


Digital Ecosystem and Business Transformation: Bibliometric Analysis of Global Startups

Loso Judijanto
IPOSS Jakarta, Indonesia

Article Info	ABSTRACT
<p>Article history:</p> <p>Received Nov, 2025 Revised Nov, 2025 Accepted Nov, 2025</p> <hr/> <p>Keywords:</p> <p>Digital Transformation Startup Ecosystems Artificial Intelligence Business Model Innovation Global Startups</p>	<p>This study conducts a comprehensive bibliometric analysis to map the global scientific landscape of digital ecosystems and business transformation in startup environments. Using Scopus-indexed publications and VOSviewer-based visualization, the analysis identifies influential literature, thematic clusters, co-authorship patterns, and country-level collaboration networks. The findings reveal four dominant intellectual pillars: digital transformation as strategic renewal, AI-enabled business model innovation, ecosystem-based capability development, and entrepreneurial resilience during crises. Network and density visualizations highlight “digital transformation” as the conceptual core, surrounded by interconnected themes including ecosystems, digital platforms, innovation, big data, and dynamic capabilities. Overlay mapping shows a clear temporal shift from foundational digitalization concepts toward more advanced themes such as sustainability, AI-driven strategies, and platform ecosystems. The co-authorship and country collaboration networks demonstrate strong research activity across Europe and Asia, led by Germany, the United Kingdom, China, India, and the Russian Federation. The study contributes by offering an integrated understanding of how global scholarship conceptualizes digital transformation within startup ecosystems and identifies future research pathways centered on AI, resilience, and sustainable digital innovation.</p> <p><i>This is an open access article under the CC BY-SA license.</i></p> <div></div>

Corresponding Author:

Name: Loso Judijanto
Institution: IPOSS Jakarta, Indonesia
Email: losojudijantobumn@gmail.com

1. INTRODUCTION

The rapid proliferation of digital technologies has reshaped the competitive landscape and accelerated the transformation of business ecosystems across the world. Startups, as key drivers of innovation, are at the forefront of these changes, leveraging artificial intelligence, data analytics, platform-

based interactions, and digitally enabled business models to achieve scale and market relevance [1], [2]. Within this shifting environment, the concept of a digital ecosystem has emerged as a strategic lens for understanding how organizations create value collaboratively rather than through isolated operations. Digital ecosystems highlight interdependence between firms,

technologies, platforms, and users, demonstrating that business success increasingly depends on the ability to integrate, coordinate, and innovate within complex technological networks [3], [4]. This phenomenon is particularly evident in global startup environments where agility, connectivity, and data-driven decision-making have become core determinants of competitiveness.

The transition toward digital business models has also accelerated due to the growing ubiquity of artificial intelligence (AI) and automation. These technologies have shifted how startups develop products, engage customers, and manage internal processes. AI-driven analytics, machine learning, robotic process automation, and digital platforms collectively enable startups to enhance efficiency while offering personalized and scalable services. As highlighted in major scholarly works summarized within the dataset such as those by [5]–[7] the digital transformation movement extends beyond technical upgrades: it represents a fundamental reconfiguration of strategic capabilities, organizational routines, and innovation pathways. Consequently, understanding how startups participate in digital transformation requires a holistic analysis that encompasses technology, strategy, and ecosystem-based collaboration. [7]–[9]

In parallel, the global literature on digital transformation has expanded significantly, producing rich insights but also presenting fragmentation across themes such as AI capabilities, business model innovation, Industry 4.0 adoption, data-driven ecosystems, and organizational redesign. The rapid expansion of this body of knowledge calls for structured mapping to clarify patterns, intellectual roots, and future research opportunities [10], [11]. Bibliometric analysis serves as a robust methodology to achieve this objective, as it quantitatively examines scientific publications to uncover influential authors, key thematic clusters, and global collaboration networks. Through network visualization, overlay mapping, co-

authorship structures, and density analysis, researchers can systematically understand how digital transformation scholarship has evolved and which directions it is likely to take in the future.

Despite the importance of digital transformation and its close relationship with startup success, prior studies often focus on isolated components—such as technological adoption or strategic alignment—without examining the larger ecosystem context that integrates these elements, creating a need for a more comprehensive assessment of the scientific landscape that shapes startup-oriented digital transformation research. By analyzing impactful publications, key authors, and evolving thematic trends, a bibliometric synthesis helps bridge existing knowledge gaps and offers clarity on how digital ecosystems foster resilience, adaptability, and sustainable growth in startups; for instance, literature on AI-enabled business model innovation, resilience during crises, and digital capabilities in SMEs appears recurrent within highly cited works, signaling a shift toward more dynamic and ecosystem-centric perspectives. Within this context, the present study positions itself as an essential contribution to understanding how global academic discourse conceptualizes the intersection between digital ecosystems and business transformation in startup environments by mapping intellectual structures, identifying seminal works, and visualizing collaborative patterns using bibliometric techniques applied to Scopus-indexed publications. This approach not only illustrates the theoretical evolution of the topic but also highlights practical implications for startup founders, policymakers, and digital innovation stakeholders, ultimately providing deeper insight into the strategic role of AI, digital platforms, and innovation networks in shaping the future of entrepreneurial ecosystems.

2. METHODS

2.1 Design

This study employs a bibliometric analysis approach to systematically map the scientific landscape of digital ecosystems and business transformation within global startup contexts. Bibliometric analysis is particularly suitable for fields experiencing rapid conceptual expansion, as it allows researchers to objectively examine publication patterns, influential works, thematic linkages, and global collaboration structures. By combining quantitative citation mapping with visual network analysis, this method provides a comprehensive and structured overview that reveals both intellectual foundations and emerging research fronts. In alignment with the objectives of this study, bibliometric techniques were used to identify high-impact literature, analyze co-authorship networks, and visualize the evolution of digital transformation themes.

2.2 Data Source and Selection Process

The dataset for this research was obtained from the Scopus database, recognized as one of the most comprehensive indexing platforms for high-quality scientific publications, and selected due to its wide disciplinary coverage and robust analytical features that ensure the reliability of citation insights and metadata retrieval. The search strategy targeted publications related to digital transformation, digital ecosystems, startups, business innovation, artificial intelligence capabilities, and technological shifts in organizational contexts, with search strings designed to capture conceptual variations such as “Industry 4.0,” “business model innovation,” “AI-enabled transformation,” and “digitalization strategies.” After applying the search filters, the retrieved publications were screened for relevance to ensure alignment with the thematic scope of digital ecosystems and startup-driven transformation, and only peer-reviewed journal articles, conference papers, and reviews indexed in Scopus were retained, while books, book chapters, editorials, and non-scholarly reports were excluded to maintain data consistency. The final dataset

represents the most influential works in the field, as reflected in Table 1, which includes high-impact publications authored by leading scholars such as Hanelt et al. (2021), Björkdahl (2020), and Sjödin et al. (2021).

2.3 Analytical Tools and Procedures

To conduct the bibliometric analysis, the study utilized VOSviewer, a widely adopted software tool for constructing and visualizing bibliometric networks. VOSviewer enables the creation of multiple forms of visual mapping, including co-occurrence networks, citation networks, co-authorship structures, and density visualizations, allowing intuitive interpretation of relationships between authors, keywords, and research themes. Four main visualization outputs were generated: (1) Network Visualization, which maps frequently occurring keywords into thematic clusters based on their co-occurrence strength, highlighting major themes such as digital transformation, AI capabilities, business model innovation, and digital ecosystems; (2) Overlay Visualization, which captures the temporal evolution of research themes by assigning colors to nodes based on publication year, enabling the distinction between emerging topics like AI-enabled transformation, digital resilience, and data-driven innovation, and earlier foundational concepts such as digitalization and strategic alignment; (3) Density Visualization, which shows research hotspots through brighter regions indicating dense concentrations of literature, thereby revealing dominant topics and underexplored areas; and (4) Co-Authorship Networks, which map collaborative relationships among authors and countries, illustrating the intellectual communities and cross-national partnerships that shape the global development of digital transformation scholarship.

In addition to visual mapping, a citation analysis was conducted to identify the most influential works that underpin the digital transformation discourse. Citation data were extracted directly from Scopus

metadata, and the most highly cited publications were summarized in Table 1, reflecting foundational contributions such as digitalization strategies (Björkdahl, 2020), digital transformation challenges addressed through multi-stakeholder collaboration (Brunetti et al., 2020), robotic process automation (Hofmann et al., 2020), and AI-enabled business model innovation (Sjödin et al., 2021). The integration of citation counts strengthens the robustness of the findings by highlighting both theoretical and empirical works that dominate scholarly attention. To ensure analytical accuracy, the study also applied systematic metadata verification

procedures, including cross-checking author names, standardizing keywords, and removing duplicate entries. The combination of Scopus-based data retrieval, VOSviewer visual analytics, and rigorous citation analysis aligns with established bibliometric practices, ensuring that the insights generated accurately reflect the structure, evolution, and intellectual foundations of the field.

3. RESULTS AND DISCUSSION

3.1 Citation Analysis: Identifying the Intellectual Foundations

Table 1. The Most Impactful Literatures

Citations	Authors and year	Title
1558	Hanelt, A., Bohnsack, R., Marz, D., Antunes Marante, C. (2021)	A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change
420	Björkdahl, J. (2020)	Strategies for Digitalization in Manufacturing Firms
354	Ibarra, D., Ganzarain, J., Igartua, J.I. (2018)	Business model innovation through Industry 4.0: A review
351	Pappas, I.O., Mikalef, P., Giannakos, M.N., Krogstie, J., Lekakos, G. (2018)	Big data and business analytics ecosystems: paving the way towards digital transformation and sustainable societies
349	Sjödin, D., Parida, V., Palmié, M., Wincent, J. (2021)	How AI capabilities enable business model innovation: Scaling AI through co-evolutionary processes and feedback loops
348	Brunetti, F., Matt, D.T., Bonfanti, A., ... Pedrini, G., Orzes, G. (2020)	Digital transformation challenges: strategies emerging from a multi-stakeholder approach
300	Volberda, H.W., Khanagha, S., Baden-Fuller, C., Mihalache, O.R., Birkinshaw, J. (2021)	Strategizing in a digital world: Overcoming cognitive barriers, reconfiguring routines and introducing new organizational forms
284	Hofmann, P., Samp, C., Urbach, N. (2020)	Robotic process automation
255	Plekhanov, D., Franke, H., Netland, T.H. (2023)	Digital transformation: A review and research agenda
251	Khurana, I., Dutta, D.K., Singh Ghura, A. (2022)	SMEs and digital transformation during a crisis: The emergence of resilience as a second-order dynamic capability in an entrepreneurial ecosystem

Source: Scopus, 2025

The citation analysis revealed a set of highly influential publications that constitute the core intellectual framework for understanding digital transformation in startups. As shown in Table 1, the most highly cited work is the systematic review by Hanelt et al. (2021), receiving 1558 citations and demonstrating its central role in synthesizing

digital transformation research and shaping ongoing scholarly debates through insights on strategic renewal, organizational capability development, and the multi-dimensional nature of digital transformation. The second-most influential contribution is Björkdahl (2020) with 420 citations, emphasizing digitalization strategies within

manufacturing firms and illustrating how lessons from traditional industries spill over into entrepreneurial ecosystems, particularly in areas of digital capability building and operational optimization. Pivotal studies by Ibarra et al. (2018) and Pappas et al. (2018)—with 354 and 351 citations, respectively—further highlight Industry 4.0-driven business model innovation and the role of big data ecosystems in enabling organizational agility and sustainability, both of which are critical for startup survival. The literature additionally reflects a strong focus on AI-driven innovation, as evidenced by Sjödin et al. (2021) with 349 citations, who argue that artificial intelligence acts as a dynamic enabler of continuous business model transformation through co-evolutionary processes and feedback loops, pointing to the growing integration of machine learning and AI capabilities into startup innovation strategies. Emerging yet impactful contributions such as Plekhanov et al. (2023) and Khurana et al.

(2022) add depth to this landscape by highlighting two contemporary trends: the increasing importance of resilience within entrepreneurial ecosystems and the expanding role of digital technologies as strategic infrastructure during crises. Together, these works affirm four dominant intellectual pillars that underpin the current discourse on digital transformation in startups: (1) digital transformation as a form of strategic renewal, (2) AI- and data-driven business model innovation, (3) ecosystem-based digital capability development, and (4) resilience and adaptability in crisis contexts. These pillars collectively inform the thematic evolution observed in the network and density visualizations, illustrating how scholarly attention has progressed toward more dynamic, integrated, and ecosystem-oriented perspectives on digital transformation.

3.2 Keyword Network Structure: Mapping the Thematic Core of the Field

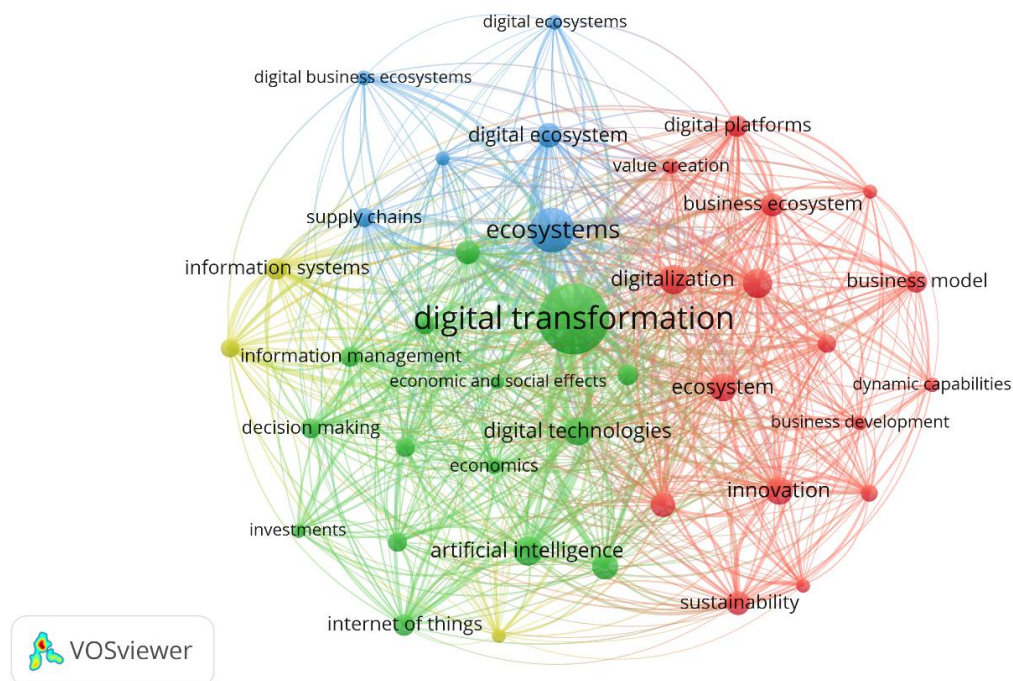


Figure 2. Network Visualisation

Source: Data Analysis Result, 2025

The Network Visualization (Figure 1) reveals the conceptual architecture of the field, with “digital transformation” serving as the central and most dominant term, demonstrating its extensive use as both a theoretical construct and a contextual anchor. Surrounding this core are multiple interconnected clusters that map the thematic landscape of digital transformation research. The first cluster, Digital Transformation and Technology Infrastructure (Green Cluster), includes terms such as digital technologies, information systems, decision making, investments, and information management, emphasizing that digital transformation is strongly rooted in technological infrastructures and data-driven managerial processes essential for startup efficiency. The second cluster, Innovation, Business Model, and Dynamic Capabilities (Red Cluster), contains keywords such as innovation, business model, business development, and dynamic capabilities, signaling that digital transformation is deeply tied to capability reconfiguration, the creation of new value propositions, and experimentation with digitally enabled business models. This aligns with highly cited studies in Industry 4.0 and AI-enabled innovation, which highlight the transformative impact of advanced technologies on organizational adaptation.

The third cluster, Ecosystems and Digital Platforms (Blue Cluster), features terms like digital ecosystems, business ecosystems, digital platforms, value creation, and supply chains, reflecting the shift toward viewing startups as part of interconnected, collaborative networks rather than isolated entities. This cluster underscores the growing recognition that platforms and ecosystems are fundamental to scaling and sustaining digital businesses. Meanwhile, the fourth cluster, Sustainability and Socio-Economic Effects (Yellow Cluster), includes keywords such as sustainability, economic effects, and Internet of Things, indicating an emerging scholarly interest in the broader societal and developmental implications of digital transformation. Although relatively smaller, this cluster points to the integration of technological progress with long-term socio-economic impact. Taken together, these clusters demonstrate that the literature has converged toward a multi-disciplinary understanding of digital transformation, where ecosystems, innovation, technological infrastructures, and sustainability considerations intersect to shape the evolving research agenda in digital startup environments.

3.3 Density Visualization: Highlighting Research Hotspots

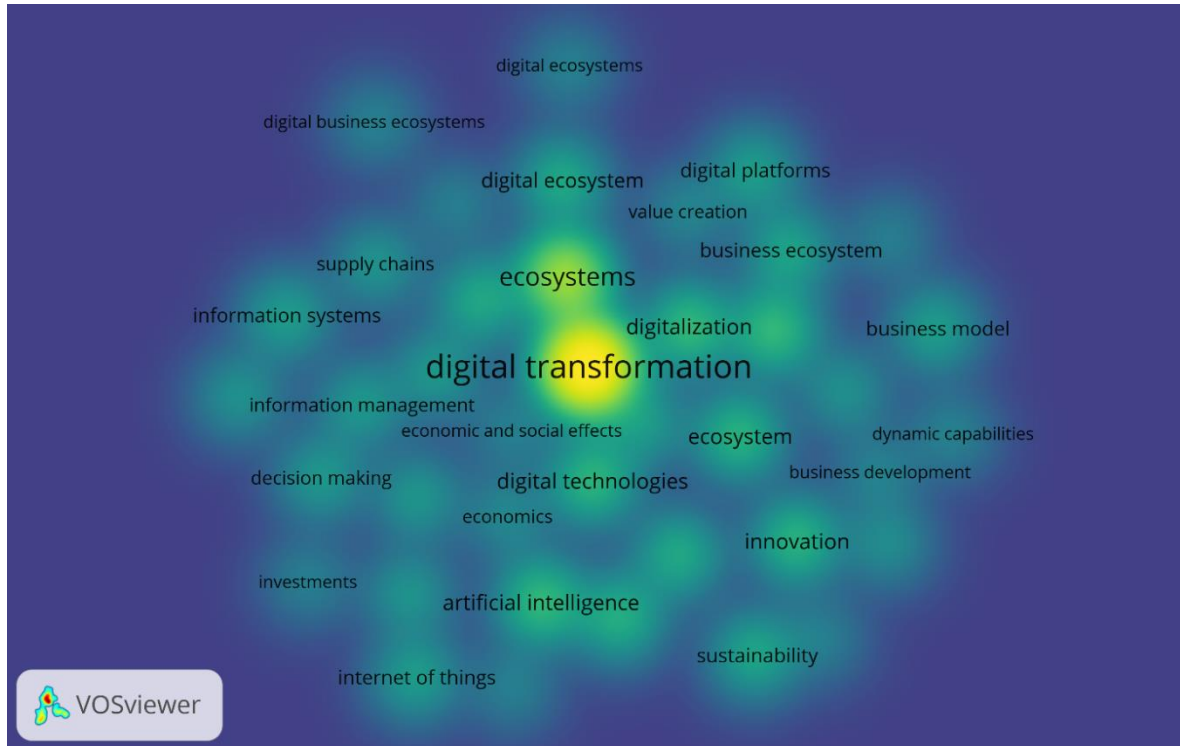


Figure 2. Density Visualization

Source: Data Analysis Result, 2025

The Density Visualization (Figure 3) reinforces the centrality of “digital transformation,” which appears as the brightest and most concentrated zone, surrounded by high-density areas related to digital technologies, ecosystems, artificial intelligence, innovation, and business models, indicating that the field prioritizes investigations into how technological advances enable new business architectures, how ecosystems facilitate digital growth, and

how AI reshapes organizational strategies. Meanwhile, lower-density areas such as decision making, investments, and supply chains represent sub-themes that, although less dominant, remain significant and are likely to emerge as future research frontiers as digital ecosystems continue to expand into increasingly operational and financial domains.

3.4 Overlay Visualization: Tracking the Evolution of Knowledge

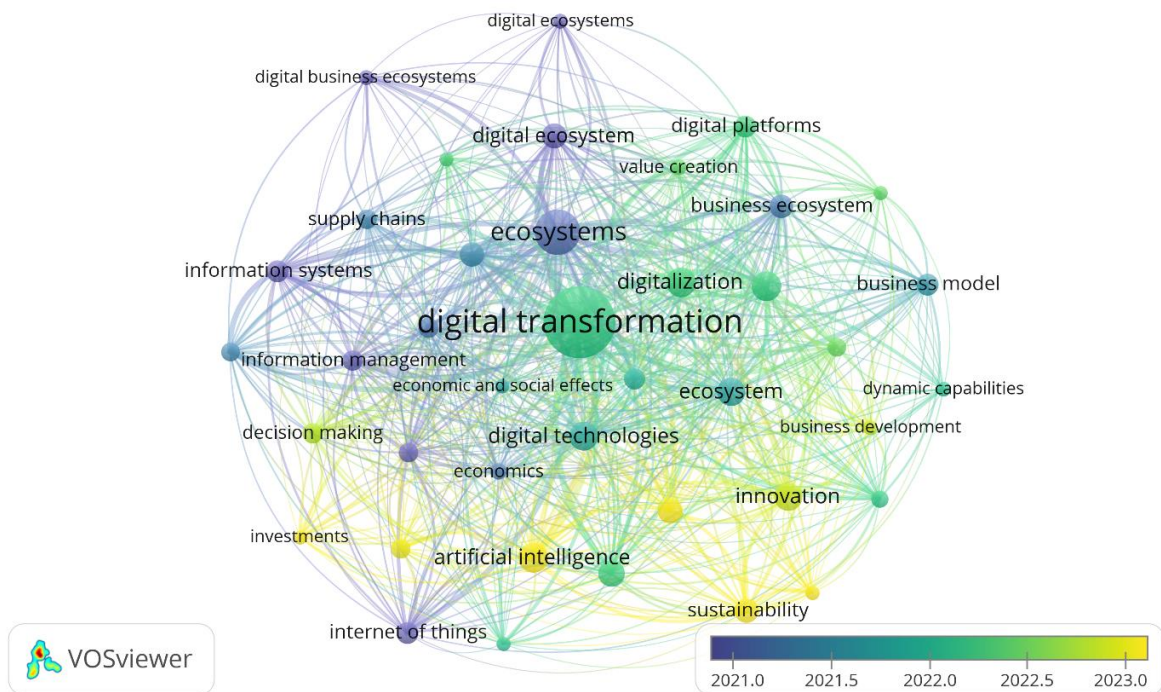


Figure 3. Density Visualization

Source: Data Analysis Result, 2025

The Overlay Visualization (Figure 3) illustrates the temporal progression of research themes from around 2021 to 2023, where earlier studies shown in dark blue focused on foundational concepts such as digitalization, information systems, and digital business ecosystems, while more recent studies represented in green to yellow shift toward innovation, sustainability, dynamic capabilities, artificial intelligence, and business model transformation. This color transition reflects a clear evolution from

infrastructure-oriented digitalization toward higher-order strategic themes—particularly AI-enabled transformation, platform ecosystems, sustainable digital business practices, and entrepreneurial resilience—indicating that contemporary research increasingly emphasizes forward-looking and strategic dimensions of digital transformation, with AI and innovation ecosystems emerging as dominant focal points.

3.5 Co-Authorship Analysis: Identifying Intellectual Communities

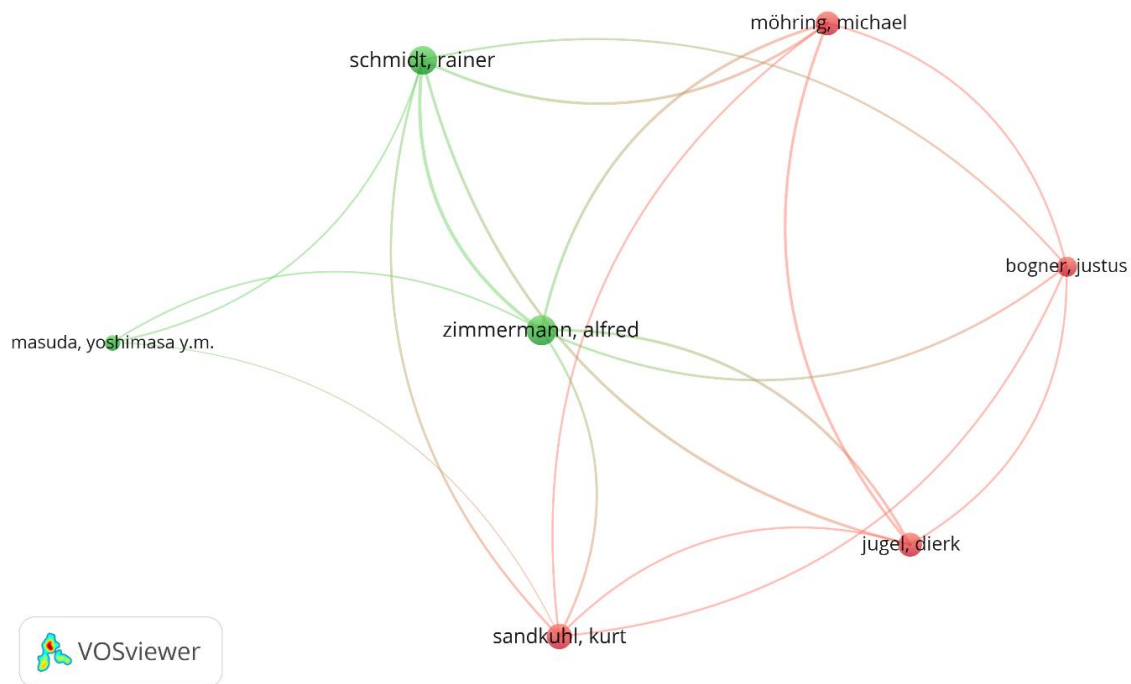


Figure 4. Author Visualization

Source: Data Analysis Result, 2025

The Co-Authorship Network (Figure 4) reveals several tightly interconnected author groups, with a prominent cluster composed of Schmidt, Zimmermann, Möhring, and Bogner, whose strong collaborative ties suggest an active research community centered on digital innovation and organizational transformation, while smaller nodes such as Masuda represent peripheral yet meaningful contributors who link across clusters. These patterns highlight the interdisciplinary nature of digital

transformation research, which bridges fields such as computer science, management, engineering, and information systems. At the same time, the coexistence of both dense and sparse collaboration structures indicates that, although certain authors play dominant roles in shaping intellectual development, the field still offers ample opportunities for new researchers to join and establish emerging collaborative networks.

3.6 Country Collaboration Network: Mapping Global Research Leadership

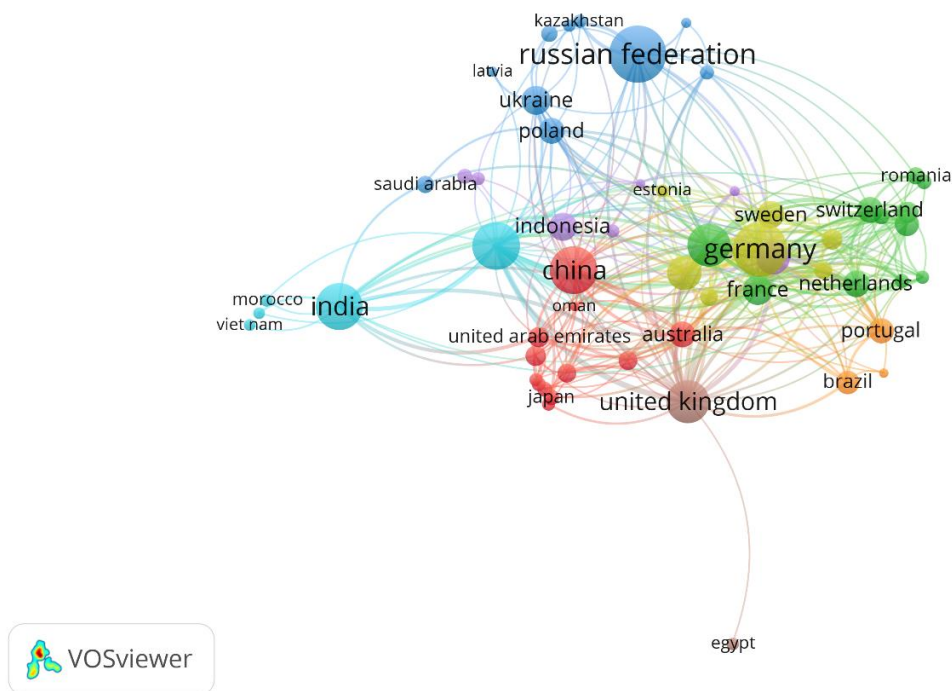


Figure 5. Country Visualization

Source: Data Analysis Result, 2025

The Country Visualization (Figure 5) identifies Germany, the United Kingdom, China, India, and the Russian Federation as the major global contributors, appearing as the largest nodes that signal both high publication output and strong international collaboration, reflecting each country's strategic commitment to digital innovation ecosystems, advanced technology industries, and well-established research funding infrastructures. At the regional level, Europe forms a dense and interconnected cluster illustrating robust cross-national networks, while Asia—represented by China, India, Japan, Indonesia, and the UAE—shows substantial contributions aligned with the rapid digitalization of emerging markets, and the Middle East together with Australia act as intermediary nodes linking Western and Asian research communities. Collectively, this network demonstrates that digital transformation research is truly global in scope, shaped by the combined influence of advanced economies and rapidly developing digital markets.

Discussion

The combined results demonstrate that digital transformation in global startups is driven by a complex interplay of technology, strategy, and ecosystem collaboration. Citation patterns confirm that foundational theories emphasize strategic renewal, capability reconfiguration, and the integration of digital infrastructures as core elements shaping how startups evolve. The keyword networks and density visualizations further reveal a clear intellectual shift toward more advanced themes, including AI-enabled business model innovation, dynamic capabilities, and sustainable digital ecosystems, highlighting that the field has moved beyond basic digitalization toward higher-order strategic and technological considerations.

The co-authorship and country visualization networks underscore the collaborative and internationalized nature of this research domain, showing that digital transformation is not confined to specific regions but is instead shaped through global

knowledge exchange. Strong partnerships, particularly among European and Asian institutions, illustrate how cross-border collaboration advances shared understanding of digital innovation and entrepreneurial transformation. These findings give rise to several theoretical implications, including a shift from firm-centric to ecosystem-centric perspectives as indicated by the prominence of ecosystems, platforms, and value creation; the strengthening of dynamic capabilities as a conceptual lens explaining startup adaptability and competitiveness; and the role of artificial intelligence as a strategic enabler of innovation, decision-making, and scalable business models.

From a practical standpoint, the analysis suggests that startups must prioritize building ecosystem partnerships rather than competing in isolation, embed AI and data analytics early to enhance innovation and efficiency, and continuously renew their digital capabilities to avoid obsolescence in rapidly changing markets. Policymakers are also encouraged to strengthen international collaboration, as global networks accelerate the diffusion of digital innovation. Although the study is limited by its reliance on Scopus data, the quantitative nature of network visualizations, and potential biases arising from the temporal scope of the dataset, the findings collectively provide a comprehensive and robust overview of global scholarly developments in digital transformation and startup ecosystems.

4. CONCLUSION

The results of this bibliometric study reveal a rapidly evolving research landscape in which digital transformation is positioned as the central pillar shaping startup competitiveness and innovation. Citation analysis shows that foundational works—such as those by Hanelt et al., Björkdahl, and Sjödin et al.—serve as essential references for understanding how organizations reconfigure strategies, capabilities, and business models in response to digital

disruptions. The network and density visualizations reinforce this by demonstrating that scholarly attention is concentrated around interconnected themes such as digital platforms, ecosystems, big data analytics, AI capabilities, and dynamic capabilities, reflecting the inherently multidisciplinary nature of digital transformation research that draws upon management, information systems, engineering, and strategic innovation. The overlay visualization further highlights a shift from early discussions centered on digitalization and technological infrastructure toward newer emphases on sustainability, AI-driven innovation, and ecosystem-based value creation, indicating a transition from descriptive technology adoption studies to more strategic, future-oriented analyses of digital capability development. Additionally, the co-authorship and country collaboration networks underscore the globally interconnected character of the field, with Europe and Asia contributing significantly to the formation of dense, collaborative research communities.

Overall, the study concludes that digital transformation in startups is not merely a technological advancement but a strategic, relational, and ecosystem-driven process that requires continuous capability development and innovation. To remain competitive, startups must cultivate dynamic capabilities, embrace AI-enabled business model transformation, and actively engage in digital ecosystems. For policymakers and practitioners, the findings emphasize the importance of fostering cross-border partnerships, strengthening digital capability development programs, and promoting data-driven entrepreneurial practices to support sustainable digital growth. Looking ahead, future research should explore deeper intersections between artificial intelligence, sustainability, entrepreneurial resilience, and platform governance to advance understanding of how digital business ecosystems will evolve in the next stage of technological and organizational transformation.

REFERENCES

- [1] M. Annas and V. Meilinda, "A Review of Indonesian Business Start-Up Incubator Models," *Startuppreneur Bus. Digit. (SABDA Journal)*, vol. 2, no. 1, pp. 86–97, 2023.
- [2] F. Schiavone, D. Mancini, D. Leone, and ..., "Digital business models and ridesharing for value co-creation in healthcare: A multi-stakeholder ecosystem analysis," ... *Forecast. Soc. ...*, 2021.
- [3] A. Omorede, "Business in the digital age: Digital innovation outcome, exit and the founder's start-up experience role," *J. Int. Counc. Small Bus.*, vol. 4, no. 1, pp. 68–78, 2023.
- [4] A. Azmy and A. Priyono, "Leadership Roles For Improving Employee Productivity at Digital Start-Up Company," *J. Manaj. Bisnis*, vol. 13, no. 1, pp. 16–27, 2022.
- [5] M. Lavčák, O. Hudec, and Ž. Sinčáková, "Local and institutional factors of start-up ecosystems: Common and inherited attributes," *J. Knowl. Econ.*, vol. 10, pp. 1765–1783, 2019.
- [6] S. Vrabec, K. Zorko, and V. Bobek, "Sustainable Start-Up Ecosystems in Terms of Capital Investment and Other Business Opportunities for Corporate Involvement—A Comparative Analysis of Hong Kong and Shenzhen," *Int. J. Econ. Financ.*, vol. 15, no. 6, 2023.
- [7] S. K. Srivastava and R. P. Khosla, "Start-up's ecosystem: a case study on DevX," *Int. J. Knowl. Learn.*, vol. 16, no. 1, pp. 97–110, 2023.
- [8] C. Ziakis, M. Vlachopoulou, and K. Petridis, "Start-up ecosystem (StUpEco): A conceptual framework and empirical research," *J. Open Innov. Technol. Mark. Complex.*, vol. 8, no. 1, p. 35, 2022.
- [9] G. Perdomo-Charry, S. Clegg, and J. Schweitzer, "Do start-up ecosystems foster start-up performance? The moderating role of network learning capability," *Int. J. Entrep. Innov.*, p. 14657503231169888, 2023.
- [10] R. Stevy, I. Puspa, D. Widjaja, and R. Ongsa, "Analysis of Internal Factors for Improving the Performance of Startup Companies in Medan, Indonesia," *J. Madani Soc.*, vol. 2, no. 1, pp. 67–74, 2023.
- [11] Y. Cheng *et al.*, "The Prevalence of Mycoplasma Pneumoniae Among Children in Beijing Before and During the COVID-19 Pandemic," *Front. Cell. Infect. Microbiol.*, vol. 12, p. 854505, 2022, doi: 10.3389/fcimb.2022.854505.