occurrence analysis on a dataset comprising 662 articles. Using VOSviewer, this technique enabled us to identify key themes and emerging research directions in the field. Our analysis focused on trends related to cloud computing and its adoption in SMEs. As shown in Figure 7, the keyword co-occurrence network reveals 45 keywords that appeared over 10 times within a total of 2,914 keywords. These frequently occurring keywords highlight their importance and relevance in the literature, providing

insights into future research directions. The co-occurrence network in Figure 6 is divided into four distinct clusters, each represented by a different colour (red, green, blue, or yellow).

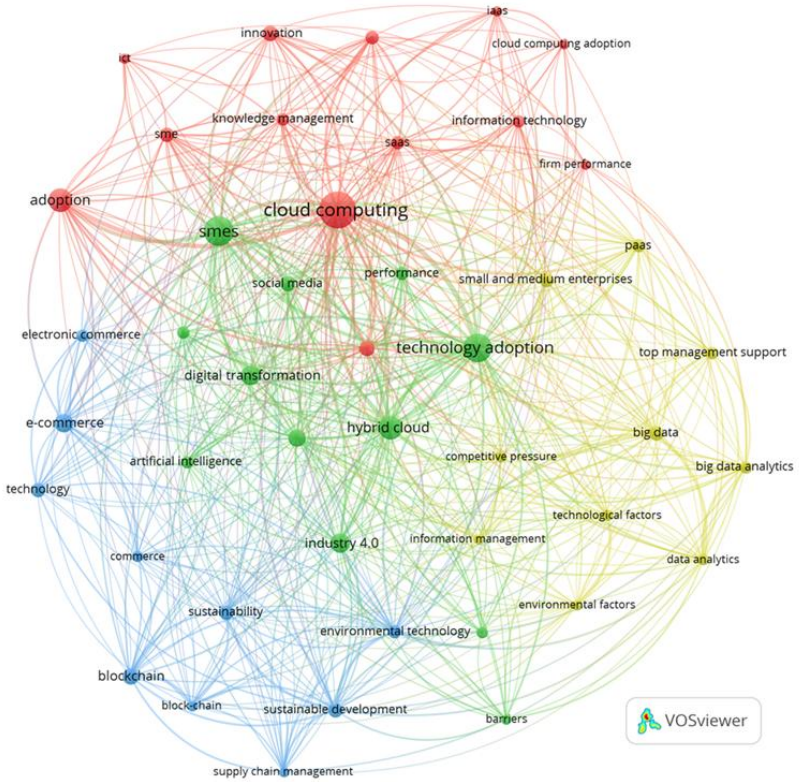

Figure 7. Answer to RQ4 : Keyword Co-occurrence Study

Cloud Innovation for SMEs: The Impact of SaaS and IaaS

Table 2 presents the keywords from Cluster-1, which highlights the topic "Cloud Innovation for SMEs: The Impact of SaaS and IaaS". This cluster revolves around the adoption and impact of cloud computing technologies on small and medium enterprises (SMEs) particularly in developing countries (Habahbeh & Obidat, 2021; M. Sharma et al., 2023). At its core the cluster highlights "digital transformation" as a key driver of innovation, with cloud-based solutions such as SaaS and IaaS playing a pivotal role in reshaping business operations (Wen et al., 2024). These technologies enable SMEs to access advanced "information technology" resources which were previously out of reach due to financial and infrastructural limitations (Tırpan & Bakırtaş, 2024). The terms "cloud computing" and "cloud computing adoption" underscore the growing interest in leveraging cloud solutions to enhance organizational efficiency, scalability and flexibility (Kamarudin et al., 2022). SMEs in developing countries face resource constraints and limited access to cutting-edge technologies are now increasingly turning to cloud computing as a cost-effective means of accelerating their digital transformation (Khayer et al., 2021).

"Knowledge management" emerges as a critical component in this context as cloud platforms facilitate the storage and sharing of organizational knowledge, thereby enhancing decision-making and innovation (Tsui, 2023). The integration of cloud computing with broader "ICT" (Information and Communication Technology) infrastructure further strengthens the digital capabilities of SMEs allowing them to compete in a rapidly evolving global market (Dziembek,

2024; Somohano-Rodríguez & Madrid-Guijarro, 2022). Ultimately, this cluster underscores the significant impact of cloud computing on "firm performance," highlighting how the adoption of these technologies fosters innovation, improves operational efficiency and drives sustainable growth for SMEs in developing economies.

Table 2
Answer to RQ4 Co-occurrence Trends in Cluster 1

Rank	Keyword	Occurrences	Links	Total link strength
1	Cloud Computing	139	43	242
2	Adoption	54	27	91
3	SaaS	42	21	49
4	SME	28	32	71
5	IaaS	26	24	55
6	Small and Medium Enterprise	19	24	53
7	Innovation	18	32	56
8	Knowledge Management	16	19	31
9	Information Technology	15	23	34
10	Cloud Computing Adoption	`12	15	20
11	Firm Performance	12	17	22
12	Developing Countries	12	15	29
13	ICT	12	12	20

Cloud, AI and Industry 4.0: Empowering the Future of SMEs

Table 3 highlights Cluster 2 "Cloud, AI and Industry 4.0: Empowering the Future of SMEs". This cluster highlights the critical themes driving the adoption of digital technologies among SMEs (Arroyabe et al., 2024). The convergence of "digital transformation," "industry 4.0," and "technology adoption" underscores the growing reliance of SMEs on advanced technologies to enhance their operational efficiency, innovation and overall business performance (Onu & Mbohwa, 2021; Pylaeva et al., 2022). In particular, the inclusion of "hybrid cloud" and "artificial intelligence" (AI) reflects the increasing integration of cloud-based solutions and AI-driven tools in SME operations enabling these enterprises to optimize resource utilization, streamline processes and improve decision-making (Ali & Khan, 2024; Xiong et al., 2024). "Social media" emerges as another significant factor demonstrating its role in expanding market reach, enhancing customer engagement and driving brand visibility for SMEs in a digital-first economy (Matarazzo et al., 2021; Meier & Peters, 2023). However, the cluster also acknowledges the "barriers" faced by SMEs in this technological shift including resource constraints, skill gaps and resistance to change. These challenges often hinder the smooth adoption and implementation of digital technologies (Arranz et al., 2024; Faiz et al., 2024).

By focusing on "performance," the cluster emphasizes the ultimate goal of digitalization to improve business outcomes. For SMEs, leveraging digital technologies is not merely about keeping pace with industry trends but also about enhancing competitiveness and long-term sustainability in an increasingly digital marketplace (Fang et al., 2024). This cluster thus provides a holistic view of the interplay between technological innovation, organizational transformation and the performance potential of SMEs as they navigate the complexities of the digital age.

Table 3
Response to RQ4 Co-occurrence Trends in Cluster 2

Rank	Keyword	Occurrences	Links	Total link strength
1	SMEs	88	37	154
2	Technology Adoption	84	41	207
3	Hybrid Cloud	58	41	108
4	Digital Transformation	40	28	64
5	Industry 4.0	40	26	58
6	Small and Medium-Sized Enterprise	31	34	99
7	Social media	25	24	46
8	Performance	18	27	44
9	Artificial Intelligence	16	22	35
10	Digital Technologies	16	26	48
11	Small and Medium-Sized Enterprises	13	14	25
12	Barriers	12	19	31

Sustainable Development through Digital Innovation

Table 4 spotlights Cluster 3 "Sustainable Development Through Digital Innovation", this cluster explores the intersection of e-commerce, blockchain technology and sustainability emphasizing their collective impact on modern supply chain management and sustainable development (Kholaif et al., 2024; Wan et al., 2022). Primarily, the cluster highlights "e-commerce" and "electronic commerce" as key drivers of digital transformation in global trade reshaping how businesses operate and interact with consumers (Yang et al., 2023). These technologies have revolutionized traditional commerce enabling more efficient and accessible marketplaces (Bernovskis et al., 2024). "Blockchain" emerge as pivotal element within this ecosystem offering enhanced transparency, security and traceability across supply chains (Centobelli et al., 2022; Gligor et al., 2022). By providing a decentralized and immutable ledger blockchain technology addresses critical challenges such as fraud, inefficiencies and trust issues in digital transactions and logistics (Onu et al., 2024; Rivera et al., 2024). Its integration with supply chain management has significantly improved operational efficiency, reduced costs and bolstered trust among stakeholders (Vazquez Melendez et al., 2024).

The cluster also underscores the growing importance of "sustainability" and "sustainable development" in the context of technological advancements (Caiado et al., 2024). Businesses are increasingly leveraging "environmental technology" to reduce their ecological footprint, optimize resource utilization and align with global sustainability goals (Saqib et al., 2024; Sharif et al., 2024). This shift reflects the need for responsible innovation that balances economic growth with environmental preservation. Overall, this cluster highlights the dynamic relationship between technology, commerce and sustainability emphasizing how advancements like e-commerce and blockchain are driving more resilient, transparent and sustainable business ecosystems. It offers valuable insights into the future of digital trade and sustainable supply chains positioning technology as a key enabler of sustainable economic growth.

Table 4
Response to RQ4 Co-occurrence Trends in Cluster 3

Rank	Keyword	Occurrences	Links	Total link strength
1	E-Commerce	36	25	55
2	Blockchain	28	27	68
3	Sustainable Development	22	31	86
4	Sustainability	20	28	60
5	Technology	20	20	38
6	Environmental Technology	18	33	89
7	Electronic Commerce	17	21	32
8	Commerce	13	22	36
9	Block-Chain	12	24	49
10	Supply Chain Management	12	24	47

Technological Dynamics in SME Transformation

Table 5 spotlights Cluster 4 "Technological Dynamics in SME Transformation, this cluster emphases on the technological and organizational dynamics shaping the adoption of advanced digital solutions within SMEs (Broccardo et al., 2024; Ciampi et al., 2022). In essence, the keywords highlight the transformative role of big data and big data analytics in driving innovation and enhancing decision-making processes within SMEs (Maroufkhani et al., 2023). These technologies enable organizations to extract valuable insights from large datasets empowering them to improve operational efficiency, optimize resource allocation and gain a competitive edge in their respective markets (Falahat et al., 2022; Shah, 2022).

A key enabler of this digital shift is PaaS which provides scalable cloud-based infrastructure that supports the deployment and management of big data solutions (Chinesta Llobregat, 2024). The integration of PaaS reduces the technological barriers SMEs often face allowing them to adopt sophisticated data analytics tools without the need for extensive in-house IT infrastructure (Modisane & Jokonya, 2021). The successful implementation of these technologies requires strong top management support as leadership plays a crucial role in driving digital transformation initiatives (Omrani et al., 2022; X. Zhang et al., 2022). Top management not only allocates resources but also fosters a culture of innovation and adaptability within the organization (Lam et al., 2021).

Competitive pressure and environmental factors are also prominent in this cluster, reflecting the external forces that push SMEs to innovate and adopt new technologies to remain competitive in a rapidly evolving business landscape (Bawono et al., 2022; Shahadat et al., 2023). The interplay between technological factors and information management further underscores the importance of effective data governance and IT infrastructure in supporting digital transformation (Ko et al., 2022). Overall, this cluster highlights the strategic importance of leveraging big data technologies and cloud-based platforms to enhance business resilience, agility and long-term competitiveness in SMEs.

Table 5
Response to RQ4 Co-occurrence Trends in Cluster 4

Rank	Keyword	Occurrences	Links	Total link strength
1	PaaS	29	25	44
2	Small and Medium Enterprises	21	33	84
3	Big Data	19	28	66
4	Big Data Analytics	15	23	62
5	Top Management Support	15	21	40
6	Competitive Pressure	14	25	46
7	Data Analytics	13	26	69
8	Technological Factors	13	24	44
9	Environmental Factors	12	25	45
10	Information Management	12	24	38

Conclusion

This bibliometric study provides a detailed analysis of current research highlighting emerging trends and shifts in academic focus. The findings show that SMEs are increasingly adopting cloud computing through service models such as IaaS, PaaS and SaaS to improve performance by spending less and gain a competitive edge. These technologies are reshaping SME operations by presenting significant opportunities and challenges. Understanding these dynamics is essential for future research to explore the broader impact of digital transformation on SMEs and offer insights into how they can effectively leverage cloud computing to overcome obstacles and achieve sustainable growth.

The study also emphasizes the transformative power of IaaS, PaaS and SaaS for SMEs focusing on the strategic adoption and integration of these cloud services. When implemented efficiently these technologies enhance operational efficiency, boost competitiveness and drive business success. Future research should explore strategies for seamless integration of cloud solutions ensuring SMEs fully maximize their potential benefits. By adopting innovative approaches researchers can help SMEs harness digital transformation to improve performance and secure a lasting competitive advantage. This ongoing exploration is vital for fostering growth and sustainability in a fast-evolving digital business environment.

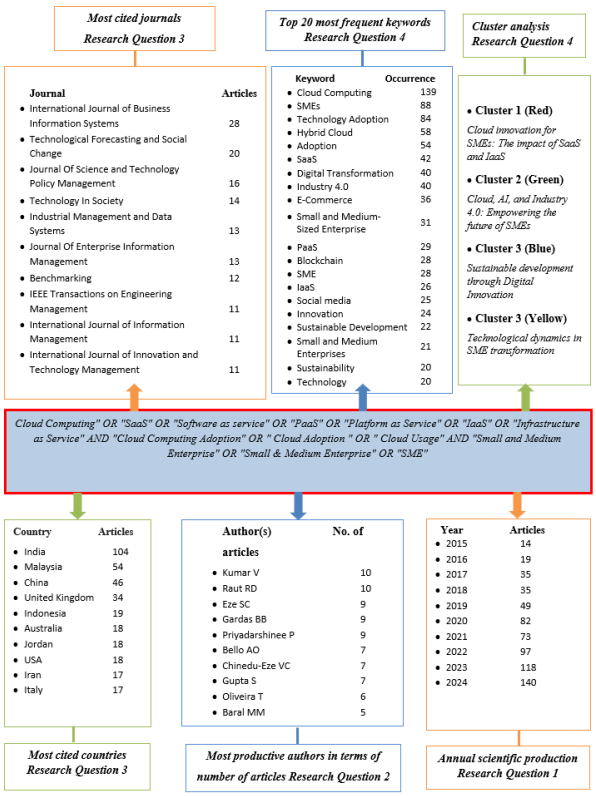

Figure 7. Research Mapping

Theoretical Implications

This study enriches the academic discourse on cloud computing adoption by SMEs providing a deeper understanding of how service models such as IaaS, PaaS, and SaaS influence business performance. It bridges the gap between digital transformation theories and practical applications offering insights into the dynamic interplay of technology, strategy and growth in SMEs. By analysing trends and emerging patterns, the research highlights the transformative potential of cloud services in driving operational efficiency and competitiveness.

The findings underscore the need for theoretical frameworks that account for the unique challenges SMEs face in adopting cloud technologies. This study encourages future research to explore the specific ways cloud solutions interact with organizational processes, business models and market demands. It also opens avenues for investigating the socio-technical aspects of cloud adoption, such as cultural readiness and employee adaptability, which remain underexplored. Additionally, the study provides a robust foundation for examining the role of cloud computing in fostering innovation and sustainability in SMEs. Scholars can build upon these insights to develop targeted strategies that address adoption barriers while maximizing the potential of cloud technologies in small and medium enterprises.

Practical Implications

For practitioners, this research highlights the strategic importance of adopting cloud computing models like IaaS, PaaS, and SaaS to enhance SME performance. It offers actionable insights for business leaders seeking to optimize operations and reduce costs while maintaining agility in a fast-evolving market. By leveraging cloud platforms, SMEs can

streamline data management, improve decision-making and access scalable tools that foster innovation without significant upfront investments.

The study also emphasizes the importance of understanding the specific needs and constraints of SMEs when integrating cloud technologies. Business leaders are encouraged to adopt tailored solutions that align with their organizational goals ensuring seamless implementation and minimizing disruption. The findings provide a roadmap for addressing adoption challenges such as resource limitations, security concerns and skill gaps. Additionally, the study underscores the role of training and capacity-building initiatives in equipping SME employees with the skills required to maximize the benefits of cloud computing.

Policymakers and industry stakeholders can leverage these insights to create supportive ecosystems that encourage cloud adoption among SMEs. This includes developing affordable cloud solutions, fostering partnerships with technology providers and offering incentives that lower entry barriers. These efforts can drive sustainable growth and competitiveness in SMEs ensuring their resilience in the digital economy.

Limitations

This study has certain limitations primarily due to its exclusive reliance on data from Scopus. Although Scopus is a widely recognized database it may exclude relevant research from other sources which could provide valuable insights. This approach might restrict the scope of findings by overlooking contributions from non-English publications or less prominent outlets. The study's ten-year timeframe from 2015 to 2024 also presents a limitation as it focuses on recent advancements but may miss earlier foundational studies important for understanding the evolution of cloud computing and its service models IaaS PaaS and SaaS in SMEs. Additionally, the focus on journal articles excludes insights from other types of documents such as conference papers, technical reports and industry publications. Future research could address these gaps by incorporating diverse data sources extending the time period and including a broader range of document types to achieve a more comprehensive understanding of the field.

Future Research Directions

Building on the findings and limitations of this study several directions for future research are proposed. While this study broadly explored the adoption and use of cloud computing and its service models IaaS, PaaS and SaaS in SMEs future research could focus specifically on other aspects like cloud deployment models Public, Private, Community and Hybrid to gain deeper insights. Expanding the scope beyond the Scopus database to include platforms like WoS, Google Scholar and IEEE Xplore could provide a more extensive understanding of digital technologies in SMEs. Extending the study period beyond 2015 to 2024 would allow researchers to trace longer-term trends and shifts in technology adoption. Future studies could also examine challenges faced by SMEs such as costs technical expertise and organizational readiness to develop strategies that facilitate smoother digital transformation. Comparative analyses across regions industries and company sizes may reveal how different contexts affect technology adoption and outcomes. A multidisciplinary approach combining perspectives from computer science economics and management could provide a more

comprehensive understanding of how cloud computing supports SME growth and competitiveness within broader business strategies.

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