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Two Decades in Five Years: Mapping Digital HR, Workflow Automation, and Innovation Ecosystem Research (2020–2025)

Arciana Damayanti[a*], Asep Miftahuddin[b], Rofi Rofaida[a], Yoga Perdana[a], Rizqiana Arifatul Husna[c], & Juliana Juliana[a]

[a]*Faculty of Economics and Business Education, Universitas Pendidikan Indonesia, Bandung, Indonesia*
[b]*Faculty of Technology and Vocational Education, Universitas Pendidikan Indonesia, Bandung, Indonesia*
[c]*Department of Management, RUDN University, Rusia*

Abstract

Digital transformation has reshaped human resource management (HRM), giving rise to digital HR practices, workflow automation and innovation-ecosystem approaches. However, the literature on Digital HRM, electronic HRM (e-HRM), and innovation ecosystems remains scattered across disciplines and themes, leaving the field's intellectual structure, thematic evolution, and future directions only partially understood. This study reviews and maps research on digital human resource management, workflow automation, and innovation ecosystems published between 2020 and 2025 using a systematic literature review (SLR) combined with bibliometric analysis and following the PRISMA 2020 framework for a transparent and reproducible selection process. An initial search of the Scopus database returned 2,163 documents for review. After applying predefined inclusion and exclusion criteria, 244 journal articles were retained and analysed in Bibliometrix and Biblioshiny to examine publication trends, influential authors, journals, countries, and institutions, along with keyword co-occurrence and thematic structures. Research activity rose sharply over the period, at an annual growth rate of 23.84%, with the conceptual core of the field centring on e-HRM, digital HRM, digital transformation, workflow automation and innovation ecosystems. The thematic map identified technology, Industry 4.0, Society 5.0, and helix-based innovation models as the dominant driving themes. The Triple Helix and Quintuple Helix frameworks are well established, whereas Pentahelix-related work remains underexplored and is still emerging. This study offers a comprehensive picture of the intellectual landscape of digital HR transformation and innovation-ecosystem research and points to a clear opportunity for future work: bringing together workflow automation, digital HR practices, and Pentahelix-based collaboration to support sustainable workforce transformation and organizational innovation.

Keywords: digital human resource management, workflow automation, innovation ecosystem, quintuple helix, pentahelix, bibliometric analysis.

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1. Introduction

Digital technology has changed the way organisations create value, manage resources, and remain competitive in an environment that rarely stands still. Artificial intelligence, cloud computing, big data analytics, and business process automation have accelerated digital transformation across industries (Haritha, 2024; Xiao, 2023; Zheng, 2026). Human resource management has been pulled into this shift and now operates as a strategic function that must keep pace with changing organizational demands, workforce expectations, and what new technologies make possible (Mandwekar, 2025; Yulianto & Madiistriyatno, 2023). As firms chase efficiency, agility, and innovation, older ways of doing HR are giving way to digital approaches built around data-driven decisions, integrated workforce management, and the ability to respond in real-time (Stanley & Aggarwal, 2025; Syafri & Andi Rasyid, 2025; Volianska-Savchuk et al., 2024).

This move toward digitalisation has produced a cluster of related ideas: Electronic Human Resource Management (e-HRM), Digital Human Resource Management (Digital HRM), Human Resource Information Systems (HRIS), and

* Corresponding author.
E-mail address: *arciana@upi.edu* (First Author)

HR Analytics. Each lets organisations automate routine administration, raise employee engagement, support talent management, and put strategic decisions on a firmer footing (Amany, 2025; Dyakiv et al., 2024; Hagemann & Klug, 2022). The evidence so far links these digital HR practices to stronger organizational performance, greater operational efficiency, higher workforce productivity, and more adaptable organisations. It is not surprising that digital HR has become one of the fastest-growing research areas in management and organizational studies, of interest to academics and practitioners alike (Al-Qassem et al., 2025; Amany, 2025; Salam & Munawir, 2024).

Workflow automation has grown alongside digital HR as one of its key technological enablers. By tying together separate systems, applications, and databases into coordinated digital processes, much of the work can be performed with little manual input. HR specifically underpins recruitment, employee onboarding, training management, performance evaluation, workforce analytics, and decision support (Alzabin, 2025; Lonkar, 2024; M & K, 2023). The payoff is not just smoother operations but also a more flexible and responsive workforce management that organisations increasingly need. Therefore, workflow automation has become difficult to separate from broader conversations about digital transformation and organizational innovation (Cui, 2025; Rocha et al., 2017).

However, technology only goes so far on its own; successful digital transformation usually depends on collaboration among many actors within wider innovation ecosystems. Thinking about these ecosystems has evolved from the Triple Helix model, with its focus on universities, industry, and government, toward broader frameworks the Quadruple and Quintuple Helix, which include society, communities, media, and even environmental concerns as contributors to innovation and knowledge creation (Cai, 2022; Kunwar & Ulak, 2024). The rise of these perspectives marks a shift away from organisation-centred innovation toward collaborative, network-based approaches that draw on a wider mix of actors and resources to create value. For digital HR, such frameworks offer a useful way to think about how organizations might build lasting innovation capacity and strengthen workforce development.

Even as the literature on digital HR, workflow automation, and innovation ecosystems has grown, it remains scattered across disciplines and research streams. Earlier reviews have tended to take up one topic at a time e-HRM here, HR analytics there, digital transformation, business process management, or innovation ecosystems, each on their own. However, how workflow automation, digital HR transformation, and ecosystem-based collaboration fit together within a single body of knowledge has received far less attention (Bhatti et al., 2025; Salin & Vittenbeck, 2025). While the Triple Helix and Quintuple Helix have drawn considerable interest, the role of Pentahelix collaboration in digital workforce transformation remains largely unexamined. This fragmentation makes it difficult for researchers and practitioners to obtain a clear view of the field's intellectual foundations, how its themes have developed, and where it is heading.

To help close these gaps, this study combines a systematic literature review (SLR) with a bibliometric analysis of journal articles indexed in Scopus between 2020 and 2025. This study aims to map the intellectual structure, conceptual evolution, and collaborative patterns of research on digital human resource management, workflow automation, and innovation ecosystems. Five research questions guided this study.

RQ1: How has research on digital human resource management, workflow automation, and innovation ecosystems evolved between 2020 and 2025?

RQ2: Who are the most influential authors, journals, countries, and institutions contributing to the field’s development?

RQ3: What conceptual structures and thematic clusters characterise the existing body of knowledge on digital HR transformation and innovation ecosystems?

RQ4: How are innovation ecosystem perspectives, including the Triple Helix, Quintuple Helix, and Pentahelix frameworks, represented in the literature?

RQ5: What emerging themes, research gaps, and future research directions can be identified to advance digital HR transformation and workflow automation research?

Drawing on 244 journal articles selected through the PRISMA 2020 framework, this study makes three contributions. It offers a comprehensive map of the intellectual and conceptual structure of research on digital HR transformation and innovation ecosystems, identifies the dominant themes, influential contributors, and emerging trends shaping the field, and sets out future research directions that bring workflow automation, digital HR, and collaborative innovation frameworks together in support of more adaptive, sustainable, and stakeholder-oriented workforce management in the digital era.

2. Methodology

2.1. Research Design

This study employed a Systematic Literature Review (SLR) approach combined with bibliometric analysis to systematically examine the development of workflow automation in digital human resource management. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure transparency, rigor, and reproducibility of the article selection process (Caratù et al., 2025; Gajowiak & Włodarkiewicz-Klimek, 2025). The PRISMA framework provides a structured procedure for identifying, screening, assessing eligibility, and selecting relevant studies for inclusion in reviews.

Bibliometric analysis was incorporated to quantitatively evaluate publication trends, influential authors, journals, countries, collaboration networks, and thematic structures in the selected literature. The combination of SLR and bibliometric techniques enables a comprehensive understanding of both the intellectual foundations and emerging research directions in workflow automation and digital HR (Bansal et al., 2025; Dubey & Singh, 2025; Thi et al., 2024).

2.2. Data Source and Search Strategy

The Scopus database was selected as the primary source of bibliographic data because of its extensive coverage of peer-reviewed journals and widespread use in bibliometric and review studies. The search process was conducted in January 2026 and focused on publications published between 2020 and 2025.

The search query was developed based on the major concepts underlying this study, namely, workflow automation, digital human resource management, HR analytics, HR information systems, employee performance, and collaborative innovation. The search was conducted within the title, abstract, and keyword fields in the Scopus database.

The initial search yielded 2,163 documents. Several filtering criteria were applied to ensure relevance and quality. The subject area was limited to Business, Management and Accounting, and Economics, Econometrics and Finance. Furthermore, only journal articles written in English were included in the analysis.

2.3. Inclusion and Exclusion Criteria

To ensure consistency and relevance, inclusion and exclusion criteria were established before the screening process.

a. Inclusion Criteria

- Publications indexed in the Scopus database.
- Articles published between 2020 and 2025 were included.
- Peer-reviewed journal article.
- Publications written in English.
- Studies related to workflow automation, digital HR, HRIS, HR analytics, digital transformation, employee performance, and organizational digitalisation.
- Publications classified within Business, Management and Accounting, or Economics, Econometrics and Finance.

b. Exclusion Criteria

- Conference papers, reviews, editorials, notes, book chapters, and trade publications were also included.
- Publications outside the selected subject areas.
- Non-English publications were excluded.
- Studies unrelated to human resource management or workflow automation.
- Duplicate or incomplete records were excluded.

2.4. PRISMA Article Selection Process

The article selection process followed the PRISMA 2020 framework, which consists of four stages: identification, screening, eligibility assessment, and inclusion.

During the identification stage, the initial search in Scopus generated 2,163 records that were screened. Subject area filtering reduced the dataset to 1,084 records by excluding publications outside the fields of Business, Management, and Accounting and Economics, Econometrics, and Finance. Restricting the document type to journal articles further reduced the dataset to 742 records. Language filtering retained 691 English-language publications, while source-type filtering limited the dataset to 612 journal articles.

The screening stage involved reviewing the titles, abstracts, and keywords to assess their relevance to workflow automation and digital human resource management. This process excluded 294 records that did not align with the research objectives, resulting in 318 articles eligible for a full-text assessment.

During the eligibility stage, the full texts of the remaining studies were examined in detail to determine their eligibility. A total of 74 articles were excluded because they were not directly related to digital HR, workflow automation, or the scope of this study. Consequently, 244 articles were included in the final dataset and subjected to bibliometric and thematic analysis.

2.5. Data Analysis Procedure

The selected articles were exported from Scopus in BibTeX format and analysed using the Bibliometrix package in R and its Biblioshiny interface. A bibliometric analysis was conducted to examine publication growth, source productivity, author productivity, citation structures, country collaboration patterns, and keyword occurrences.

Several analytical techniques were used. A descriptive bibliometric analysis was used to examine publication characteristics and research productivity. Citation analysis was performed to identify the influential publications and authors. A co-occurrence analysis was conducted to explore the conceptual structures and thematic relationships among the keywords. Thematic mapping and evolution analyses were used to identify research trends and emerging topics. Finally, collaboration network analysis was used to investigate the relationships among countries, institutions, and researchers.

2.6. Research Framework

This study integrates systematic literature review procedures with bibliometric techniques to generate a comprehensive understanding of workflow automation in digital human resource management. The methodological framework comprises four interconnected stages: literature identification, PRISMA based screening and selection, bibliometric analysis, and synthesis of future research directions. The resulting framework enables the identification of knowledge structures, research trends, thematic developments, and potential opportunities for future investigations in the field of digital HR and workflow automation.

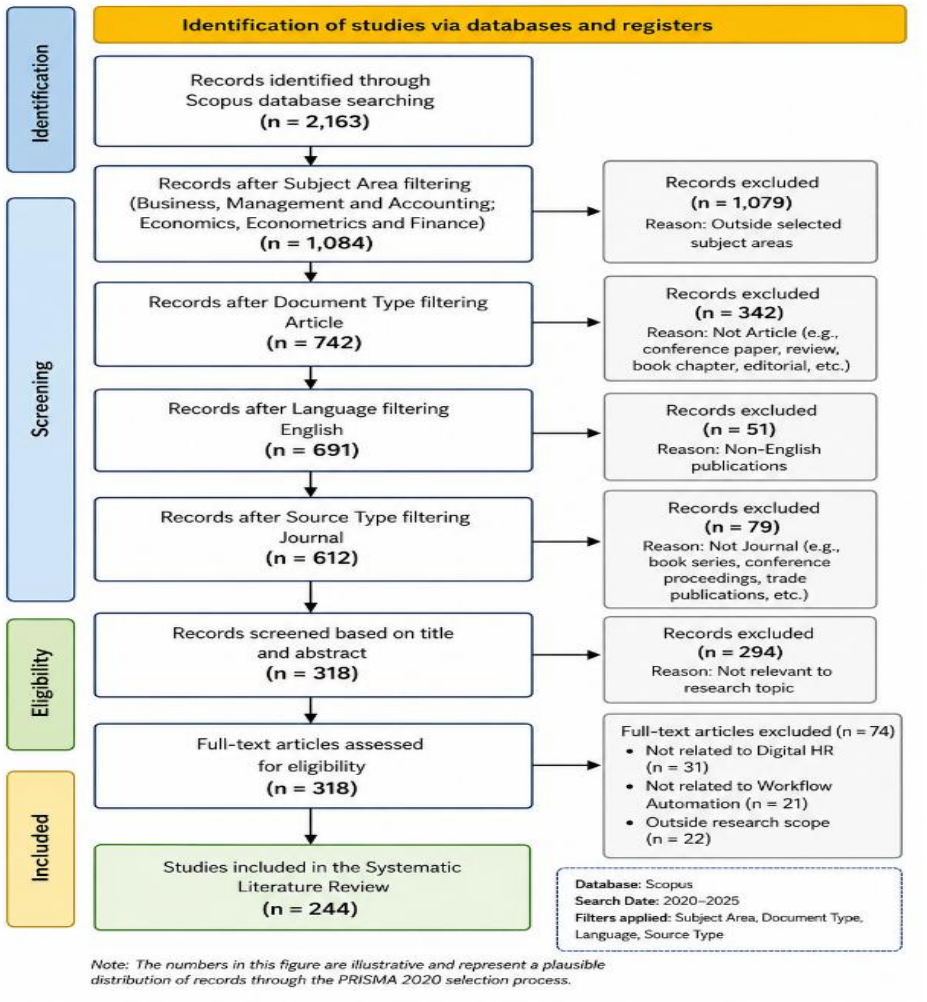

Figure 1. The PRISMA 2020 flow diagram illustrating the article selection process.

3. Results and Discussion

3.1. Results

This section reports the results of the bibliometric analysis of 244 Scopus-indexed journal articles published between 2020 and 2025. The aim is to trace the intellectual and conceptual structure of research on workflow automation, digital human resource management, e-HRM, and innovation ecosystems, along with the collaboration patterns that have shaped them. The results are presented through several complementary views: dataset characteristics, publication dynamics over time, the most influential authors, the contributions of individual countries and institutions, patterns of collaboration, keyword structures, and the development of research themes. Read as a whole, they show how the field has grown and which authors, topics, and knowledge domains have been central to that growth.

This analysis goes beyond counting publications. To examine the conceptual foundations of the field, it draws on keyword co-occurrence networks, thematic mapping, and three-field (Sankey) analysis, which help surface the dominant research clusters, emerging topics, and links among keywords, institutions, and countries. Combining these descriptive and network-based perspectives provides a fuller picture of how research on digital HR and workflow automation has evolved and points to where the most promising opportunities for theory and practice may lie. The following subsections take these analyses in turn, beginning with an overview of the dataset and moving toward more detailed thematic and intellectual-structure results.

3.1.1 Overview of the Bibliographic Dataset

Table 1 summarises the general characteristics of the dataset used in this study. After screening, 244 journal articles published in Scopus-indexed outlets between 2020 and 2025 were retained for the analysis. These articles appeared in 159 different sources, a fairly wide spread that points to active and varied literature on digital human resource management, workflow automation, innovation ecosystems, and organizational digital transformation. Output grew at an annual rate of 23.84% over the period, indicating a clear sign of rising interest in technology-driven HRM and digital innovation. The average document age is only 2.84 years, confirming that this is a young and fast-moving field still taking shape around current organizational challenges.

Despite their recency, the articles have already attracted attention, averaging 24.33 citations each, a respectable figure for this new work. The dataset contains 978 author keywords alongside 377 Keywords Plus terms, a vocabulary wide enough to signal how conceptually broad and multidisciplinary the area is. The themes include e-HRM, digital transformation, workflow automation, innovation ecosystems, organizational performance, and sustainability, mirroring the way human resource management is increasingly intertwined with information systems and digital technologies.

The collaboration figures point in the same direction. In total, 715 authors contributed to the 244 articles, and only 22 papers were written by a single author; on average, each paper had 3.27 co-authors. Co-authorship has become the normal mode of knowledge production in this field. International collaboration is less common but still meaningful, accounting for 29.10% of publications. Collectively, these numbers indicate that research on digital HR, workflow automation, and innovation ecosystems increasingly draws on interdisciplinary and cross-national work, which helps advance both theory and practice.

Main Information About the Data

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2020-2025
Sources (Journals, Books, etc.)	159
Documents	244
Annual Growth Rate (%)	23.84
Document Average Age (years)	2.84
Average Citations per Document	24.33
References	0
DOCUMENT CONTENTS	
Keywords Plus (ID)	377
Author's Keywords (DE)	978
AUTHORS	
Authors	715
Authors of Single-Authored Documents	19
AUTHORS COLLABORATION	
Single-Authored Documents	22
Co-Authors per Document	3.27
International Co-Authorships (%)	29.10
DOCUMENT TYPES	
Article	244

Figure 2. Descriptive Statistics of the Bibliographic Dataset

3.1.2 Source Dynamics and Scientific Growth

The growth of the field is most evident in how its leading journals have published over time. Figure 2 traces the most productive sources between 2020 and 2025, and the upward movement is clear: output on digital human resource management, workflow automation, and innovation ecosystems rose steadily across the period, with the sharpest acceleration coming after 2022. This timing aligns with the wider push toward digital technologies and automation in organisations and the growing interest in collaborative models of innovation.

The *Journal of the Knowledge Economy* was the most active outlet. Its cumulative output climbed steadily throughout the period and reached approximately 20 articles by 2025—the steepest trajectory of any source in the dataset. This prominence is significant because it situates workflow automation and digital HR within broader debates about knowledge-based innovation, digital transformation, and ecosystem collaboration, rather than treating them as narrow HR concerns.

Several other journals also feature prominently, including *Triple Helix*, the *International Journal of Manpower*, *IEEE Transactions on Engineering Management*, and *Quality - Access to Success*. *The Triple Helix* grew steadily, mirroring the rising interest in multi-stakeholder collaboration and helix-based models of innovation. The *International Journal of Manpower* maintained a stable output, a reminder that workforce management, employee performance, and human capital remain central concerns even as work becomes more digital. *IEEE Transactions on Engineering Management* helped bridge the technological and managerial aspects of the conversation, particularly in studies of automation and digital transformation.

Figure 2 also shows the literature spread. Early on, publications clustered in a handful of journals. Recently, a wider range of outlets have taken up topics such as digital HR, automation, sustainability, innovation ecosystems, and organizational performance. This broadening confirms the interdisciplinary nature of the field: research on workflow automation and digital HR is no longer confined to traditional HR journals but now overlaps with innovation management, information systems, and technology management.

Taken together, these patterns describe a field that is expanding quickly, drawing in more disciplines, and binding technological and managerial perspectives. With its leading journals still growing, digital HR, workflow automation, and collaborative innovation ecosystems appear to remain active research themes, with considerable room for further theoretical and empirical work.

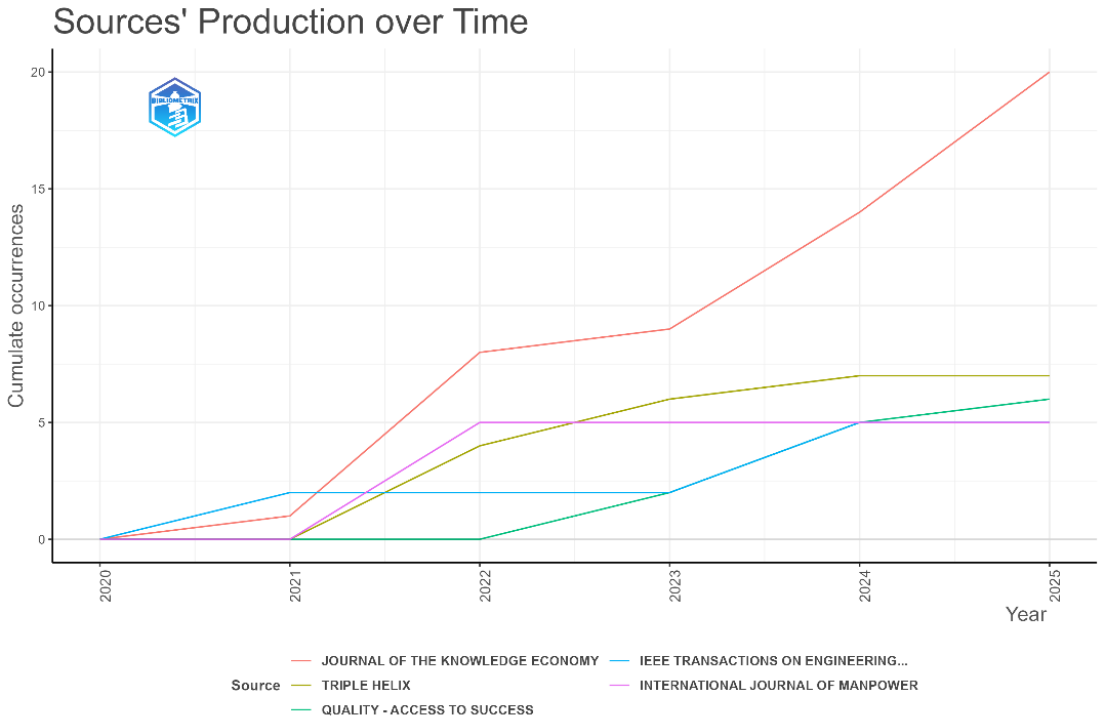

Figure 3. Source Dynamics and Scientific Growth (2020–2025)

3.1.3 Most Relevant Authors

Examining individual researchers offers another perspective on the field's intellectual roots. Figure 4 lists the most productive authors working on digital human resource management, workflow automation, innovation ecosystems, and helix-based models of collaboration. The output is spread across a fairly broad group of scholars, although a small number stand out as the field's most prolific contributors.

Carayannis E.G. leads the list with ten articles in the dataset. This is not surprising: he helped develop the Quadruple and Quintuple Helix frameworks, which now underpin much of the work on innovation ecosystems, digital transformation, and collaborative governance. His strong presence is a sign that ecosystem-based thinking remains central to how scholars understand organizational adaptation and innovation in the digital era.

Next is Nyathi M., with six articles, and Shahreki J. and Strohmeier S., with four each. Strohmeier's place on the list is worth noting in particular because his work has significantly shaped the conceptual development of digital HRM and electronic HRM (e-HRM). Together, these authors reflect on how closely human resource management, digital technologies, and organizational innovation have become intertwined in recent research.

A larger cluster of scholars Campbell D.F.J., Chen Z., Del Vecchio P., Fekadu M., Grigoroudis E., Kekwaletswe R., Passiante G., and Walia N. each contributed three articles. Their counts are lower, but their work has widened the field, providing perspectives on innovation management, sustainability, digital transformation, organizational performance, and technology adoption. In other words, the picture is one of intellectual variety rather than a single dominant school of thought.

Overall, Figure 3 shows a field supported by a network of influential scholars whose work cuts across disciplines. The mix of specialists in innovation systems, human resource management, information technology, and organizational studies underlines how interdisciplinary the area has becomeand provides future theoretical and empirical work with a solid base to build on.

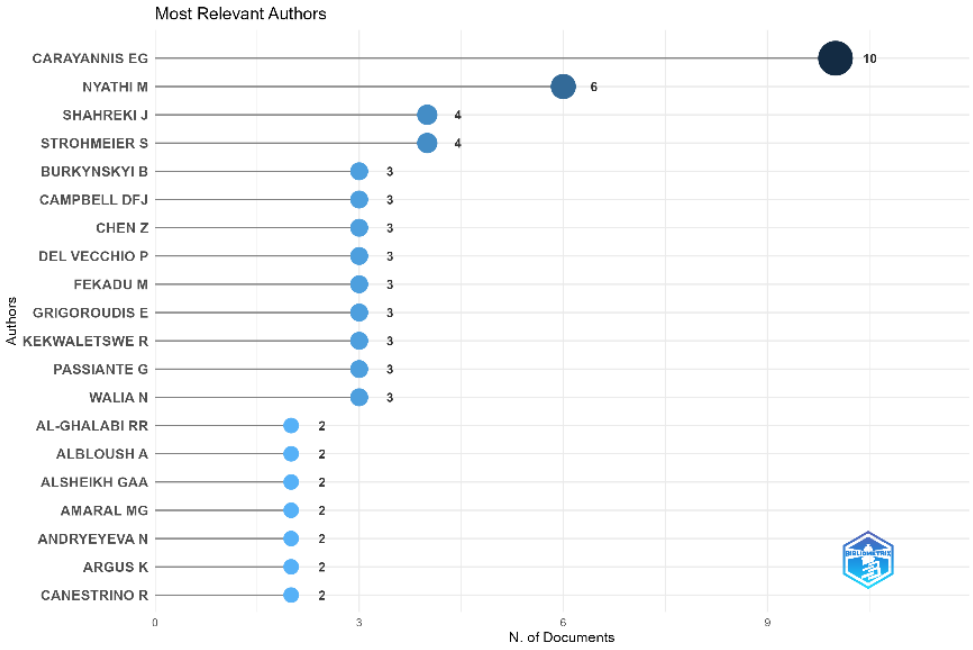

Figure 4. Most Relevant Authors in the Research Field

3.1.4 Country Scientific Production

Where research comes from says a good deal about how a field is developing globally. Figure 4 maps scientific production across countries, and while contributions come from many places, the differences in the volume and pace of growth are striking. Activity has clearly expanded in both advanced and emerging economies, a sign of how central digital transformation has become to organizational and national agendas.

Indonesia was the most productive country in the dataset. Its output rose sharply after 2022 and remained ahead of every other country through 2025. This pattern points to rising local interest in digital transformation, innovation ecosystems, human resource development, and collaborative governance, which is likely due to national efforts to promote digitalisation, Industry 4.0, and ecosystem-based innovation.

India, the United States, Malaysia, Spain, and Italy contributed substantially. India's output grew steadily, reflecting its expanding work on digital technologies, workforce development and organizational innovation. The United States has maintained a steady presence throughout, hardly surprising, given its long track record in management, information systems, and innovation research. By contrast, Malaysia, Spain, and Italy picked up most noticeably in the later years, a sign of widening international interest in digital HR and workflow automation.

Figure 4 also underscores the global nature of the field. With contributions arriving from so many regions, it is clear that the problems and possibilities of digital HR and workflow automation are not tied to any one setting; they are shared concerns for organizations trying to work more efficiently, compete more effectively, and innovate in a digital environment. This spread of contributing countries also opens the door to cross-cultural and comparative studies that can deepen both theory and practice in the field.

Taken together, the evidence points to a steadily internationalising field of study. A few countries have established themselves as leaders, but the continued spread of research across regions suggests a broadening of the knowledge base and stronger global engagement. This, in turn, creates room for more international collaboration and exchange something the complex problems of digital transformation, workforce management, and innovation ecosystems will require.

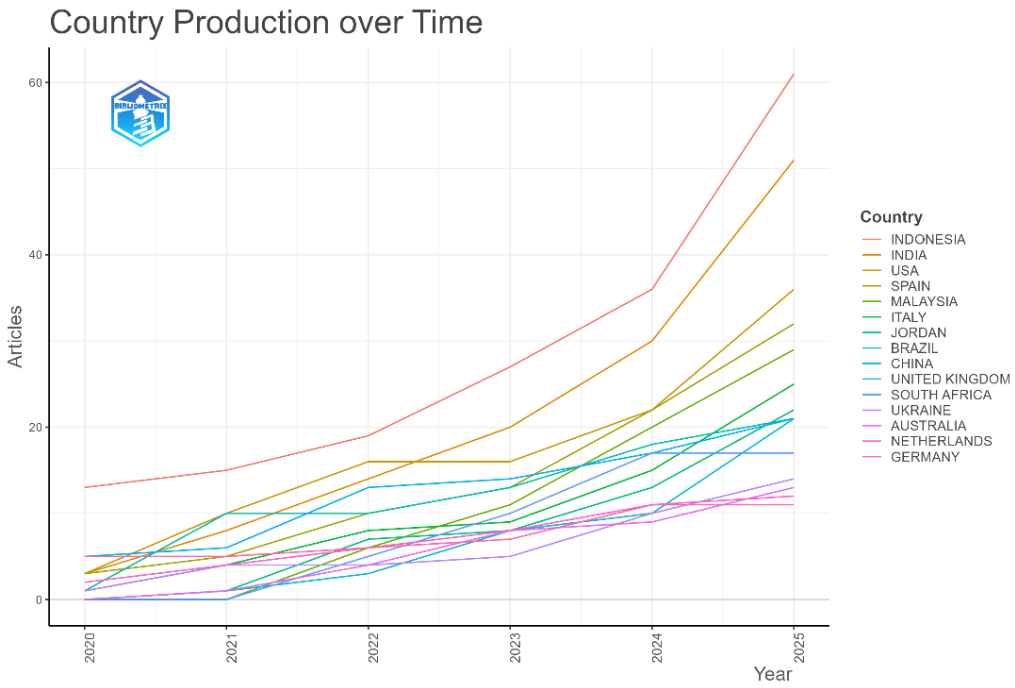

Figure 5. Country Scientific Production Over Time (2020–2025)

3.1.5 Affiliation Productivity Analysis

Institutions shape the production and sharing of knowledge in a field is produced and shared. Figure 5 shows that work on digital human resource management, workflow automation, and innovation ecosystems is spread across universities in different countries. Some have contributed consistently over the years, while others have grown quickly of late, indicating that more institutions are turning their attention to digital transformation and innovation research.

Aston University is among the most productive affiliations, with its output rising, especially in the later years of the period. Its steady contribution reflects an active research program on organizational innovation, digital transformation, and workforce management. Dhofar University, North-West University, and the University of

Johannesburg have likewise become more active, pointing to growing interestacross both developed and emerging settingsin what technological change and innovation ecosystems mean for organisations.

Several institutions saw their output increase after 2022, in step with the wider global push toward digitalisation and organizational adaptability. This shift probably reflects several things at once: the spread of digital technologies, heavier investment in innovation research, and a growing view of human capital as a strategic asset rather than a cost. The fact that these institutions are located in different parts of the world reinforces the point that digital HR and workflow automation are now an international concern, not the preserve of a handful of countries or universities.

Figure 5 also highlights the value of institutional variety. Universities with different research strengths bring different lenses to the field human resource management, information systems, innovation management, organizational behaviour, digital transformation and that mix makes for richer theoretical debate and more rounded solutions to the problems organisations actually face.

Overall, the affiliation analysis points to a broad network of universities that sustain work in this area. The fact that institutions from many regions are contributing more reflects a maturing field and underlines how much institutional collaboration matters for generating new insight into workflow automation, digital HR, and innovation ecosystems. It also hints at what may come next: research that leans more heavily on partnerships among universities, industry, government, and the other stakeholders involved in digital transformation.

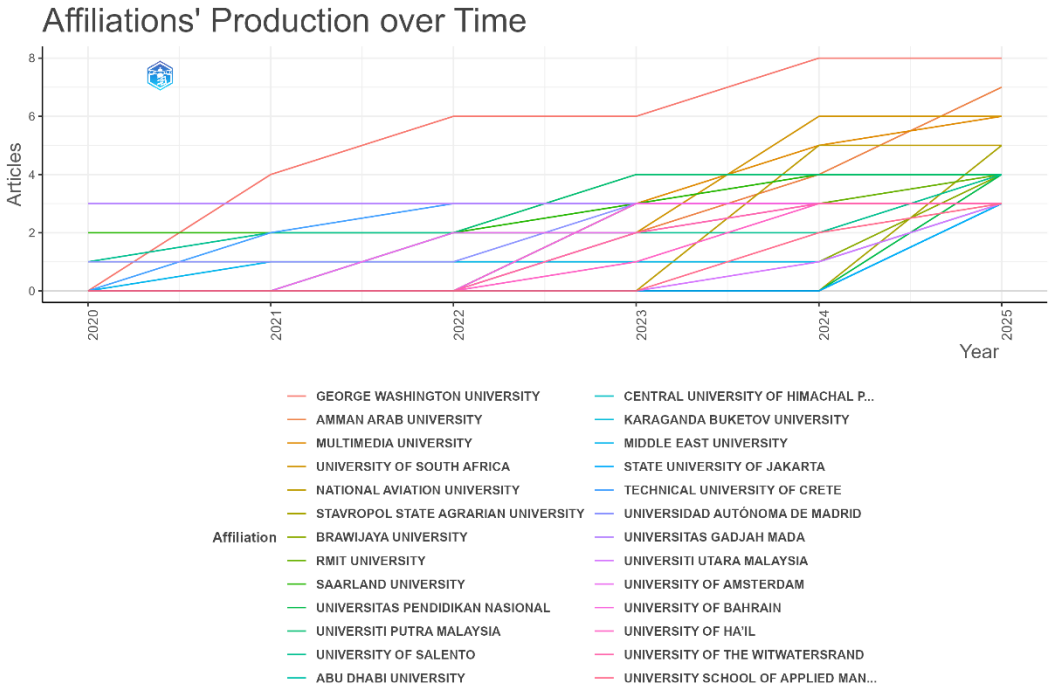

Figure 6. Affiliations' Scientific Production Over Time (2020–2025)

3.1.6 Three-Field Plot Analysis

The three-field plot links three sides of scientific production at once author keywords, institutions, and countries and lays bare how they connect. Figure 6 shows these three columns side by side, with flows between them. Reading across, it becomes possible to see which research topics are tied to which institutions and which parts of the world, and thus to get a sense of both the knowledge structure of the field and the collaborative web behind it.

On the keyword side, e-HRM, the Quintuple Helix, human resource management, digital HRM, and digital transformation stand out as the most prominent themes. Their dominance confirms that current research focuses on two things: folding digital technologies into HR practices and the role of innovation ecosystems in organizational change. The appearance of sustainability-related terms adds further nuance digital HR is increasingly treated not just as a technical project but as a route to longer-term organizational and social goals.

Among institutions, several universities are close to these leading themes, including Aston University, North-West University, and the University of Johannesburg. The links suggest that particular institutions have built up expertise in particular areas digital transformation, innovation ecosystems, and human resource development and that a relatively small set of academic centres does much to steer the intellectual direction of the field.

On the country side, Indonesia, India, the United States, Malaysia, and several European nations are strongly tied to the dominant themes. Indonesia stands out for its dense connections to innovation ecosystems, digital transformation, and human resource development, in line with its growing research presence in these areas. The United States and the European countries, meanwhile, link most strongly to more established themes around organizational innovation and digital management a reminder of their continuing influence on the global research agenda.

Figure 6 also makes the field's interconnected character plain. The flows among keywords, institutions, and countries show that research on digital HR and workflow automation does not sit within neat geographic or disciplinary boundaries; it emerges instead from the interplay of many actors working in different institutional and national settings. That structure helps ideas travel, encourages international collaboration, and supports the kind of multidisciplinary work the problems of digital transformation tend to demand.

Taken together, the three-field plot places digital HR, innovation ecosystems, and collaborative governance at the center of the current research landscape. The tight links among leading keywords, productive institutions, and major contributing countries suggest a field that has matured into a globally connected, interdisciplinary domain. This view of the conceptual structure sets the stage for a closer look at how the research themes themselves relate to one another.

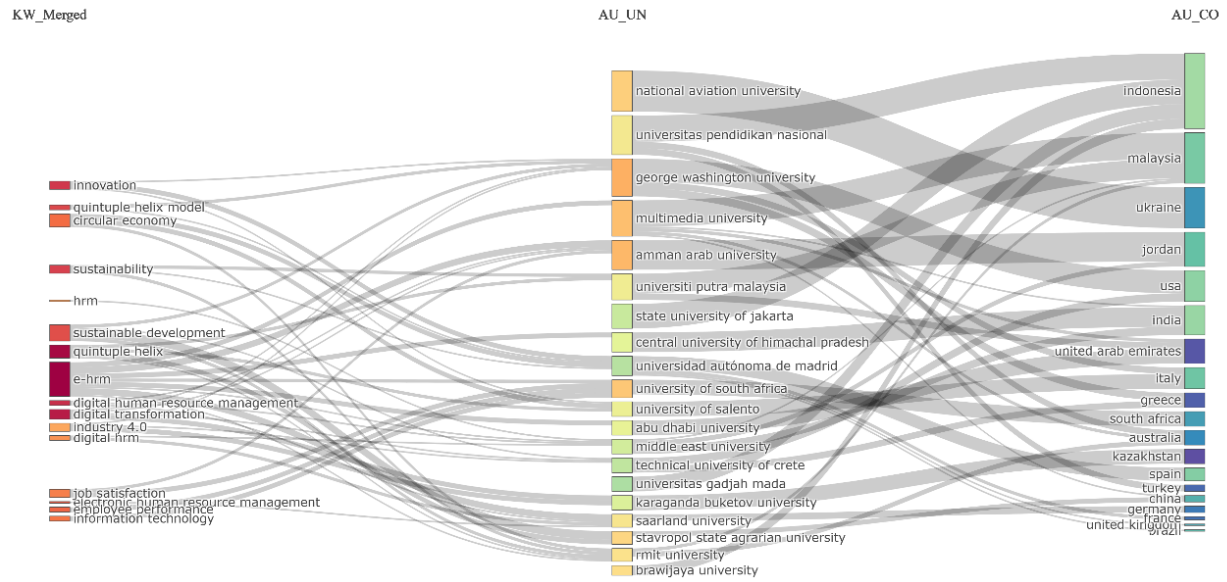

Figure 7. Three-Field Plot of Keywords, Affiliations, and Countries

3.1.7 Keyword Co-occurrence and Conceptual Structure

To get at the conceptual foundations of the field, the keywords were examined in two ways: by raw frequency and through a co-occurrence network. Figures 7 bring out the dominant concepts and the way they group into clusters. The word cloud in Figure 7 simply shows which terms appear most often; the network in Figure 7 goes further, mapping how those terms connect and combine into recognizable research themes.

Figure 8 puts e-HRM, Quintuple Helix, human resource management, digital HRM, and digital transformation at the front of the dataset. Their frequency signals where attention is going: toward weaving digital technologies into HR functions and, more broadly, toward organizational transformation. That innovation-related terms such as Quintuple Helix, innovation ecosystem, and sustainability are so visible suggests the literature now reaches well past day-to-day HR concerns into collaborative, ecosystem-based ways of thinking about innovation.

The network in Figure 9 sorts into several connected clusters. The first gathers around e-HRM, human resource management, and digital HRM studies of how HR practice is being digitalized, covering employee management systems, workforce analytics, and organizational performance. This is the literature's core, and it makes the strategic weight of technology in reshaping HR clear. The tight links among these terms suggest digital HR has matured into a research stream with a solid theoretical and empirical base.

A second cluster forms around Quintuple Helix, innovation ecosystems, sustainability, and collaborative governance. Here the emphasis falls on multi-stakeholder interaction among academia, industry, government, communities, and media as the engine of innovation and knowledge creation. The visibility of the Quintuple Helix concept shows how much weight researchers now give ecosystem collaboration in driving digital transformation and sustainable development. This connects directly to the growing conversation around Pentahelix approaches and their use in organizational and societal innovation.

A third cluster brings together digital transformation, technological innovation, and organizational adaptation, with close ties to technology adoption, digital capability, business process improvement, and organizational resilience. The pattern here is telling: workflow automation appears less as a tool for trimming operational costs than as a strategic lever for transformation. On this reading, organizations adopt it to stay agile, innovative, and competitive in fast-moving environments.

Across both figures, then, the field shows a densely interconnected conceptual structure that ties together digital HR, innovation ecosystems, sustainability, and digital transformation. The fact that these themes sit alongside one another points to research that increasingly works across disciplines to make sense of technology-enabled workforce management. These clusters also set up the next step tracing how the themes have developed and matured, which the thematic map takes up in the following section.

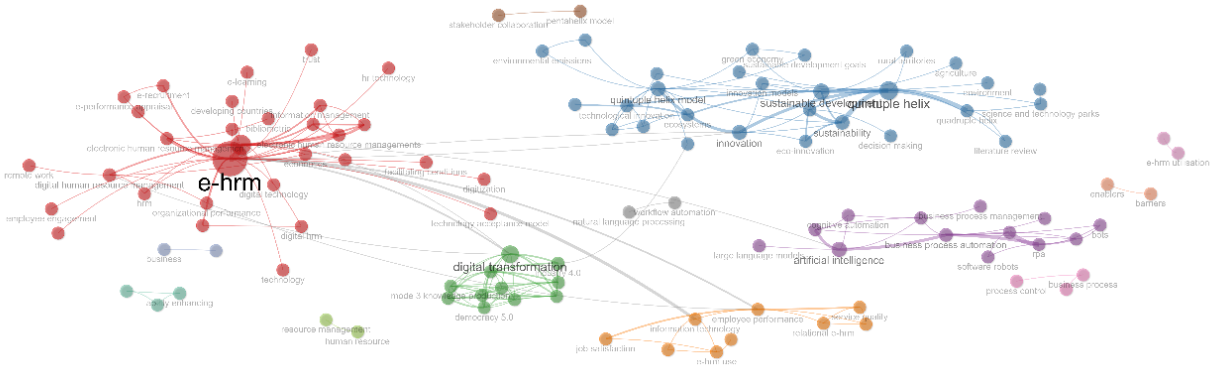

Fig 8. *Most Frequent Keywords in the Research Field*

3.1.8 Thematic Map Analysis

The thematic map gauges how mature and how relevant each research theme is by plotting two measures against each other centrality, or how connected a theme is to others, and density, or how internally developed it is. The result sorts themes into four quadrants: motor, basic, niche, and emerging or declining. Figure 8 shows that research on digital human resource management, workflow automation, and innovation ecosystems spreads across all four, with themes at very different stages of development and influence.

The upper-right quadrant holds the motor themes high on both centrality and density, which means they are well developed and central to the field. Technology, Industry 4.0, Society 5.0, Triple Helix, and related innovation concepts sit here. Their position marks technological change and innovation-ecosystem frameworks as the field's main drivers, and their many links to other topics suggest they act as anchors for discussions of organizational transformation, workforce development, and digital innovation.

In the lower-right quadrant are the basic themes high in centrality but lower in density. These are foundational topics, tightly connected to the rest of the field even if they still have conceptual room to grow. e-HRM, human resource management, digital HRM, organizational performance, and sustainability fall here, which confirms that digital HR remains one of the field's load-bearing pillars and a hub linking different research streams. The presence of

sustainability among them shows that researchers increasingly want digital transformation tied to longer-term organizational and societal goals.

The upper-left quadrant gathers the niche themes well developed internally but loosely connected to the wider field. Topics around specific applications, particular technology uses, and specialized HR practices appear here. They yield useful insights, but their reach stays largely within their own corners of the literature. Even so, niche themes are often where methodological innovation happens, and some may grow more influential as the field matures.

The lower-left quadrant contains the emerging or declining themes, low on both measures. Pentahelix collaboration, stakeholder engagement, community-based innovation, and some sector-specific applications turn up here. Their placement shows they remain underexplored next to established concepts like e-HRM and digital transformation. The more likely reading, though, is not decline but early days: these themes seem to mark a rising interest in how collaborative innovation ecosystems can support organizational digitalization and workforce development.

One contrast stands out. Triple Helix and Quintuple Helix concepts are prominent, yet Pentahelix is barely visible in the thematic structure. Helix-based frameworks have clearly drawn attention in innovation and knowledge-ecosystem research, but their Pentahelix variant has scarcely been applied to digital HR and workflow automation. That gap is exactly where future work could contribute bringing stakeholder-collaboration frameworks together with technology-enabled human resource management systems.

Read as a whole, Figure 9 describes a field that is maturing, built on well-established themes around digital HR, innovation ecosystems, and technological transformation. But several promising themes remain thin especially those tied to collaborative governance, stakeholder ecosystems, and Pentahelix-based approaches. The implication for future research is fairly direct: move past a purely technology-centered framing and look at how multi-stakeholder collaboration might make workflow automation and digital HR more effective, more sustainable, and more scalable.

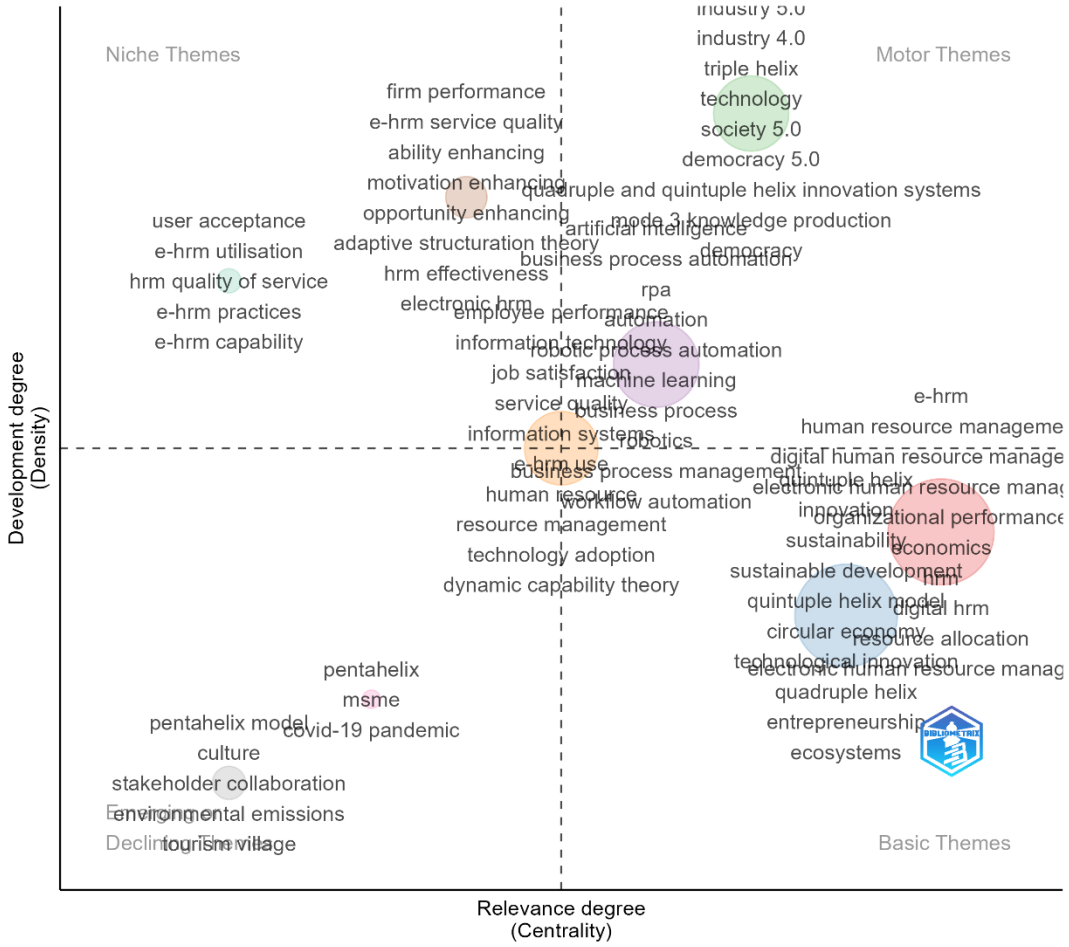

Figure 9. Thematic Map of Workflow Automation and Digital Human Resource Management Research

3.2. Discussion

The results indicate a rapidly growing field between 2020 and 2025. A rising annual growth rate, together with a steady stream of new publication outlets, suggests that researchers and organisations have been responding to the mounting demand for digital transformation in workforce management. The breadth of this growth across journals matters too: it indicates that digital HR is no longer seen as a back-office administrative function but as a strategic capability bound up with competitiveness, innovation, and sustainability. This speaks directly to RQ1, as research in this area has expanded markedly over the past five years, propelled by advances in digital technologies, automation platforms, and data-driven management.

Several contributors have clearly shaped the field's intellectual development. Authors such as Carayannis and Strohmeier, among others, have done much to build the theoretical groundwork for digital transformation, innovation ecosystems, and e-HRM, while journals like the Journal of the Knowledge Economy and Triple Helix have become key outlets. Geographically, Indonesia, India, and the United States stand out for their productivity, and a number of universities have published more over time. This is the substance of RQ2: it names the actors driving the field forward and shows how international the research on digital HR and workflow automation has become.

The conceptual analysis sharpens the picture of what the literature is actually about. Keyword and co-occurrence results place e-HRM, digital HRM, human resource management, digital transformation, and innovation ecosystems at the core, and the strong ties among them suggest research that increasingly reads these together technological innovation alongside organizational and human resource concerns rather than apart from them. Workflow automation, on this evidence, is treated less as a technical fix than as a strategic means of improving performance, employee experience, and the quality of decisions. That addresses RQ3, mapping the main intellectual structures and thematic links that hold the field together.

The role of innovation-ecosystem frameworks deserves particular attention. The thematic map shows Triple Helix and Quintuple Helix concepts featuring strongly, in line with a growing sense that successful innovation depends on collaboration across stakeholders. The Pentahelix perspective, however, sits among the emerging themes and remains thinly represented despite its relevance. This is what RQ4 was after: integrating stakeholder-collaboration frameworks into digital HR and workflow automation research is still at an early stage. Most studies stay focused on technological implementation and organizational outcomes, and relatively few ask how governments, academia, industry, communities, and media might together drive digital workforce transformation.

That workflow automation has risen to a strategic research theme carries weight for both theory and practice. Theoretically, the findings back the view of digital transformation as a socio-technical process—one that plays out through the interplay of technology, organizational capabilities, and stakeholder ecosystems, not technology alone. In practical terms, organizations can use automation for more than operational efficiency; it can also strengthen talent management, workforce analytics, employee development, and organizational learning. As automation works its way deeper into HR, the implication is that workforce management will need to become more adaptive and more data-driven.

The thematic structure also points to where research might usefully go next. The most obvious opening is to study how workflow automation can be combined with Pentahelix-based collaboration in both public and private organizations. Second, low-code and no-code platforms might play a role in digital HR transformation, especially where resources are limited. A third concerns the social and ethical side of automation employee acceptance, digital skills, privacy, and algorithmic decision-making which has drawn less attention than the technology itself. Finally, comparative and cross-country studies could show how different institutional settings shape the adoption and effectiveness of workflow automation in HR.

Overall, the field appears to be maturing: growth is strong, international participation is widening, and integrated themes are taking shape around digital HR, workflow automation, innovation ecosystems, and organizational transformation. Plenty of room remains, though, to push the theory further and broaden the empirical base particularly by bringing collaborative governance and Pentahelix perspectives into the conversation. That is where the most promising work likely lies: developing fuller, more sustainable, and more stakeholder-oriented approaches to managing the digital workforce.

4. Conclusion

This study maps the development of research on workflow automation, digital human resource management, and innovation ecosystems through a systematic literature review and bibliometric analysis of 244 Scopus-indexed journal articles published between 2020 and 2025. The field has grown considerably over the years, in step with the rising importance of digital transformation in how organisations are managed and how their workforces are developed. This has resulted in a varied and collaborative research landscape with 715 authors across 159 sources, with international engagement on the rise.

At its core, the field is organised around digital HR, e-HRM, digital transformation, workflow automation and innovation-ecosystem frameworks. The co-occurrence and thematic analyses show that these themes are closely linked, together shaping a body of work on technology-enabled workforce management. The growing visibility of innovation-ecosystem concepts, particularly Triple Helix and Quintuple Helix, points to a wider recognition that collaboration and knowledge exchange matter for organizational transformation and innovation.

Despite its maturation, the field still has clear gaps. The thematic map shows that Pentahelix-based collaboration, stakeholder engagement, and ecosystem-oriented approaches remain underexplored, next to better-established themes such as e-HRM and digital transformation. The lesson for future work is to look beyond a technology-centric view and ask how collaboration among academia, industry, government, communities, and media can make digital HR and workflow automation more effective. This would offer a more rounded understanding of organizational digital transformation and how to develop a workforce sustainably.

In practical terms, the findings argue for treating workflow automation as a strategic capability rather than just a tool that can support organizational agility, operational efficiency, evidence-based decisions, and workforce performance. Organisations pursuing digital transformation can use it to streamline HR processes, improve the employee experience, and place management on a firmer data footing. None of this happens automatically; it depends on a supportive culture, the right digital skills, and working relationships across the surrounding stakeholder ecosystem.

Taken together, the contribution of this study is to lay out the intellectual structure, thematic evolution, and emerging directions of research on workflow automation and digital HR. The results should be useful to researchers, practitioners, and policymakers and offer a starting point for further work on integrated digital HR systems. The most promising path ahead lies at the intersection of workflow automation, Pentahelix collaboration, and digital workforce development, a combination that could help build more inclusive, adaptive, and sustainable models of human resource management for the digital era.

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