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Research Trends in Smart Workflow Automation: A Bibliometric Study from Scopus

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ABSTRACT

This study presents a comprehensive bibliometric analysis of smart workflow automation research using Scopus-indexed publications to map its intellectual structure, thematic evolution, and global collaboration patterns. A dataset covering the period 2000–2025 was extracted, cleaned, and analyzed using VOSviewer for science mapping and Microsoft Excel for performance metrics. Results reveal that the field is anchored by core concepts such as automation, internet of things, machine learning, and work-flows, which consistently occupy central positions in the research network. Emerging themes, including blockchain, supply chains, security, and ubiquitous computing, reflect a shift toward secure, interconnected, and efficiency-driven automation ecosystems. Co-authorship and country collaboration analyses highlight the pivotal roles of the United States, China, and Germany, supported by extensive cross-border partnerships. Temporal trend mapping demonstrates a transition from early industrial automation and foundational cyber-physical infrastructure toward integrated, value-oriented applications. The study offers practical guidance for industry adoption strategies, enriches theoretical understanding of the field's conceptual landscape, and identifies promising research frontiers for future exploration.

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1. INTRODUCTION

In an era increasingly defined by the promise of Industry 4.0, the concept of **smart workflow automation** has become a beacon of organizational efficiency, blending artificial intelligence, robotic process automation, and intelligent systems to reimagine how work gets done. Scholars define **intelligent automation** as the convergence of AI and RPA techniques to reduce repetitive tasks while learning and improving over time [1]. This hybrid approach empowers organizations to not just automate, but to optimize decision-making and process flow—making systems smarter, more agile, and notably more human-centric. Within manufacturing, **smart manufacturing** is reshaping the production landscape through digital integration—leveraging sensors, real-time data analytics, and flexible automation to foster rapid adaptability and resilience. Although this domain often centers on physical operations, its principles translate easily to workflows in services, administration, and knowledge work—where intelligent, adaptive automation can streamline complex process chains and enhance responsiveness [2], [3].

Concurrently, research in **bibliometric analysis** has offered clarity on technological evolution by mapping the rise, influence, and interconnections of scientific literature. For instance, a recent bibliometric study of AI from Scopus (2013–2023) revealed the explosive growth of AI research—highlighting emerging foci like generative, explainable, and reinforcement learning. Similarly, bibliometric work on **smart public governance** (via Scopus) identified how "smart" research (e.g., smart cities vs smart government) has matured and shifted over decades. These studies showcase how bibliometrics can surface domain evolution, collaboration patterns, and emerging themes in rich ways.

In the domain of **robotic process automation (RPA)**, bibliometric approaches are likewise revealing. A study exploring RPA in business used Scopus data to trace key authorship networks, publication trends, and citation structures—offering a clearer picture of how RPA scholarship has evolved in organizational contexts. Likewise, efforts combining RPA with **process mining** (through literature reviews) show growing academic interest in how process discovery can guide automation strategies—further underscoring the value of structured analysis [4], [5]. Moreover, the emergence of tools like "**Smart Bibliometrics**" underscores the growing sophistication of bibliometric methodology. By integrating data from Scopus and Web of Science and employing science-mapping techniques, such studies reveal how research domains take shape, where hotspots reside, and where the blind spots are. This rich methodological background primes us to ask: what can we discover about **smart workflow automation**, a field that blends automation, intelligence, and process management, when we examine its scholarly footprint?

Taken together, these literature streams suggest that smart workflow automation is at the crossroads of automation technology, data-driven intelligence, and organizational process reengineering. Yet, despite its practical momentum, the scientific contours of this field remain loosely defined. A bibliometric study rooted in Scopus promises to chart its development—unveiling patterns and possibilities that remain otherwise hidden. Despite the growing adoption of smart automation solutions, there remains **no comprehensive bibliometric study** that maps how academic interest in **smart workflow automation** has evolved—especially one that draws on robust Scopus indexing, traces publication volumes, influential authors or institutions, thematic clusters, and emerging trends. Without such clarity, researchers and practitioners risk navigating innovation without a clear lens—a gap this study aims to close. Therefore, this study sets out to **conduct a bibliometric analysis of smart workflow automation using Scopus**, aiming to: (1) assess publication and citation trends over time; (2) identify the most influential contributors (authors, journals, institutions, countries); (3) uncover key thematic clusters and research hotspots; and (4) map collaboration networks and emerging fronts in the field.

2. METHOD

This study adopts a **bibliometric research design** to systematically map the scholarly landscape of *smart workflow automation* using the Scopus database as the primary data source. Scopus was chosen because of its extensive coverage of peer-reviewed journals, conference proceedings, and international publications across disciplines, offering both breadth and reliability for trend analysis [6]. The search strategy was developed iteratively to capture variations in terminology, including keywords such as *"smart workflow automation"*, *"intelligent workflow"*, *"AI-driven process automation"*, and *"hyperautomation"*. Boolean operators and wildcard symbols were used to broaden retrieval while maintaining relevance. The initial dataset included all document types indexed in Scopus without language restriction, but results were later filtered to English-language publications to ensure interpretive consistency. The search period was set from **2000 to 2025** to reflect both early developments in workflow automation and contemporary advancements within the Industry 4.0 era.

Following data retrieval, **screening and cleaning procedures** were applied to enhance accuracy. Duplicate entries were removed, and records unrelated to the research theme were excluded through title, abstract, and keyword review. Bibliographic information—including authors, title, abstract, keywords, publication year, source title, author affiliation, country of origin, and citation count—was exported in *CSV* format. Data pre-processing also involved standardizing author and institution names to avoid fragmentation in co-authorship and institutional network analysis, a common issue in bibliometric mapping [7].

The cleaned dataset was then analyzed using **VOSviewer** for science-mapping and **Microsoft Excel** for descriptive statistics. The analysis comprised four key dimensions: (1) **science mapping** to visualize co-authorship, co-citation, and keyword co-occurrence networks; (3) **thematic clustering** to identify research hotspots and intellectual structures; and (4) **temporal trend mapping** to track the evolution of themes over time.

3. RESULT AND DISCUSSION

3.1 Authorship Mapping

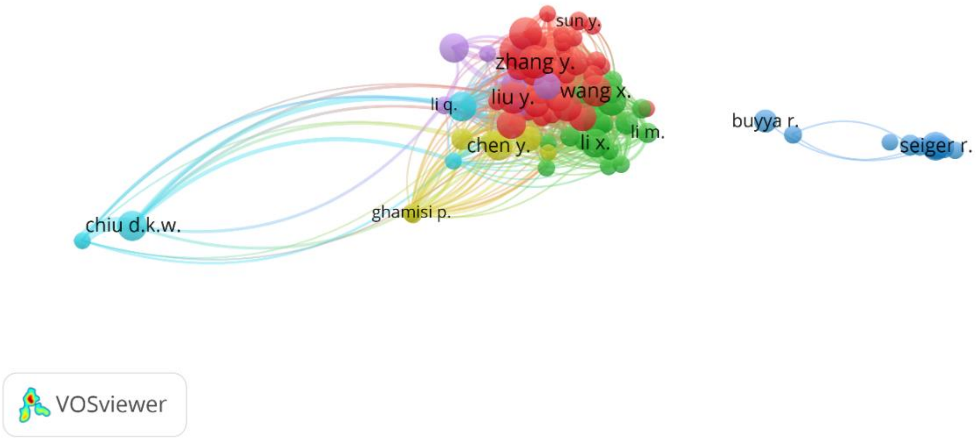

Figure 1. Author Visualization
Source: Data Analysis

Figure 1 illustrates the **co-authorship structure** within the smart workflow automation research dataset from Scopus. Each node represents an author, with node size corresponding to the number of publications and/or citations, and colors indicating distinct collaborative clusters. The dense central cluster—dominated by authors such as *Zhang Y.*, *Liu Y.*, *Wang X.*, *Li X.*, and *Chen Y.*—reflects a tightly interconnected research community with strong internal collaboration. Several bridging links connect peripheral scholars like *Li Q.* and *Ghamisi P.* to this core, indicating occasional cross-cluster collaboration. On the left, authors such as *Chiu D.K.W.* form a smaller but still connected subgroup, maintaining collaborative ties with the main network. Meanwhile, the pair *Buyya R.* and *Seiger R.* on the right represents an isolated collaboration cluster with no visible co-authorship links to the central group, suggesting a specialized or parallel research focus within the broader field.

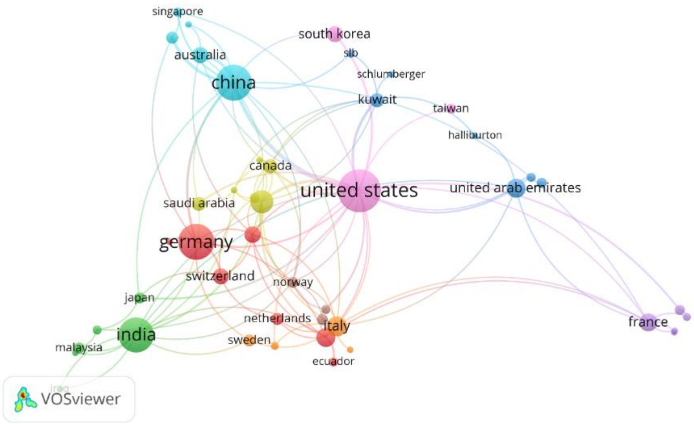

Figure 2. Country Visualization
Source: Data Analysis

Figure 2 represents the **country collaboration network** in the field of smart workflow automation research based on Scopus data. Each node corresponds to a country, with its size indicating the relative volume of publications or citation impact, while the colors denote distinct collaboration clusters. The **United States** emerges as the most prominent hub, exhibiting extensive collaborative links with both Western and Asian countries, including China, Germany, India, and the United Arab Emirates. **China** and **Germany** also appear as major contributors, forming strong bilateral connections and serving as bridges between multiple regional clusters. **India**, **Australia**, and **Saudi Arabia** are notable for their connections across diverse geographies, suggesting broad international engagement. Smaller but well-connected nodes, such as **Italy**, **Netherlands**, and **France**, indicate active but more regionally focused participation. Peripheral nodes like **Ecuador** and **Malaysia** appear in specific collaboration pathways, hinting at niche research contributions. The network's structure reflects a multi-polar research ecosystem, with the United States and China driving much of the global output, while European and Asian countries sustain robust cross-border partnerships.

3.2 Thematic Clustering

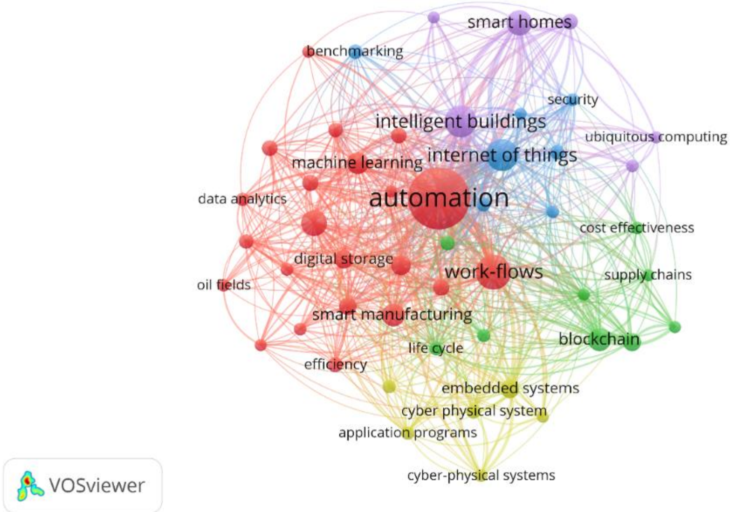

Figure 3. Network Visualization
Source: Data Analysis

Figure 3 presents a **keyword co-occurrence network** for smart workflow automation research, where each node represents a keyword, node size indicates frequency of occurrence, and links denote co-occurrence relationships. The color coding shows distinct thematic clusters, reflecting the conceptual structure of the field. **First**, the **red cluster** is dominated by the term *automation*, which appears as the largest and most central node, indicating its foundational role in the domain. This cluster also includes *machine learning*, *data analytics*, *digital storage*, *efficiency*, and *smart manufacturing*, suggesting a strong emphasis on integrating AI-driven analytics into automated processes. The dense interconnections imply that these themes are frequently studied together, often in contexts aiming to enhance process optimization and operational intelligence.

Second, the **green cluster** revolves around *work-flows*, *blockchain*, *supply chains*, and *cost effectiveness*. This grouping points toward applications of smart workflow automation in business operations and logistics, where distributed ledger technologies and process optimization can improve transparency, efficiency, and cost savings. The co-occurrence patterns reveal growing interest in how blockchain and workflow automation can jointly transform supply chain management, particularly in ensuring secure and verifiable transactions. **Third**, the **blue cluster** centers on *internet of things (IoT)* and *security*, connected closely to *intelligent buildings* and *ubiquitous computing*. This cluster highlights the technological infrastructure enabling automation, particularly the integration of IoT devices to collect real-time data and enhance operational intelligence. Security appears as a critical linked keyword, reflecting the challenges of safeguarding interconnected systems against cyber threats in smart automation contexts.

Fourth, the **purple cluster** includes *smart homes* and related terms, reflecting the consumer-facing side of smart workflow automation. These studies often explore automation in residential environments, integrating IoT, energy management, and intelligent systems to improve convenience, efficiency, and sustainability. The positioning of this cluster toward the periphery suggests that while it is related to the broader automation discourse, it forms a somewhat distinct application area compared to industrial and enterprise workflows. **Finally**, the **yellow cluster** contains terms like *embedded systems*, *cyber-physical systems*, *life cycle*, and *application programs*, indicating a focus on the underlying engineering and software design aspects of smart workflow automation. This group represents the technical backbone that supports the more application-oriented clusters, linking hardware integration with software-driven control mechanisms. The interlinkages across clusters demonstrate that while technical foundations are specialized, they remain deeply interconnected with applied research areas, forming a tightly knit knowledge network in the smart workflow automation field.

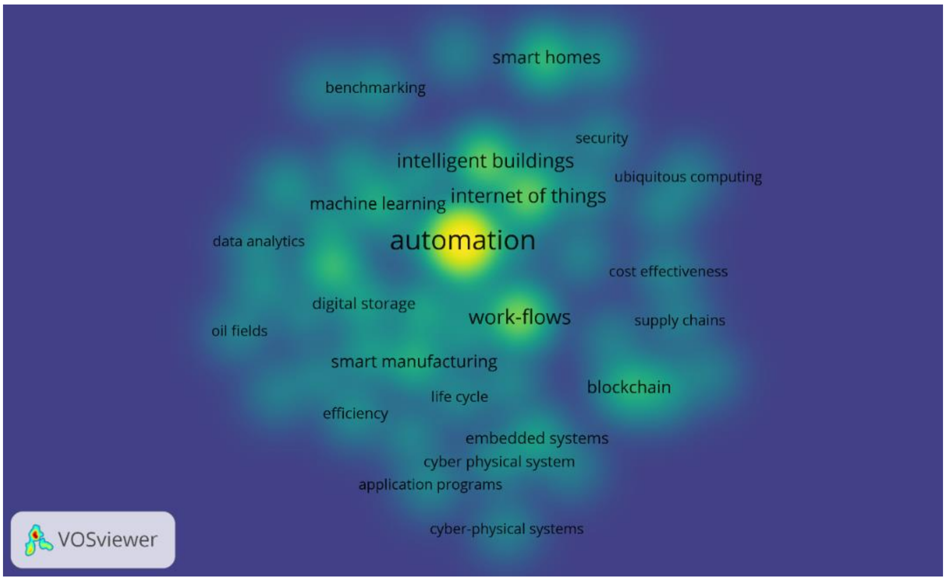

Figure 4. Density Visualization
Source: Data Analysis

Figure 4 highlights the **frequency and prominence** of keywords in smart workflow automation research. The bright yellow zones, led by *automation*, indicate the highest occurrence and centrality in the field, signifying that it is the primary conceptual anchor. Closely linked and moderately bright areas include *internet of things*, *machine learning*, *work-flows*, *intelligent buildings*, and *smart manufacturing*, reflecting their frequent co-occurrence with automation in scholarly discourse. These high-density zones suggest that current research is heavily concentrated on integrating AI-driven and IoT-enabled technologies into workflow systems to optimize operations. In contrast, the green to blue areas, such as *blockchain*, *smart homes*, *security*, *cost effectiveness*, and *embedded systems*, represent emerging or more specialized topics. While they are less dominant than the core terms, their position in the network indicates potential growth areas and niche applications of smart workflow automation. These include security protocols for connected systems, blockchain-enabled supply chains, and cyber-physical infrastructure for automation.

3.3 *Temporal Trend mapping*

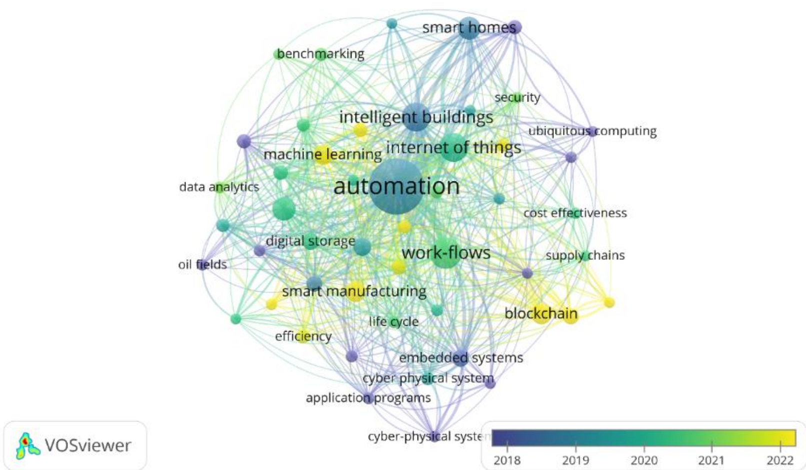

Figure 5. Overlay Visualization
Source: Data Analysis

Figure 5 maps the **temporal evolution** of research topics in smart workflow automation, with colors representing the average publication year for each keyword. The blue-to-purple tones indicate earlier research focus areas, while green to yellow tones highlight more recent and emerging topics. Central, mature themes such as *automation*, *internet of things*, *machine learning*, and *work-flows* appear in greenish hues, suggesting sustained attention over the past few years and continued relevance in the field. These concepts form the core intellectual structure around which newer research ideas are evolving. Peripheral but increasingly prominent keywords, such as *blockchain*, *cost effectiveness*, and *supply chains*, are shown in bright yellow, marking them as **recently emerging areas**—primarily around 2021–2022. Their positioning indicates that scholars are exploring how distributed ledger technologies and economic optimization models integrate with automation to enhance transparency, resilience, and performance in workflows. Similarly, *ubiquitous computing* and *security* appear in more recent colors, reflecting contemporary concerns with ensuring secure, pervasive, and seamless connectivity in automated environments.

Earlier foundational topics, such as *oil fields*, *data analytics*, *benchmarking*, and *cyber-physical systems*, are represented in darker blue and purple shades, indicating their peak prominence in earlier years (around 2018–2019). While these remain important, their role has shifted to underpinning newer areas of inquiry rather than being the primary research frontiers. This temporal spread reveals an evolutionary trajectory where the field has moved from foundational technical infrastructure and industrial applications toward broader integration with IoT ecosystems, business process optimization, and cutting-edge technologies like blockchain.

3.4 *Citation Overview*

Table 1. Most Cited Article

Citations	Author and Year	Title
3509	[8]	Blockchains and Smart Contracts for the Internet of Things
245	[9]	A framework for integrating BIM and IoT through open standards
182	[10]	Artificial Intelligence in Radiotherapy Treatment Planning: Present and Future
179	[11]	An edge computing based smart healthcare framework for resource management
132	[12]	Artificial intelligence-based decision-making algorithms, Internet of Things sensing networks, and sustainable cyber-physical management systems in big data-driven cognitive manufacturing
122	[13]	Role of Blockchain-Enabled Smart Contracts in Automating Construction Progress Payments
112	[14]	A Practical Evaluation of Information Processing and Abstraction Techniques for the Internet of Things
110	[15]	A blockchain-driven supply chain finance application for auto retail industry
110	[16]	Laboratory automation in clinical bacteriology: What system to choose?
101	[17]	Exploring blockchain technology in international trade: Business process re-engineering for letter of credit

Source: Scopus, 2025

3.5 *Practical Implication*

The results of this bibliometric study provide actionable insights for industry practitioners, policymakers, and technology strategists involved in smart workflow automation. First, the prominence of core themes such as *automation*, *internet of things*, and *machine* *learning* highlights that organizations seeking to implement automation initiatives should prioritize integrating AI-powered analytics with IoT-enabled systems to achieve real-time decision-making. The emergence of *blockchain* and *supply chains* as recent keywords indicates growing interest in enhancing security, transparency, and traceability within automated workflows—suggesting that industries with complex logistics chains, such as manufacturing and healthcare, could benefit from piloting blockchain-enabled process automation. Additionally, the presence of application-oriented themes like *smart manufacturing* and *intelligent buildings* provides guidance for sector-specific adoption strategies, while the clustering of *security* with other IoT-related terms signals the need for robust cybersecurity frameworks as automation scales.

3.6 Theoretical Contributions

This study contributes to the academic literature by offering a comprehensive mapping of the intellectual structure and evolution of smart workflow automation research. The identification of thematic clusters—ranging from foundational technical domains (cyber-physical systems, embedded systems) to applied areas (smart homes, supply chains, blockchain)—adds depth to our understanding of how the field is organized conceptually. By overlaying temporal analysis, this research also advances theory by showing the shift from early industrial automation topics (2018–2019) toward integrated, interconnected, and security-conscious automation ecosystems (2021–2022). Furthermore, the co-authorship and country collaboration networks extend knowledge about the global distribution of expertise, revealing that the United States, China, and Germany serve as central hubs for scholarly influence, which may inform future comparative or cross-country studies on innovation diffusion in automation technologies.

3.7 Limitations

While this study provides valuable insights, it has several limitations that should be acknowledged. First, the analysis is based solely on the Scopus database; although Scopus offers broad and reputable coverage, excluding other databases like Web of Science or IEEE Xplore may omit relevant publications, especially those in niche engineering domains. Second, the bibliometric method focuses on quantitative mapping and does not capture the qualitative depth of individual studies—meaning that emerging concepts may not appear prominently if they have yet to accumulate substantial citation counts. Third, keyword-based searches are inherently sensitive to terminology; variations in how authors describe similar concepts (e.g., *intelligent workflow* vs. *smart workflow*) may affect the completeness of the dataset. Finally, given the fast-paced nature of technological innovation, the dataset reflects the state of research up to the search date, and newer developments may already be reshaping the thematic landscape.

4. CONCLUSION

This bibliometric study has mapped the intellectual structure, thematic evolution, and collaborative landscape of research in **smart workflow automation** using Scopus-indexed publications. The findings reveal that the field is anchored by core themes such as *automation*, *internet of things*, *machine learning*, and *work-flows*, which have maintained centrality and relevance over time. Emerging areas like *blockchain*, *supply chains*, *security*, and *ubiquitous computing* indicate a shift toward secure, interconnected, and value-driven automation ecosystems. The co-authorship and country collaboration analyses show that the United States, China, and Germany play pivotal roles in shaping the discourse, supported by strong cross-national partnerships. By combining performance metrics with network and temporal analyses, this study offers both a snapshot of the field's current state and a trajectory of its research evolution—providing a valuable reference point for academics, industry practitioners, and policymakers seeking to advance innovation and adoption in smart workflow automation.

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