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EMBRACING TECHNOLOGY-DRIVEN WORKFORCE AGILITY: A SCIENTOMETRIC REVIEW OF SUSTAINABLE DIGITAL TRANSFORMATION USING VOSVIEWER

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ABSTRACT

In the current era of rapid changes, technological advancement, and disruption at every turn, workforce agility has become a critical feature to uphold the competitive edge of organizations and for their long-term sustainability. This paper uses the SPAR-4-SLR protocol to systematically review and analyse 184 objectified documents, combining bibliometric and thematic analyses through VOSviewer to map the intellectual landscape while opening up new research directions. The results consolidate core theoretical frameworks and track research evolution along with thematic clusters that underscore the complex nexus between workforce agility, digital transformation, and adaptive capability. Central to these are the understanding that the supporting digital technologies such as AI, Industry 4.0, and data analytics should join human-side enablers such as psychological empowerment, flexible leadership, and commitment to continuous learning and upskilling to yield agile workforce behaviours in a volatile environment. The research highlights additional research gaps and fertile avenues for scholarly endeavour while offering practical strategies practitioners can use to formulate workforce policies and systems that maintain a balance between technological progress and human motivation, thereby enabling organizations to thrive amid the chaotic regions of a digitized world economy...

KEYWORDS *Technology-Driven Workforce Agility, Sustainable Digital Transformation, Scientometric Analysis, VOSviewer, Bibliometric Review.*

1. Introduction

In today's fast-paced business world, being able to adapt quickly has become a key factor that sets companies apart. As organizations face constant technological changes and unpredictable market conditions, workforce agility has become essential. This term refers to how quickly employees and teams can adjust to shifts in digital tools, organizational structures, and market demands. By fostering this agility, businesses can stay competitive, resilient, and sustainable even when the future feels uncertain (Gobniece & Titko, 2024). With the rise of technologies like artificial intelligence (AI), Industry 4.0, and cloud computing, the need for a flexible and skilled workforce has grown, especially in industries that are becoming more digital (Li, L.,2022).

Digital transformation goes beyond just automating everyday tasks; it also requires a significant shift in the culture and mindset of the workforce. Studies indicate that for transformation to be truly successful, it needs a blend of digital tools and human-focused elements like psychological empowerment, adaptable leadership, and a commitment to lifelong learning (Kavya et al., 2023). These qualities allow employees to work independently, adapt to changing demands, and collaboratively create value within digital environments. However, the existing research in this area is quite scattered, with many studies zeroing in on specific outcomes like employee engagement or task efficiency, rather than providing a comprehensive view of how digital transformation enhances agility for both individuals and organizations (Judijanto et al., 2025).

As the concept of technology-driven workforce agility (TDWA) evolves amidst the rapidly expanding boundaries of sustainable digital transformation, it has now gained a significant amount of attention academically and practically by researchers and practitioners around the globe. However, the body of literature remains highly fragmented; only a handful of studies have assembled a broad understanding of how to conceive workforce agility through a sustainable digital transformation lens—while also emphasizing the opportunities and challenges that arise from such a convergence (Tessarini Junior & Saltorato, 2021; Utomo & Latukismo, 2022; Alviani et al., 2024; Hatunoğlu, 2024). Existing reviews have cited the need for stronger and contextualized research on workforce agility in technology-driven and sustainability contexts (Table 1). Meanwhile, there have been scholarly investigations into workforce agility through parallel areas of organizational change management (Van Veldhoven et al., 2021), remote and hybrid work (Burton et al., 2021), strategies of sustainable digital transformation (Pinto et al., 2024), and corporate sustainability practices in relation to new and emerging technologies (Alshdaifat et al., 2024). To evaluate this fragmentation, Table 1 offers a summarized look at recent systematic literature reviews (SLRs) that have explored workforce agility from various perspectives. While these studies serve as useful starting points, they highlight the necessity for a thorough scientometric mapping of the intellectual and thematic frameworks within this rapidly developing field.

Table 1. Comparison of Recent SLRs with Present Study.

Author (Year)	Title	Focus / Scope	Type of Review	Time Span	Sample Size
Tessarini Junior & Saltorato (2021)	*Workforce agility: A systematic literature review and a research agenda proposal*	Dimensions of agile workforce (proactivity, flexibility, resilience, competence)	Systematic literature review	Up to June 2020	Not specified
Utomo & Latukismo (2022)	*Trends and Patterns in Workforce Agility Literature: A Scopus-based Bibliometric Analysis*	Mapping evolution from 1993 to 2020; publication clusters, themes	Bibliometric & network analysis	1993–2020	>140 studies
Alviani et al. (2024)	*Workforce agility: a systematic literature review and research agenda*	Definitions, roles, theories, methodological gaps across levels of analysis	Systematic literature review	Up to 2024	74 articles

Hatunoğlu (2024)	*Workforce agility: a systematic literature review and comparison with domestic studies*	Broad conceptual review; Turkish vs. international research	Systematic literature review	Not specified	36 articles
Present study	*Embracing Technology-Driven Workforce Agility: A Scientometric Review of Sustainable Digital Transformation Using VOSviewer*	Technology-driven workforce agility in the context of sustainable digital transformation	Scientometric review	1996–2025	184 articles

There have been few studies that focus specifically on technology stimulated workforce agility (TDWA) and its potential contribution to advancing the UN sustainable development goals (SDGs) performance (Pinto et al., 2024; Alshdaifat et al., 2024; Moresi et al., 2024). In general, the literature focuses either on broad conceptualized analysis of workforce agility or specific contexts in industry or organizations, while ignoring the different facets of sustainable digital transformation emphasis in workforce agility. Assessing the strengths and weaknesses of TDWA within a contextualized framework can enable better understanding and a broader analysis and application of workforce agility, in general, to retain or recycle a sense of organizational resilience, adaptability, and competitive advantage in organizations. In this context, there is an important need to produce an up-to-date and deeper scientometric mapping of the literature in order to illustrate the changing relationship between workforce agility and sustainable digital transformation. In exploring the relevance, thematic areas and potential futures in TDWA research and its sustainability aspects, this study addresses an important need in the literature. Digitally transforming their system processes are now more important than ever for industries. Identifying technological, organizational or policies that can develop and sustain the practice of agile workforce processes in organizations is vitally important. The data in this science review also provide a consolidated space for academics, practitioners and policy makers to work together, and bridge the gap between theory and practice.

Given the diversity in technology's capabilities to support adaptability, innovation and customization, workforce agility - driven by technology - is critical in an evolutionarily changing business world. In the case of sustained digital transformation, we view workforce agility as a critical issue in respect to outcomes based on shifts in market demand, the acceleration of technology in industry, and increased expectations around sustainability. Although both organizational agility and workforce agility are intended to convey similar concepts, in the context of economic efficiencies, environmental responsibilities, and social inclusion workforce agility (as discussed above) is a different way of depicting workforce agility but one that is considered inevitable for driving resilience and future competitiveness. In consideration of these developments, we believe it important to carry out a wide-ranging review of the literature to help organizations responsibly, strategically, and critically, integrate technology-enabled agility within different organizational contexts; to facilitate both immediate and continued adaptability, while undertaking sustainable growth and development.

In line with the scope of early bibliometric and scientometric literature (Donthu et al., 2021; Lim et al., 2022; Mukherjee et al., 2022; Paul et al., 2021), this research experiences a bibliometric and thematic review to fill the current literature gap concerning technology-driven workforce agility (TDWA) in the sustainable digital transformation context to help enhance organizational resilience, adaptability, and sustainability. This research provides a pathway toward defining the current state and future direction of TDWA research. This review follows the SPAR-4-SLR methodology (Paul et al., 2021), used to systematize a theoretically or conceptually endowed evidence review (research of quality and rigor) method, and intended for clarity on systematic literature review under multiple interrelated conditions that may exist in the literature. This study undertakes a new perspective of an evidence review by combining the quantitative aspects of a scientometric analysis with some qualitative thematic insights (Kavya et al., 2023) of 184 publications indexed by Scopus, as pertinent to identify key conceptual clusters, theoretical framework, or key systems literature for TDWA or sustainable digital transformation as potential future pathways for organizations. This research certainly advances previous research by providing a new vantage point for working in the area of sustainable digital transformation with

workforce agility as indicated by the many studies that provide important foundations, but the literature still appears to lack a visible and data driven understanding associated with sustainable digital transformation and workforce agility areas of research. Many reviews appear to provide useful foundations but don't utilize a consensus systematic approach or systematic review, and established bibliometric methods and tools to structure categorized data within a small body of literature. However, at least in our opinion, there appears to be opportunities to build on our findings by utilizing all aspects of sciomentric analysis to ensure a thick describing of key themes that emerge from the literature, and as part of this study developed a review contained within ecological frameworks. Using RQ1, this study analyzed the performance structure of research within the field using RQ2 to analyze the intellectual structure using significant theoretical focuses, thematic clusters, and conceptual links. Furthermore, RQ3 offers a direction for future researchers hoping to expand knowledge and practice in this area. So, this study attempts to answer these questions:

RQ1: What are the trends and changes in publication and citation patterns within literature on Workforce Agility and Sustainable Digital Transformation?

RQ2: What are the major themes and theoretical foundations in this domain?

RQ3: What future directions can guide researchers in advancing this field?

By addressing these questions, this review aims to bridge existing research gaps, provide a one-stop reference for academics and practitioners, and outline a robust research agenda to advance the understanding and application of workforce agility in digitally dynamic contexts.

2. Methodology

This study aims to conduct a thorough review of research publications on technology-driven workforce agility in the context of sustainable digital transformation applying a systematic, replicable method that ensures breadth, correctness and precision of the analysis (Paul et al., 2021). The study combines bibliometric analysis and systematic literature review techniques to guarantee both depth and breadth of coverage. The directing review framework is the SPAR-4-SLR protocol (Paul et al., 2021), which consists of the three steps of assembling, arranging, and assessing. Furthermore, the bibliometric methods of science mapping and performance analysis—which Donthu et al. (2021) recommend—are used. Figure 1 shows the methodological and workflow stages.

2.1 Assembling

The assembling stage of this review diverges into two foundational sub-stages, i.e., identification and acquisition.

This study aims to determine on identifying academic publications about technology-driven workforce agility and sustainable digital transformation, intending to map the intellectual structure of this emerging domain. The bibliometric metadata using the VOSviewer of selected documents was extracted to assess the thematic evolution and research productivity. Given their critical role in promoting scholarly discourse, peer-reviewed journal articles were selected as the primary source type (Paul et al., 2021). Because of its extensive indexing and cross-sectoral relevance in scientometrics research, the Scopus database was used to guarantee the dataset's credibility and interdisciplinary scope (Donthu et al., 2021; Paul et al., 2021).

For the acquisition stage of this review paper, Scopus which is a large, multidisciplinary abstract and citation database of peer-reviewed literature, is used to download documents for the literature review (Lim et al., 2022; Paul et al., 2021). The search period for this study was till June'25. The search keywords used were “tech* OR digital* OR IT* AND workforce agility or employee agility or agile workforce”. In total, 365 documents were obtained from the search at the end of this stage.

2.2 Arranging

The two main sub-stages of this stage are purification and organization.

In this stage of arranging i.e. organization, the documents are sorted and arranged using Scopus filters. Language, source type, and document types were the organizing codes that were employed.

In this next stage of arranging i.e. purification, the journal was chosen as the source type for purification, and conference papers and articles were chosen as the document types because they usually advance the field's scholarly understanding (Paul et al., 2021). This produced 184 articles. As a result, at the conclusion of this stage, 184 documents had been collected for analysis and interpretation.

2.3 Assessing

Evaluation and reporting are the two sub-stages that make up the assessing stage.

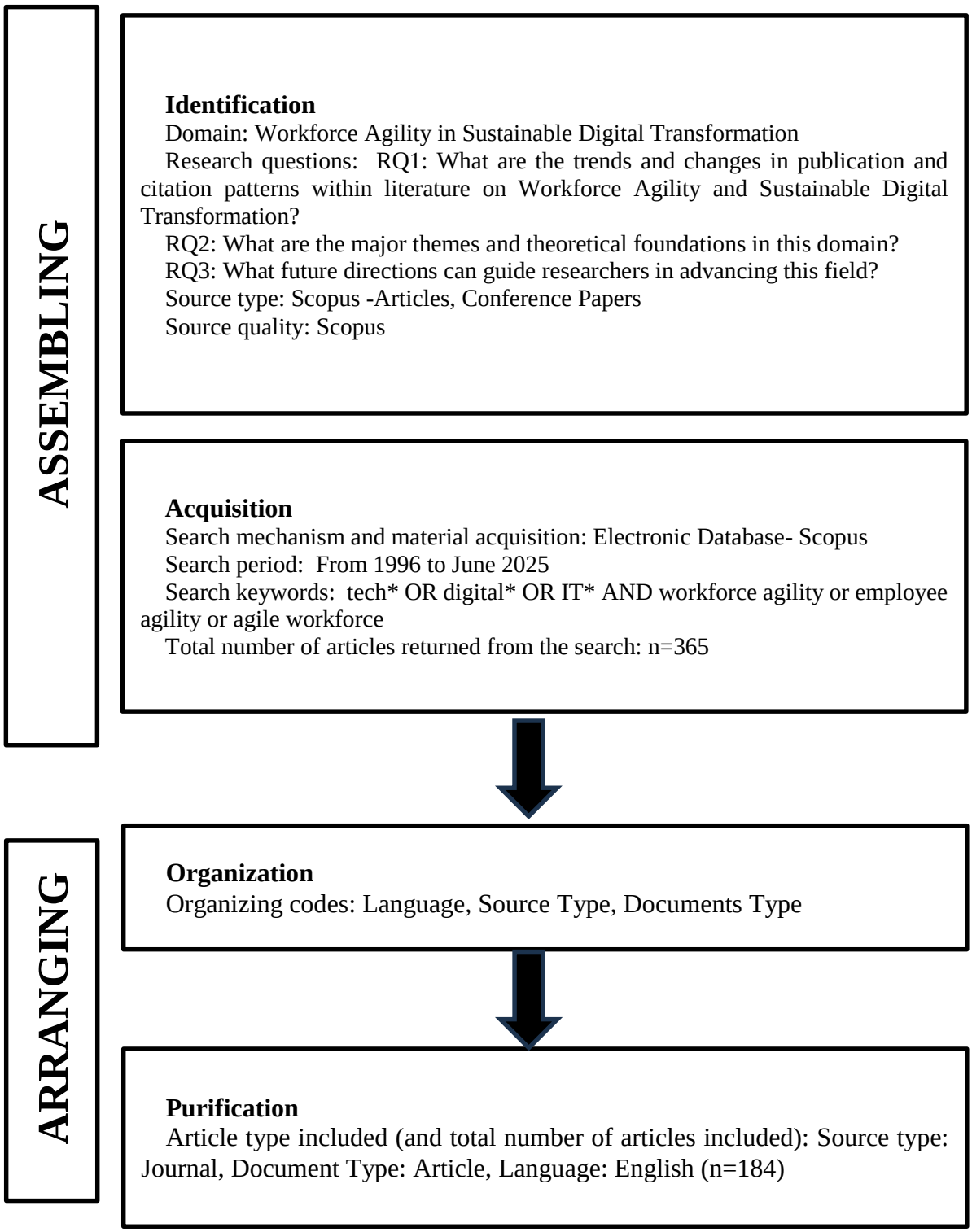
Evaluation stage: - This review uses an inductive approach for the evaluation stage, which means it makes inferences based on patterns in the data (Lim et al., 2022). Science mapping and performance analysis were the two primary forms of analysis that were carried out (Donthu et al., 2021).

In order to identify the most influential articles and sources and to display trends in publications and

citations, performance analysis used simple descriptive statistics. Key research themes in Technology-Driven Workforce Agility and Sustainable Digital Transformation were identified through bibliometric coupling, content analysis to uncover important theories, and keyword co-occurrence analysis to examine commonly used terms.

Microsoft Excel and VOS viewer were the tools utilized for these analyses and mapping.

Reporting stage: -The results were presented for the reporting stage using a combination of text, tables, and figures, following the guidelines by Paul et al. (2021).



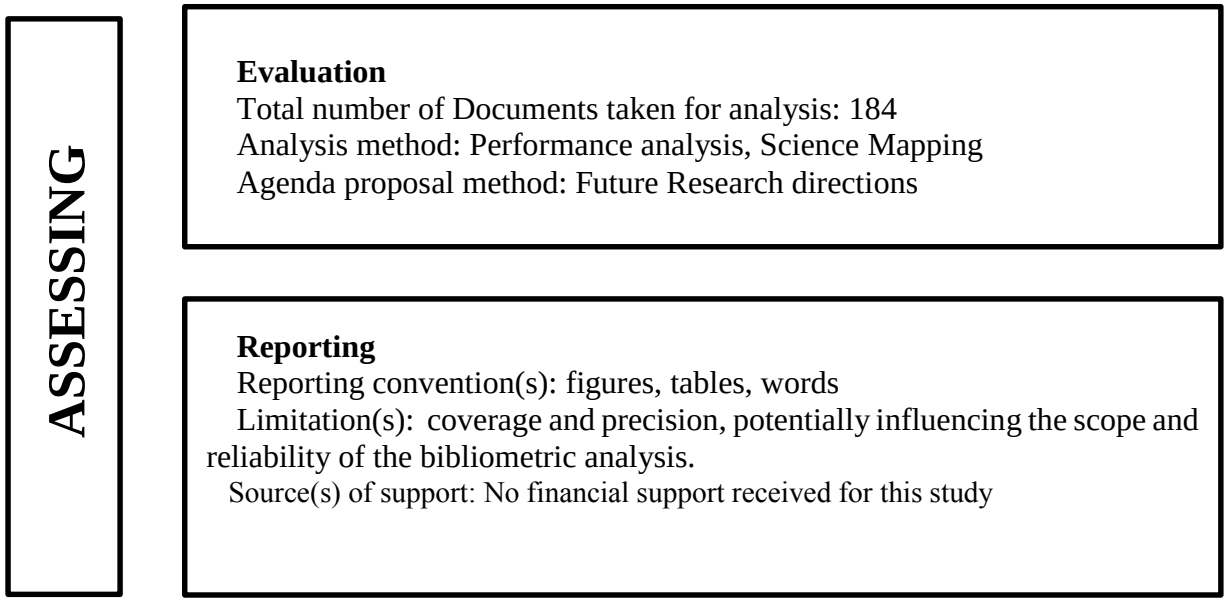


Figure 1. SPAR-4-SLR Methodology. Source: Paul et al. (2021).

3. Publication and Citation Patterns

3.1 Publication by Year

Using the information processing with the VOSviewer program, Figure 2 shows when papers about the subject were published between 1996 and 2025. For the first part of the timeline (1996-2017), there is limited data, with rare outputs greater than five documents per year, indicating that this area of research was still relatively immature and had not yet received broad scholarly support.

In contrast, after 2018 there is a clear upward shift in established and the volume of published documents, with gradual, yet steady increase in published documents. The upward shift really began to be established in 2020 and since then, the overall trend demonstrates increased amounts of published documents. By 2024, the volume of published documents peaked with initial total of over 35 documents in one year. There is a reduced published amount in year 2025 but the overall trend maintains expanding and changing area of research.

This rapid growth can be attributed to the following overlapping considerations:

1. Digital Shift: Organizations are not adopting digital technologies, and there is research on the plausibility of implementing more sustainable technology-based workforces.

2. AI and Automation: The use of AI and automation in organizations makes it unique research space with new questions on dynamics on the workplace and flexibility.

3. COVID: The global health issues regarding the pandemic was key driver for digital transformation and made both academic and practical aspects of sustainable technology-based organizations, prominent

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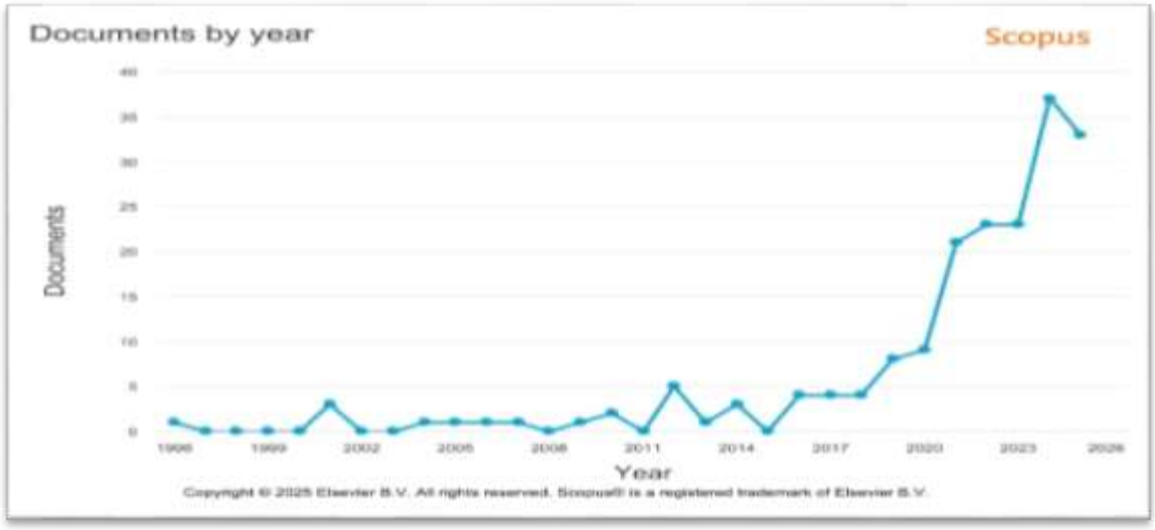

Figure 2. Distribution of Publications by Year. Source: Scopus Database

Above is the Annual Publication Trend of Workforce Agility

4. Sustainability Pressures: Challenges from regulations and societal expectations have forced sectors to research digitally-based options for sustainability.

5. Data-Based Evidence: The rise of big data has enabled the quantitatively review of workforce Behaviour, usefulness, and uptake of digital tools.

6. Interdisciplinary Collaboration: The confluence of management science, information systems, and sustainability sciences establishes a broad-based topic, increasing the multitudes and scope of contributions.

This continuing rise in publications suggests the growing significance of workforce agility and sustainable digital interactions in the climate of global volatility, technology changes, and sustainability pressures. The progress from infancy to an engaging area of studies coincides with wider changes in industry and academia, confirming this topic's production is timely and important.

3.2 Publication by Country

In Figure 3, the distributions of publications by countries have appeared, demonstrating those with impactful contributions related to the topic of research. India produces the most publications with 50 documents, followed by the US with 31 documents. The United Kingdom ranked third, and produced 15 documents, followed by Australia and Iran, who each produced 11 documents. China and Italy each produced 10 documents, followed by Malaysia with 9 documents. Germany and South Africa produced 8 documents. These findings suggest that more exploration of research contributions from the plethora of other countries could benefit future research.

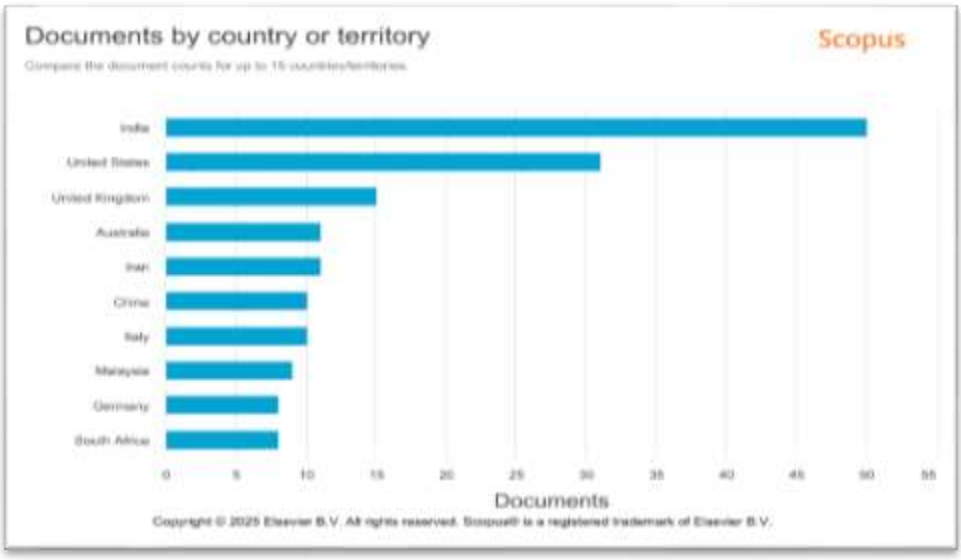

Figure 3. Distribution of Publications by Country. Source: Scopus Database Publication by Affiliation

3.3 Publication by Affiliation

According to Figure 4, the institutions with the highest levels of publication activity are the University of Johannesburg, Free University of Bozen-Bolzano and Amrita School of Business with 5 documents. Furthermore, Amrita Vishwa Vidyapeetham and Pandit Deendayal Energy University both had 4 documents. The institutions that had 3 documents are University Kebangsaan Malaysia, Northwestern university, University of Madras, University of Nottingham, and University of Tehran.

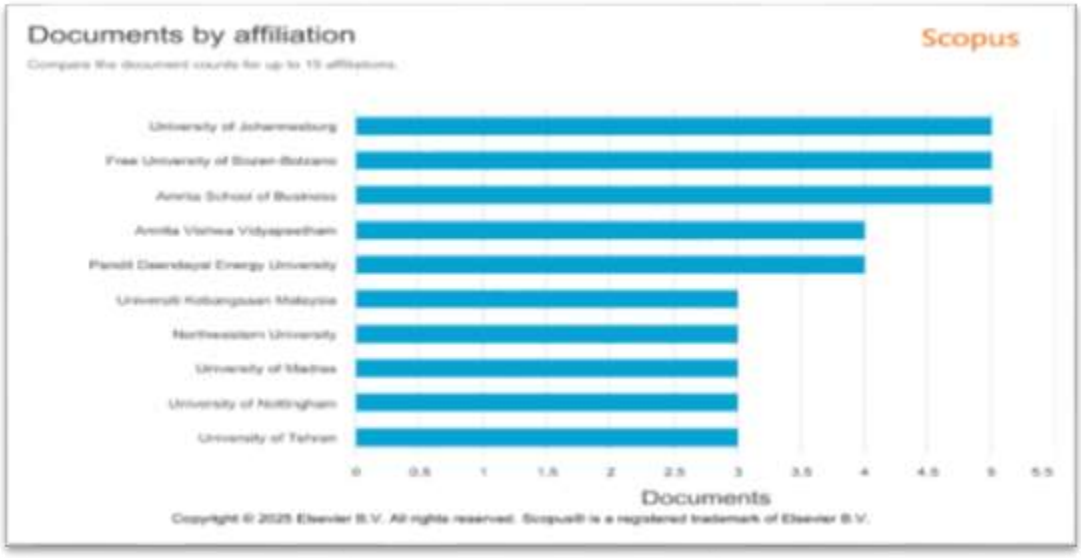

Figure 4. Distribution of Publications by Affiliation. Source: Scopus Database.

3.4 Publication by Source

Figure 5, shows that across years, there have been publications from the research topic that were dispersed across different publications. For instance, the IIE Transactions Institute of Industrial Engineers had 2 documents in 2002-2003 as marked in the orange line. The International Journal of Agile Systems and Management showed 2 documents in 2022-2023 as marked in the blue line. The Global Business and Organizational Excellence journal also had 2 documents in 2020 as marked by the purple line. The other publications, in order of appearance, include the International Journal of Business Excellence (the red line), Global Journal of Flexible Systems Management (the green line), International Journal of Production Research (the cyan line), Administrative Sciences (the brown line), Applied Sciences Switzerland (the yellow line), BMC Nursing (the orange line), and Engineering Construction and Management (the dark brown line), where each comprised of at least 1-2 documents over the publication years and illustrate a dispersed but consistent amount of research produced over time.

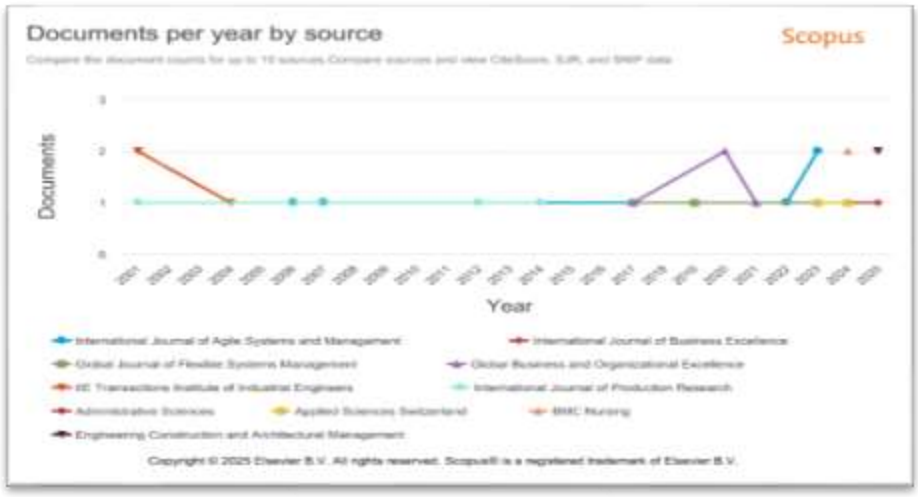

Figure 5 Distribution of Publications by Source. Source: Scopus Database

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3.5 Publication by Subject Area

The distribution of research by subject area as indicated in the Figure 6, reflects Business, Management, and Accounting as the highest discipline with 50 documents (29.7%), Social Sciences with 20 documents (11.7%) and Engineering with 19 documents (11.1%). Also, Computer Science provided 15 documents (9.0%) and Decision Sciences contributed 13 documents (7.6%). The other discipline areas were Economics, Econometrics and Finance (4.4%), Medicine (4.1%), Psychology (3.8%), Environmental Science (3.2%), and Arts and Humanities (2.9%). The other categories combined accounted for 21 documents (12.5%). Table 2, given below summarizes the complete breakdown of the publications by subject area.

Table 2. Publication by Subject Area

Color	Field	Documents	Percentage (%)
Blue	Business, Management & Accounting	50	29.7
Red	Social Sciences	20	11.7
Light green	Engineering	19	11.1
Purple	Computer Science	15	9
Orange	Decision Sciences	13	7.6
Turquoise	Economics, Econometrics, and Finance	8	4.4
Maroon	Medicine	7	4.1
Yellow	Psychology	6	3.8
Cream	Environmental Science	5	3.2
Brown	Arts and Humanities	5	2.9
Dark green	Other	21	12.5

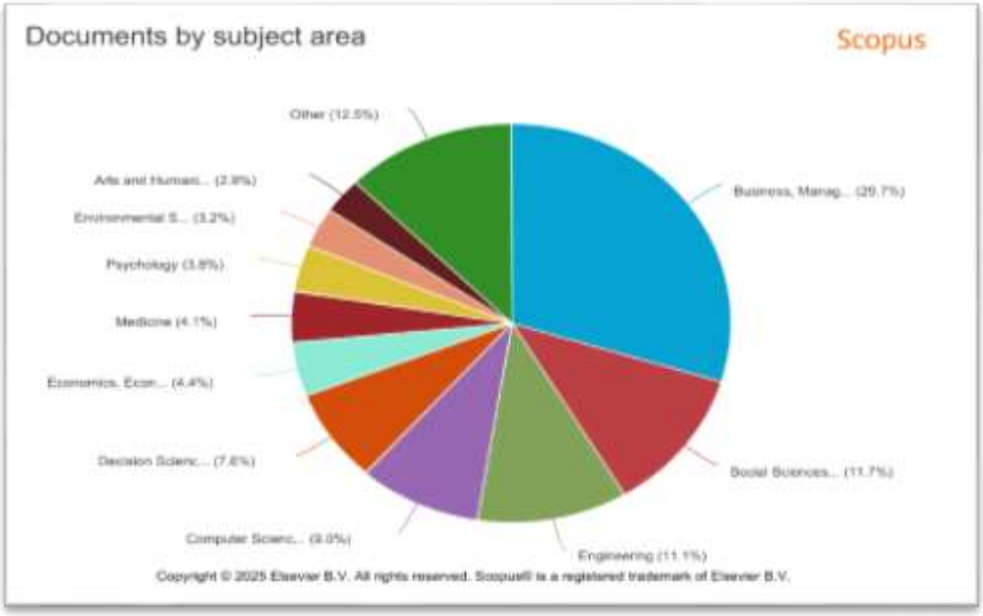

Figure 6. Distribution of Publications by Subject Area. Source: Scopus Database

4. Top Sources for Technology-Driven Workforce Agility and Sustainable Digital Transformation

The top journals ranked by total citations are presented in Table 2. The International Journal of Production Research (447 citations) is the top contributing outlet discussing production, manufacturing systems, and operations management. The journal's relevance is in articulating how workforce agility can improve operational efficiencies, optimize pre-determined resources, and contribute to sustainable production practices in increasingly digitalized environments. The Global Journal of Flexible Systems Management (234 citations) discusses system flexibility and dynamic capabilities – both closely related concepts to workforce agility. Their articles demonstrate how organizations address digital disruption by developing structures and learning systems capable of being flexible. IIE Transactions (now IISE Transactions) with 226 citations contribute to the literature on industrial engineering and systems optimization. This journal has some helpful articles on human-system interactions, work design, and digital tools – all important aspects of embedding agile workforce modes during transformational initiatives. The Global Business and Organizational Excellence journal (154 citations) connects practice to theory on organizational performance and provides frameworks for developing agile leaders, aligning the organization towards strategy, and developing its employees' adaptability skills. This journal bridged the gap between understanding and incorporating agile solutions for human-centered transformation with digital innovation. The International Journal of Agile Systems and Management (29 citations) focused on the constructs of agility on systems and organizations during times of transition. Their work is foundational to understanding how to use agile methodologies for the workforce and organizational design in relation to digital transformation

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Table 3. Top 10 Sources for Technology-Driven Workforce Agility and Sustainable Digital Transformation

Journal Name	Total Citations	Total Documents
International Journal of Agile Systems and Management	29	5
Global Business and Organizational Excellence	154	4
Global Journal of Flexible Systems Management	234	3
IIE Transactions (Institute of Industrial Engineers)	226	3
International Journal of Business Excellence	3	3
International Journal of Production Research	447	3
Administrative Sciences	21	2
Applied Sciences Switzerland	6	2
BMC Nursing	2	2
Engineering, Construction and Architectural Management	0	2

Although equal to other journals in number of citations, Administrative Sciences (21 citations) and Applied Sciences Switzerland (6 citations) are starting to provide valuable insights into organizational behavior and use of digital tools in applied research settings. BMC Nursing (2 citations) is indicative of trends in agility as it relates to healthcare workforce strategies amid digital and operational challenges. Finally, Engineering, Construction and Architectural Management had 0 citations in two documents, yet shows an additional interest in workforce agility in industries undergoing digital change as it relates to the construction industry, especially related to AI-enabled project management and smart infrastructure systems. Taken as a whole, these journals demonstrate an emergent area of interdisciplinary research, examining workforce agility, but also highlight how individually and collectively the studies are theorizing, measuring, and applying agility dimensions in multiple industries amidst a sustainable digital transformation.

5. Top articles on Technology-Driven Workforce Agility and Sustainable Digital Transformation

The most referenced articles in this area discuss the enablers, frameworks and organizational practices that underpin workforce agility in the context of digital transformation from a variety of perspectives.

Sanchez and Nagi (2001) analyze the basic mechanisms required of agile manufacturing systems including modularity and ICT connectivity which provide an environment capable of rapid reconfiguration and responsiveness for an organization. Sanchez and Nagi (2001) demonstrate that technical systems can help create an agile workforce environment by enabling Behaviour such as multitasking, adaptability, flexibility, etc., which are critical to addressing the complexities related to digital transformation in a service environment. Alavi et al. (2014) examine organizational structure and learning as preconditions to workforce agility. Their findings suggest that in decentralized and low-formality environments, knowledge sharing and employee proactivity (e.g. anticipating first problems) can increase employee engagement in a manner that initiates a circle of continuous learning, and sustainable transformation. Nijssen and Paauwe (2012) emphasize the role of HRM practices in creating agility during chaotic situations, in their studies they also position HR practices, skill diversity emphasis, and talent mobility, as distinct HR levers for using human capital at the organization's discretion in times of uncertain digital environments. Van Oyen et al. (2001) examined collaborative versus non-collaborative work systems as part of workforce agility, and found that team-based problem solving and flexibility through scheduling flexibility improved workforce agility. These researchers also highlight cross-training and communication as important features of workforce adaptability in AI integrated production environments. Patil and Suresh (2019) use a TISM framework to map the enablers of agility in IoT-driven projects. Their findings show that digital transformation leaders are primarily interested in technology adaptability, communication infrastructure, and decentralized decision-making. Similarly, Patri and Suresh (2017) identify enablers of agility within healthcare organizations using a similar methodology, including IT systems, real-time access to data, and workforce empowerment. They articulate that technology-human interface is critical in enabling adaptability in high-risk service industries such as health care. Muduli (2017) provides additional insights to the mediating role of HR practices and psychological empowerment on agile Behaviour. The study notes intrinsic motivation as a critical factor; Muduli also shows that empowerment and competence could be as valuable as structural redesign as a practice in the current digital era. Chonko and Jones (2005) coined the term agility selling to represent the salesforce adaptation speed in response to changing customer demands Their results further suggest that agility is more valuable in competitive services than customer-centricity or quick responses. Mrugalska and Ahmed (2021) conduct a systematic literature review on the subject of organizational agility from an Industry 4.0 related perspective, categorizing enabling technologies (AI, IoT, big data), but also taking into account required human competencies to enable the operationalization of technologies. This literature review establishes a basis for future digitally resilient workforce strategies. Finally, Jordan et al. (2004) provide the discussion of chained cross-training models that lessen idle time and increase the flexibility of teams. They argue that overlapping skill sets will enhance adaptability during rapid change in production or service settings.

Table 4. Top 10 articles on Technology-Driven Workforce Agility and Sustainable Digital Transformation

Documental Title	Year	Journal	Author	Total Citations	Contributions
A review of agile manufacturing systems	2001	International Journal of Production Research	Sanchez L.M.; Nagi R.	256	examines the components of agile manufacturing systems, including reconfigurable layouts, modular design, and ICT integration. It emphasizes how system responsiveness and rapid reconfiguration in production lines set the stage for developing agile workforce behaviors — such as multitasking, adaptive scheduling, and digital competence — making it crucial for organizations navigating transformation.

Organic structure and organizational learning as the main antecedents of workforce agility	2014	International Journal of Production Research	Alavi S.; Abd. Wahab D.; Muhamad N.; Arbab Shirani B	166	establishes a direct link between organic organizational design (i.e., decentralized decision-making, low formalization) and workforce agility. It reveals that environments fostering knowledge sharing, continuous learning, and team autonomy promote proactive behavior and adaptability among employees—key for digital readiness and sustainable transformation.
HRM in turbulent times: How to achieve organizational agility?	2012	International Journal of Human Resource Management	Nijssen M.; Paauwe J.	150	Proposes human resource management (HRM) practices as strategic levers for organizational agility. It underscores HR's role in talent mobility, skill diversity, and employee empowerment during periods of uncertainty, advocating for HR systems that facilitate rapid redeployment of human capital in volatile digital environments.
Performance opportunity for workforce agility in collaborative and noncollaborative work systems	2001	IIE Transactions (Institute of Industrial Engineers)	Van Oyen M.P.; Gel E.G.; Hopp W.J.	137	By comparing collaborative and non-collaborative production environments, this paper evaluates how task interdependence, communication, and flexible scheduling influence agility. It finds that systems designed for team-based problem solving and cross-training significantly enhance workforce agility—vital in AI-integrated production systems.
Modelling the Enablers of Workforce Agility in IoT Projects: A TISM Approach	2019	Global Journal of Flexible Systems Management	Patil M.; Suresh M.	125	constructs a Total Interpretive Structural Modelling (TISM) framework to rank and relate key enablers of workforce agility within IoT-based project contexts. Key enablers include technological adaptability, communication tools, and decentralized decision-making, providing a roadmap for digital transformation leaders in tech-intensive sectors.

Modelling the Enablers of Agile Performance in Healthcare Organization: A TISM Approach	2017	Global Journal of Flexible Systems Management	Patri R.; Suresh M.	97	identifies the specific enablers driving agility in healthcare settings, such as IT infrastructure, real-time data systems, and staff empowerment. It highlights the human-technology interface as a vital determinant of adaptive capacity in critical service environments like hospitals.
Workforce agility: Examining the role of organizational practices and psychological empowerment	2017	Global Business and Organizational Excellence	Muduli A.	92	investigates how HR practices (e.g., training, job rotation) and psychological empowerment (e.g., autonomy, competence) synergize to create agile employee behaviour. It shows that fostering intrinsic motivation is as important as structural redesign when cultivating digital-age agility.
The need for speed: Agility selling?	2005	Journal of Personal Selling and Sales Management	Chonko L.B.; Jones E.	92	Focusing on salesforce agility, the authors introduce the concept of "agility selling"—how quickly and effectively a salesperson can respond to changing client needs. The study connects agility to customer-centricity and real-time information processing, emphasizing its role in competitive digital marketplaces.
Organizational agility in industry 4.0: A systematic literature review	2021	Sustainability (Switzerland)	Mrugalska B.; Ahmed J.	90	synthesizes agility frameworks in the context of Industry 4.0. It classifies enabling technologies (AI, IoT, big data) and identifies human competencies needed to leverage them. It lays the groundwork for developing digitally resilient and agile organizational models.
Chained cross-training of workers for robust performance	2004	IIE Transactions (Institute of Industrial Engineers)	Jordan W.C.; Inman R.R.; Blumenfeld D.E.	74	presents cross-training models that minimize workforce idle time while improving adaptability. It advocates for “chained” training approaches that build overlapping skill sets across teams—enhancing flexibility in dynamic production or service operations.

A study of information systems issues, practices, and leadership in Europe	2019	European Journal of Information Systems	Kappelman L.; Johnson V.; Torres R.; Maurer C.; McLean E.	64	Surveying European IS leaders, this study highlights digital leadership challenges, cybersecurity, and skills gaps affecting agility. It underscores the need for adaptive information systems and leadership vision to manage digital transitions, emphasizing human-technology alignment.

Collectively, these studies provide a robust theoretical and practical base for understanding how workforce agility can be cultivated through technology, HR systems, and organizational design. They demonstrate how agility supports sustainable digital transformation across varied service sectors.

6. Science Mapping of Workforce Agility in Sustainable Digital Transformation Research

6.1 Theoretical Framing for Workforce Agility in Sustainable Digital Transformation

The adoption of AI and digital technologies to enhance workforce practices in sustainable business models has given rise to an emerging research area called workforce agility, which has been examined in detail through artificial intelligence (AI) tools and methods of scientometrics such as VOSviewer. The most common theoretical frameworks related to workforce agility include the Resource-Based Theory, Dynamic Capabilities, Self-Determination Theory, Technology Acceptance Models, and new behavioral-integrative models such as the Attitude–Ability–Behaviour–Outcome (A-A-B-O) Framework. The resource-based view identifies how internal capabilities, such as a digitally fluent and upskilled workforce, could become strategic resources to keep momentum for a digital economy (Gobniece & Titko, 2024). The dynamic capabilities approach states the organization engaged in an agility routine can continually realign itself with continual technological change (Al Moaid, N. A. A.,2024). Self-determination theory frequently used in the area of organizational change supports understanding how autonomy and intrinsic motivation creates staff ownership of digital tools and agile work. A technology acceptance model provides a baseline to assess how perceived ease-of-use and usefulness of a technology impacts workforce behavior. Recent literature is beginning to suggest competence gaps and motivation barriers; identify, theory-driven upskilling and change-readiness strategies are necessary. As research in digital transformation evolves, researchers encourage evolving these established theories for specific contexts drawing on grounded theory methods to explain workforce agility (Alviani, D., Hilmiana, W., Widianto, S., & Muizu, W. O. Z. (2024))

Table 5. Theories in Workforce agility and Sustainability Digital Transformation Research.

Year(s)	Field	Theory / Framework	Origin	Example of Use (in SDT & Workforce Agility context)
1959	Strategic Management	Resource-Based Theory (RBT)	Penrose (1959); Barney (1991)	Workforce agility (skills, adaptability, tech capabilities) as strategic resources driving SDT competitiveness
1985	Psychology Motivation	Self-Determination Theory (SDT)	Ryan & Deci (1985)	Explains how intrinsic motivation and autonomy fuel employee engagement and agile behavior in tech transitions

~1980s–1990s	Psychology / Sociology	Social Exchange Theory	Blau (1964); revised in Org. studies	Agile employee attitudes shaped by reciprocal trust and value in digital adoption
~1980s–2000s	Psychology / Learning Theory	Social Cognitive Theory	Bandura (1986) & later applications	Workforce ability (skills, efficacy) enabling readiness for digital transformation
1989	Technology Adoption / IS	Technology Acceptance Model (TAM)	Davis (1989)	Framework for understanding workforce adoption of new digital tools
1995	Information system / Organizational Design	Task-Technology Fit (TTF)	Goodhue & Thompson (1995)	Ensures that digital tools align with agile job tasks (Ismail et al., 2024)
2003	Information Systems	UTAUT (Unified Theory of Acceptance and Use of Technology)	Venkatesh et al. (2003)	Considers social influence and support conditions in digital tool use
2021	Digitalization & Org Agility	Dynamic Capabilities / Co-evolution Theory	Teece et al. / Ciampi et al. (2021)	Co-evolution of digital technologies and agile workforce routines
2024	Workforce / HR Studies	Attitude–Ability–Behaviour–Outcome (A-A-B-O) Framework	Emerging synthesis in literature	Classifies agility into components that influence digital transformation success

6.2 Keyword Co-occurrence of Themes in Workforce agility and Sustainability Digital Transformation Research

This research utilizes keyword co-occurrence analysis to outline the key components of a conceptual framework about sustainable AI research in the services sector. Keyword co-occurrence analysis can be an important bibliometric tool as it identifies relationships and patterns in existing literature (Baker et al., 2019; Emich et al., 2020). Identifying relationships and patterns will allow us to determine current trends based on analysis that highlights gaps in the literature and could lead to future research. This process helps generate useful insights that can inform further research as well as help guide policy (Börner et al., 2003; Donthu et al., 2021; Zupic & Čater, 2014). Bibliometric analysis is often accomplished in conjunction with network visualization software such as VOSviewer (van Eck & Waltman, 2010). We have also used VOSviewer to visualize the keywords network, which is shown in Figure 3.

This examination contributes a clear review of emerging themes in keyword co-occurrence analysis utilizing statistical computation and reporting methods. Important bibliometric measures, such as average year of publication (APY), average citation (AC), degree (DG) and occurrence (OC) were subsequently reported in Table 5 to provide a thorough bibliographic analysis. APY results indicate a keyword's relevance over time, whether it is more recent or older; AC indicates an average influence of a keyword; DG indicates the number of connections a keyword has to other keywords; and OC shows the frequency in which a keyword appears in research (Andersen, 2021; Callon et al., 1983; Donthu et al., 2021; Waltman et al., 2010).

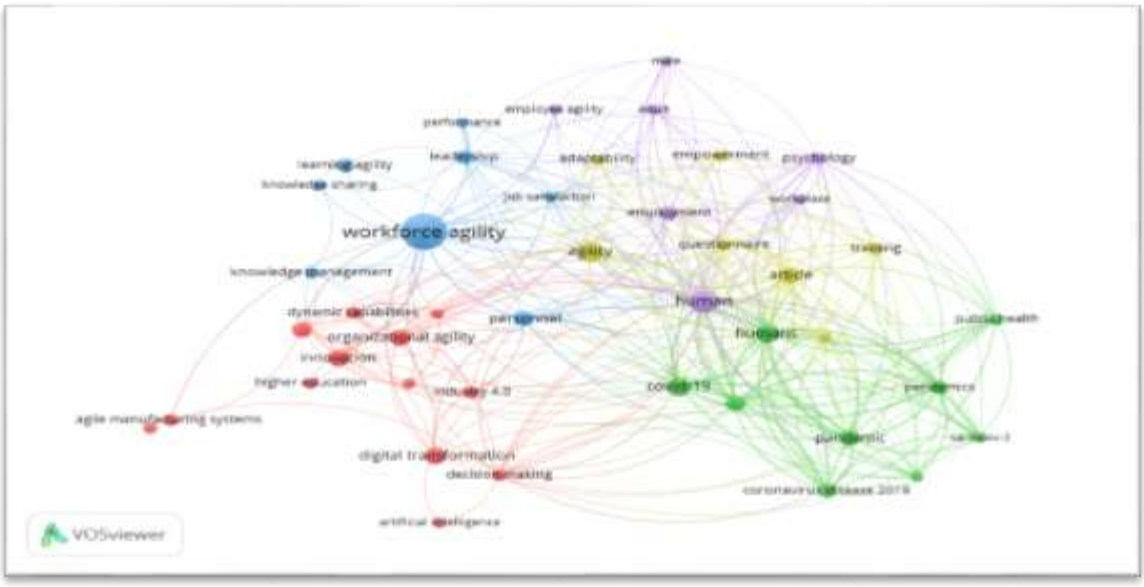

Figure 7. Network of Keyword Co-occurrence of Themes.

Note: Cluster 1 (Blue) = Workforce Agility & Knowledge Dynamics. Cluster 2 (Red) = Digital Transformation & Innovation Systems. Cluster 3 (Green) = Pandemics & External Change. Cluster 4 (Purple) = Psychological and Demographic Dimensions. Cluster 5 (Yellow) = HR & Training Systems in Agile Context.

Cluster	Color	Theme	Sample Keywords
1	Blue	Workforce Agility & Knowledge Dynamics	workforce agility, learning agility, performance, leadership, job satisfaction, knowledge sharing, knowledge management
2	Red	Digital Transformation & Innovation Systems	digital transformation, dynamic capabilities, organizational agility, artificial intelligence, innovation, industry 4.0, decision making, higher education, agile manufacturing
3	Green	Pandemics & External Change	covid-19, public health, pandemic, coronavirus disease 2019, sars-cov-2, humans, employment, adaptability
4	Purple	Psychological and Demographic Dimensions	human, male, adult, empowerment, psychology, workplace, article, employee agility
5	Yellow	HR & Training Systems in Agile Context	training, agility, personnel, resilience, adaptability, questionnaire

Table 6. Bibliometric Data on the Co-occurrence of Keywords in Themes.

Themes & Keyword	OC (Occurrence)	DG (Degree)	APY (Avg. Publication Year)	AC (Avg. Citations)
Cluster I (Blue): Workforce Agility & Knowledge Dynamics				
workforce agility	48	31	2020.73	26.23
employee agility	4	9	2023.75	9.75

learning agility	7	4	2019.14	13.86
performance	4	5	2023.50	14.75
leadership	7	16	2021.57	9.71
job satisfaction	4	11	2023.75	10.5
knowledge sharing	4	4	2024.00	2.5
knowledge management	5	7	2021.20	34.2
Cluster II (Red): Digital Transformation & Innovation Systems				
digital transformation	17	14	2024.2	3.2
dynamic capabilities	6	5	2023.0	21.5
organizational agility	17	14	2024.0	11.4545
artificial intelligence	2	2	2023.5	10.75
Innovation	18	13	2022.2	17
Industry 4.0	9	7	2023.0	21
Decision Making	26	19	2020.8	43.8
Higher Education	2	2	2019.8	13.4
Agile Manufacturing	1	1	2017.0	20.8
Cluster III (Green): Pandemics & External Change				
covid-19	14	25	2022.86	7.79
public health	5	15	2022.40	8.2
pandemic	9	19	2022.00	10.56
coronavirus disease 2019	7	18	2023.14	4.71
sars-cov-2	4	16	2021.75	12.25
humans	13	29	2022.62	10.85
employment	7	17	2021.29	15
adaptability	5	9	2021.40	17.2
Cluster IV (Purple) Psychological and Demographic Dimensions				
human	20	33	2023.00	9.15
male	4	11	2024.25	0.5
adult	4	13	2024.25	0.5
empowerment	5	11	2022.80	10.8
psychology	6	21	2022.00	21.5
workplace	4	12	2022.50	21
article	11	29	2023.00	7.45
employee agility	4	9	2023.75	9.75
Cluster V(Yellow): HR & Training Systems in agile Context				

training	6	20	2023.00	3.17
agility	16	23	2019.63	32.94
personnel	9	19	2021.44	36.22
resilience	6	11	2022.00	7.67
adaptability	5	9	2021.40	17.2
questionnaire	5	26	2022.40	10.8

Using VOSviewer to examine the co-occurrence of keywords has identified five clusters that are made up of studies in Workforce agility and Sustainable Digital Transformation Research. Each of the clusters presents a focus area in the literature that provides valuable insights into current studies and opportunities for future research.

6.2.1 Cluster I (Blue): Workforce Agility & Knowledge Dynamics

Keywords: workforce agility, learning agility, performance, leadership, job satisfaction, knowledge sharing, knowledge management

Theme: Currently, this cluster looks at how greater agility and knowledge dynamics between employees has positive effects on organizational adaptability, performance, and sustainability as we make digital transformation efforts.

Workforce agility is the ability of employees to switch or make changes quickly in order to cope with abrupt or dynamic market changes (Makkar & Rani, 2024). Factors such as leadership support, organizational learning, and shared vision are some influential aspects that facilitate agile mindsets in the workplace. When organization factors, such as leaders encourage the workforce to shift quickly, employees will become adaptable and resilient to change to maintain performance in uncertain and violent environments (Makkar & Rani, 2024).

Knowledge Sharing & Strategic Agility Job satisfaction was directly related to strategic agility with knowledge sharing as a mediating variable. When employees have job satisfaction and motivation to share their knowledge ability, organizations gain flexibility, enhanced production systems, and the capacity to produce long-term innovations (Hameed et al., 2022).

Learning Agility and Job Satisfaction Learning agility is the capacity to learn quickly and can be applied to changing circumstances which has a positive and strong relationship with job satisfaction. When leaders encourage learning agility helps ensure greater employee motivation and engagement improves overall performance and retention of employees (Munawar et al., 2024). The learning agility also had a mediating relationship in the connection between support of leadership and job satisfaction (Kim & Kim, 2021).

6.2.2 Cluster II (Red): Digital Transformation & Innovation Systems

Keywords: digital transformation, dynamic capabilities, organizational agility, artificial intelligence, innovation, industry 4.0, decision making, higher education, agile manufacturing

Theme: This cluster outlines the convergence of digital innovation, based on AI and Industry 4.0, and organizational agility as a means for organizations to cope with disruption and improve performance.

Digital Transformational Leadership & Organizational Agility

Digital transformational leadership significantly drives organizational agility and has been suggested to partially mediate the relationship between transformational leadership and the outcomes of successful digital transformation, in the public and private sectors (AlNuaimi et al., 2022). The relationship has been evidenced across contexts of expectation, revealing a leadership-agility-transformation relationship (Ly et al., 2024).

Knowledge Sharing, Innovation & agility

Knowledge sharing and open innovation emerged as significant enablers responsible for linking digital transformation to organizational agility and were only more effective when transformed leadership acted as a moderator and was observed in SMEs in China (Bux & Zhu, 2025)

Dynamic Capabilities & Business Model Innovation

Being leaders of digital transformation underpins, organizational agility, imbeds an environment of business model innovation facilitated by effective systems of knowledge transfer in SMEs, which strengthens an organizations' digital maturity and adaptation (Ramadan, M., Bou Zakhem, N., Baydoun, H., Daouk, A., & Youssef, S., 2023).

6.2.3 Cluster III (Green): Pandemics & External Change

Keywords: covid-19, public health, pandemic, coronavirus disease 2019, sars-cov-2, humans, employment, adaptability

Theme: This cluster is about the significant organizational and workforce transformations triggered by pandemics such as COVID-19. It primarily addresses our understanding about adaptability, workforce transitions, and pandemic-related public health imperatives.

Healthcare Workforce Practices During COVID-19

Health workers faced some of the most exposure during the COVID-19 pandemic. There was a study of hygiene practices of health care workers in India that found a notable gap between clinical and para-clinical workers and concluded that routine reinforcement of hygiene education and behavior is essential during a pandemic (John, S., Subrahmanian, S. A., & Xavier, R. T.,2021)

Mental Health & Global Change

The pandemic was an impetus for looking at mental health at the global level differently. Illingworth (2021) made the case that mental health needs to respond to the pandemic-related challenges by prioritizing the localization and relevance of mental health strategies and practices, in the context of the WHO Mental Health Action Plan (Illingworth, 2021).

6.2.4 Cluster IV (Purple): Psychological and Demographic Dimensions

Keywords: human, male, adult, empowerment, psychology, workplace, employee agility

Theme: this cluster focuses on how psychological empowerment and demographics and contextual dynamics relate to workforce agility, performance, and engagement in organizations undergoing digital transformation.

Psychological Empowerment & Workforce Agility

The organization-level component of workforce agility is perhaps most powerfully driven by psychological empowerment as conceptualized across Spreitzer's dimensions, that meaning, competence, self-determination and impact combine in a model of work design and individual capacities (Beehr & Gliebman 2003) to ensure the enterprise is capable of identifying emergent business requirements quickly and responding effectively before being required. For example, in Muduli (2017) and Amanda et al. (2024) studies found strong evidence that employees who experience high levels of empowerment demonstrated increased levels of adaptability, proactivity and resilience.

Empowerment → Engagement → Performance

Empowerment leads to engagement which subsequently leads to employee performance The literature consistently finds a positive relationship between psychological empowerment and work-engagement, were higher levels of work engagement lead employees toward improved task performance. Moreover, we see that the experience of psychological empowerment related to work engagement has the mediated influence stronger for younger workforce cohorts and is consistent with the JD-R theory framework. Age is also a moderator factor in this chain of capacity/experience of the process of empowerment and work engagement so there may be demographic differences in the effectiveness of empowerment (Juyumaya & Torres, 2022) (Van den Broeck, et.al,2016)

Leadership, Inclusion & Demographic Equity

Leadership, Inclusion and Demographic Equity Inclusive and responsible leadership contributes to increased employee psychological empowerment in workplaces, along with demographic and gender equity. This relates to employee agility and adaptability, whereby the leadership style is correlated with a specific set of behaviors across a diverse employee population of all demographic groups (Cyfert et al., 2022).

6.2.5 Cluster V (Yellow): HR & Training Systems in Agile Context

Keywords: training, agility, personnel, resilience, adaptability, questionnaire

Theme: This cluster underscores the importance of human resource development and the placement of training systems as integral policy tools to develop an agile, resilient and adaptive workforce—critical to organizations undertaking digital transformation and must respond to rapid market demands.

Strategic Training & Workforce Agility

Training is pivotal for strengthening employee agility. Studies indicate that engaging in innovative and continuous development (i.e. training) programs helps workers gain flexibility and cognitive readiness that is fundamental for adaptation in dynamic environments. Georgescu et al. (2024) contend that valued training interventions have a direct correlation to increased organizational resilience and adaptive capabilities, especially in knowledge-intensive fields (Georgescu et al., 2024).

Resilience, Role Flexibility & Proactive Behaviour

As Park et al. (2021) states, building psychological resilience and adaptive performance is necessary for agile workforces. Their research contextualizes key components like role flexibility, learning orientation and proactivity that can be developed through formal HR systems and the informal workplace structuring support. In addition, these behavioral attributes are important antecedents of change practices when changes are present in an organization during abrupt technological disruption and organizational change (Park et al., 2021).

Adaptive HR Systems for Dynamic Environments

Adaptive HRM systems support agility by building individual capabilities, but they also can transform workplace culture. It has been suggested that HR strategies supporting digital agility, and stress management not only drive organizational effectiveness in uncertain surroundings, but they also support employee retention (Caligiuri et al., 2025). In their work, Caligiuri et al. (2025) addresses potential connections that may exist between resilience building, sustained innovative capabilities, and strategic HRM.

7. Bibliographic Coupling of Documents in Workforce Agility and Sustainable Digital Transformation Research

The relationship strength between two publications through bibliographic coupling depends on the count of shared references in their reference lists (Kessler, 1963). The process of bibliographic coupling takes place when two publications share a reference to an identical third publication in their bibliographic citations. The research conducted bibliographic coupling of documents for studying the integration between Workforce Agility and Sustainable Digital Transformation. The analysis through VOSviewer resulted in four clusters which display the thematic clusters shown in Table 6.

Table 7. Themes Emerging in Bibliographic Coupling of Documents

Document & Themes	Total Link Strength	Citations
Cluster 1: Framing Workforce Agility through Structural Adaptability and Strategic Models: Foundations for Agile Transformation in Organizational Systems **Key Authors/Papers: Sanchez (2001), Alavi (2014), Muduli (2017), Qin (2010), Patri (2017)** **Theme: The main emphasis of this cluster addresses fundamental conceptual frameworks together with models about workforce agility and agile manufacturing systems and organizational flexibility. The fundamental research establishes key theoretical concepts that explain agility within workforce and production systems.**		
A review on workforce agility alavi (2013)	78	42
Organic structure and organizational learning as the main antecedents of workforce agility, Alavi (2014)	90	166
Workforce agility for stochastically diffused conditions-A real options perspective, qin 2010	74	50
Workforce agility: Examining the role of organizational practices and psychological empowerment, Muduli 2017	104	92
Modelling the Enablers of Agile Performance in Healthcare Organization: A TISM Approach, patri 2017	32	97
A review of agile manufacturing systems, sanchez (2001)	22	256
HRM in turbulent times: How to achieve organizational agility? nijssen (2012)	20	150
Cluster 2: Advancing Psychological and Digital Enablers of Agility – Unpacking how self-efficacy, emotional intelligence, and workplace spirituality shape agile workforce frameworks. **Key Authors/Papers: Srivastava (2022), Soliman (2021), Maran (2022), Franco (2022), Saeed (2022), Varshney (2020), Menon (2020)**		

Theme: This cluster explores how psychological traits, spirituality, digital competencies, and employee experience impact agility in modern work environments. It links workforce agility with mental well-being, emotional intelligence, and digital transformation.		
Who fits into the digital workplace? Mapping digital self-efficacy and agility onto psychological traits, Maran (2022)	46	54
The impact of workplace spirituality on lecturers' attitudes in tourism and hospitality higher education institutions, Soliman (2021)	24	47
Workplace spirituality as panacea for waning well-being during the pandemic crisis: A SDT perspective, Srivastava 2022	46	61
Workforce agility and its links to emotional intelligence and workforce performance: A study of small entrepreneurial firms in India, Varshney (2020)	58	40
Enablers of workforce agility in engineering educational institutions, Menon (2020)	111	59
Organizational drivers of innovation: The role of workforce agility, Franco (2022)	57	58
Towards Examining the Link Between Workplace Spirituality and Workforce Agility: Exploring Higher Educational Institutions Saeed (2022)	58	48
Cluster 3: Advancing Agile Capabilities in Technology-Driven Environments – Investigating how Industry 4.0, IoT, and structured frameworks drive employee agility in digitally evolving workplaces. **Key Authors/Papers: Patil (2019), Mrugalska (2021), Salmen (2022)** **Theme: Focuses on technology-driven transformation, including IoT, Industry 4.0, and systematic literature reviews on organizational agility. It highlights enablers of agility in tech-heavy sectors.**		
Modelling the Enablers of Workforce Agility in IoT Projects: A TISM Approach, Patil (2019)	73	125
Paving the way for progress in employee agility research: a systematic literature review and framework, Salmen (2022)	150	37
Organizational agility in industry 4.0: A systematic literature review, Mrugalska (2021)	3	90
Cluster 4: Adaptability and Change Management in Dynamic Environments **Key Authors/Papers: Park (2021), Medeiros (2020)** **Theme: This cluster reflects employee adaptation, change resilience, and performance under dynamic conditions, particularly post-pandemic or during organizational transitions.**		
How can employees adapt to change? Clarifying the adaptive performance concepts, Park (2021)	74	63

Data science for business: benefits, challenges and opportunities, Medeiros (2020)	1	51

7.1 Cluster 1: Framing Workforce Agility through Structural Adaptability and Strategic Models: Foundations for Agile Transformation in Organizational Systems

Cluster 1 is considered the core conceptualization of workforce agility theories upon which it proposes basic insights into how organizations may build agile capabilities from structural, strategic, and human-centered perspectives. Drawing upon models from agile manufacturing, organizational behavior, and strategic HRM, the cluster provides a two-way inter-disciplinary synthesis labelling factors that make workforce agility necessary and achievable in contexts made complex and dynamic on the basis of their duality.

At its core is the framework from Sanchez and Nagi (2001), whose preliminary review forms the basis of considering agility as a manufacturing and strategic imperative. Objective principles relating to fast responsiveness, re-configurability, and knowledge-based production are outlined in their study, which, in turn, feeds into how the notion of 'agility' is characterized within organizational design.

This groundwork is extended by Alavi and Wahab (2013), who review the broader construct of workforce agility, framing it as a core dynamic capability necessary for sustained competitiveness. They emphasize the shift from hierarchical to organic organizational forms, a theme expanded in Alavi et al. (2014), where organizational learning and structure are identified as primary antecedents to workforce agility. These studies collectively assert that agility must be embedded in organizational DNA through learning-oriented cultures and flat, adaptive structures.

Muduli (2017) considers HRM and psychological perspectives to evaluate the relationships between organizational practices and psychological empowerment in fostering individual agility. His studies indicate that employee involvement, autonomy, and leadership are the key4 drivers of workforce agility.

From a decision-theoretic standpoint, the agile enterprise is analyzed in stochastically diffused circumstances by Qin and Nembhard (2010) (not available in abstract data but cited by prior references), proposing an option theory to manage uncertainty and to link workforce deployment with financial strategy in volatile environments.

Patri and Suresh (2017) provide a system-oriented view by applying the Total Interpretive Structural Modelling (TISM) approach to model agility enablers in healthcare settings. Their study identifies and ranks parameters such as integration of technology, commitment of leadership, sharing of resources, and so on, establishing the sector-specific challenges in implementing agility.

Finally, Nijssen and Paauwe (2012) take a big-picture approach, looking at HRM during challenging times and introducing a practical framework that connects adaptable HR systems with the ever-changing environment. Their research highlights the importance of aligning strategies and building capabilities through effective people management, especially in unpredictable situations. Together, the papers in this collection offer a comprehensive view of workforce agility, covering everything from the factory floor to high-level HR strategies, and they lay down a solid theoretical foundation for future studies. While this cluster outlines the key theories and factors that drive agility, it also sparks important conversations about measurement frameworks, the ability to adapt across different contexts, and how to weave learning, empowerment, and technology into traditional systems.

7.2 Cluster 2: Advancing Psychological and Digital Enablers of Agility – Unpacking how self-efficacy, emotional intelligence, and workplace spirituality shape agile workforce frameworks.

Cluster 2 takes a closer look at the human-centered factors that drive workforce agility, especially as we face the challenges of digital transformation, emotional pressures, and changes within institutions. Unlike Cluster 1, which focuses on foundational elements, this cluster digs into the psychological traits, behavioral motivations, and workplace culture that enable both individuals and organizations to handle uncertainty with resilience and purpose. Leading the charge is Maran et al. (2022), who explore how our intrinsic psychological traits shape our digital self-efficacy and agility. Their research underscores the significance of aligning personality and building digital confidence, which ultimately determines who thrives in digitally transformed work environments. This connects to the notion that agility isn't just about structure; it's also a deeply personal and cognitive experience. The spiritual aspect of workplace experiences is a key theme in several studies within this cluster. For instance, Srivastava and Gupta (2022) use a Self-Determination Theory (SDT) lens to demonstrate how workplace spirituality can help protect against declining well-being during tough times, like the COVID-19 pandemic. Similarly, Soliman et al. (2021) examine how spirituality influences lecturers' attitudes in hospitality and tourism education, revealing its impact on job satisfaction and commitment in service-oriented fields.

Saeed et al. (2022) take this exploration a step further by establishing a clear connection between workplace spirituality and workforce agility in higher education

institutions. They highlight the importance of inner alignment and purpose-driven engagement as key drivers of organizational flexibility. On a socio-emotional level, Varshney and Varshney (2020) delve into the relationship between emotional intelligence and workforce performance in small entrepreneurial firms. Their research indicates that agile teams don't just rely on technical skills; they also thrive on emotional regulation, empathy, and the ability to adapt interpersonally — all crucial elements in the fast-paced world of small businesses. Menon and Suresh (2020) adopt an institutional perspective, pinpointing factors that foster agility in engineering education, such as robust training infrastructure, supportive leadership, and adaptable work practices. Their findings show that even in traditionally rigid fields like academia, agility can be nurtured through thoughtful organizational design. Lastly, Franco and Landini (2022) (though not directly accessed in the abstract, but acknowledged through citation) investigate the organizational factors that drive innovation, placing workforce agility as a vital link between internal capabilities and innovative results. Together, these studies underscore that psychological well-being, emotional agility, and spiritual alignment are not just add-ons to workforce agility — they are fundamental. This body of work shifts the conversation from mere systems and structures to the inner strengths of individuals and the cultures they are part of.

7.3 Cluster 3: Advancing Agile Capabilities in Technology-Driven Environments – Investigating how Industry 4.0, IoT, and structured frameworks drive employee agility in digitally evolving workplaces.

Cluster 3 dives into the fascinating crossroads of workforce agility and technological transformation. It highlights how cutting-edge technologies like Industry 4.0 and the Internet of Things (IoT) are reshaping the way organizations operate, their capabilities, and what employees expect from their work environments. This cluster adds to the ongoing conversation about how agility needs to adapt in the face of growing digital complexity, rapid innovation cycles, and fast-paced project settings. At the heart of this discussion are Mrugalska and Ahmed (2021), who conducted a thorough literature review that pinpoints organizational agility as a vital dynamic capability for success in the industry 4.0 era. Their work lays out a comprehensive taxonomy of factors that enable agility, such as embracing new technologies, fostering a digital culture, ensuring process flexibility, and maintaining real-time responsiveness. This underscores the multifaceted nature of agility, especially within advanced manufacturing systems and smart technologies. Adding to this, Patil and Suresh (2019) utilize a Total Interpretive Structural Modelling (TISM) approach to specifically investigate workforce agility in IoT project environments. Their research highlights significant challenges like high technological uncertainty, project complexity, and the need for real-time data processing. They also identify key enablers for developing agile responses, including strong leadership involvement, skill development, and cross-functional teamwork—emphasizing the importance of integrated socio-technical agility frameworks.

Taking the theoretical scope of this cluster to the next level are Salmen and Festing (2022), who conducted a thorough literature review that lays out a solid framework for researching employee agility. They weave together various threads from organizational behavior, HRM, and digital strategy to provide a well-rounded view of employee agility. Their findings highlight the pressing need for clear concepts and consistent methods when studying agility, especially in our increasingly VUCA (Volatility, Uncertainty, Complexity, Ambiguity) world. These studies collectively position Cluster 3 as a forward-thinking area of research, not just enhancing technological readiness but also establishing a strong theoretical foundation for agility in workplaces that are digitally transformed and focused on innovation. While this cluster embraces the potential of agility within digital ecosystems, it also emphasizes the need for robust frameworks, interdisciplinary models, and human-centered strategies to ensure that agility aligns with the latest technologies and innovation goals.

7.4 Cluster 4: Navigating Change through Adaptability and Data-Driven Agility – Exploring how behavioral flexibility and data science enable agile responses in dynamic organizational environments.

Cluster 4 shines a light on how both individuals and organizations can adapt to change, emphasizing the behavioral and technological aspects of agility. It focuses on the shifting demands of today's workplace, where disruption, uncertainty, and rapid digital advancements call for not just new tools but also fresh mindsets. In their 2021 study, Park and Park clarify the concept of adaptive performance, defining it as a unique element within the larger context of workforce agility. They address the increasing confusion surrounding how adaptability is defined and measured in organizational studies. By refining the concept, they suggest that adaptive performance encompasses flexibility, emotional regulation, and a learning orientation—qualities that are crucial for employees navigating technological and strategic shifts. This research establishes a psychological foundation for viewing agility as a behavioral response to ongoing disruption. Adding to this behavioral perspective, Medeiros et al. (2020) delve into data science as a key driver for business, providing a more technological viewpoint on agility. Their research outlines the advantages, challenges, and strategic possibilities that come with data-driven transformation. They point out how big data, analytics, and machine learning are influencing agile decision-making across various industries. While data science enhances responsiveness and efficiency, the

authors also warn about the challenges related to data governance, talent acquisition, and cultural readiness—issues that are often overlooked in digital strategies.

The papers in Cluster 4 shine a light on two key areas: cognitive flexibility and digital literacy. They highlight that being agile is not just a trait found in individuals but also a crucial requirement for organizations. To stay ahead in unpredictable environments, companies need to integrate analytical tools and flexible infrastructures that enable them to respond quickly and plan strategically. This cluster connects the human side of adaptability with the technological, encouraging organizations to invest in both their employees' growth and their digital skills to not just survive but truly thrive in a fast-changing world.

The way documents are bibliographically coupled within these thematic clusters, as shown in Figure 4, reveals a rich, multidimensional look at workforce agility. This spans everything from foundational theories and strategic models to psychological factors, technological changes, and adaptive skills. Together, these clusters shed light on how organizations weave agility into their structures, digital environments, and human-centered approaches. They spark important discussions about the shifting dynamics between adaptability, digitalization, emotional intelligence, and data-driven decision-making—ultimately influencing innovation, organizational resilience, and workforce sustainability in ever-changing settings.

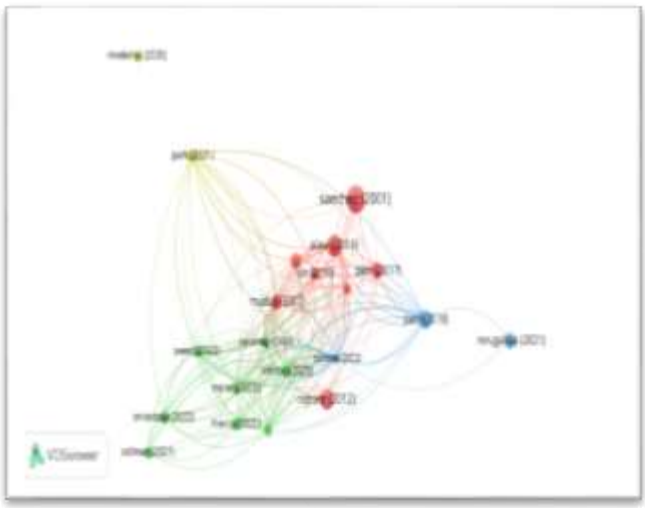

Figure 7. Bibliographic Coupling Network of Documents.

8. Research Contribution

This study advanced scholarship on technology-driven workforce agility (TDWA) and sustainable digital transformation in several important ways. First, this is the first attempt at developing a multisite scientometric and thematic analysis that stitches together existing stranded areas of scholarship as a single contribution to the literature in this area. Employing the SPAR-4-SLR methodology (Paul et al., 2021) alongside VOSviewer-based bibliometric map-making provides a systematic review of the 184 publications (all Scopus-indexed) relevant to Technology driven Workforce agility (TDWA). While the method employed is rigorous and provided a both quantitative and qualitative analysis, our use of the dual approach also provided additional rigor in research into a relatively novel field in the management and organizational literature. Second, our study provides an intellectual structure of this domain that highlights theoretical domains, conceptual clusters, collaboration networks, and developmental trends in publication output and citation counts. Third, we provide insights for practice by practically outlining the enablers, drivers, and challenges of TDWA as an approach to realizing organizational resilience and adaptive capacity within the context of sustainable digital transformation. Fourth, we provide a future research agenda with explicit directions for scholars to explore upon emerging themes, under researched contexts, and challenging changing technology paradigms. Finally, we provide a contribution of method by effectively integrating bibliometric tools with protocols that permitted a review of a larger dataset in management and organization research. Thus, we offer a roadmap for scholars seeking to undertake existing reviews larger datasets in the future.

9. Future Directions

This review highlights the increasing significance of workforce agility, which is a complex concept influenced by various factors like structural, psychological, technological, and adaptive capabilities. Future studies should aim to create models of agility that are tailored to specific contexts, especially in sectors like healthcare, education, and digital services that are heavily service-oriented and knowledge-driven. With digital technologies becoming more integrated into organizational frameworks, it's crucial for researchers to investigate how tools like artificial intelligence, the Internet of Things, and data analytics can either support or hinder agile practices at both the individual and organizational levels. Empirical research that looks into the relationship between digital adoption and employee adaptability will be particularly important in hybrid or fully remote work environments. Moreover, we need to delve deeper into the behavioral and cognitive aspects of agility—such as digital self-efficacy, emotional intelligence, and resilience—and how these characteristics interact with team dynamics and leadership styles to promote agile performance. Another vital area for research is the creation of standardized, psychometrically sound tools for assessing workforce agility across different cultural and industry settings, which would enhance comparability and practical use. There's also a compelling argument for linking workforce agility research with broader theoretical frameworks, like dynamic capabilities theory and

organizational learning, to gain a clearer understanding of how agility is developed and maintained over time. Finally, as organizations navigate increasing disruptions from global crises, future research should focus on how workforce agility contributes to organizational resilience and recovery, as well as how agility strategies adapt before, during, and after such events. These research directions not only push the theoretical limits of workforce agility but also provide valuable insights for practitioners aiming to create more resilient and adaptable organizations.

10. Conclusion

Workforce agility has become an essential skill in today's fast-paced, tech-driven, and unpredictable work environments. This study takes a deep dive into the existing literature on workforce agility, meticulously analyzing 184 peer-reviewed articles sourced from the Scopus database. By using bibliographic coupling and thematic analysis, the research outlines the intellectual landscape of this field, pinpointing key research themes, theoretical foundations, and new areas of interest. The review revolves around three main questions: 'What are the trends in publication and citation within workforce agility literature?', 'What core themes and theoretical viewpoints are shaping the conversation around agility?', and 'What future research directions should we explore to push the boundaries of workforce agility?'. Through performance analysis and science mapping, the study identified four distinct thematic clusters: foundational theories and models, psychological and digital enablers, technological transformation driven by Industry 4.0, and adaptive responses to external changes. This research adds value to both theory and practice by providing a clear overview of how workforce agility has evolved, emphasizing its multifaceted nature that includes structural, cognitive, technological, and behavioral aspects. The insights gained are beneficial for scholars looking to develop theories around agility, for practitioners eager to implement strategies that enhance agility, and for policymakers aiming to prepare the workforce for the challenges of a digitally evolving landscape.

While this study has made some valuable contributions, it does come with a few limitations. The analysis relied solely on the Scopus database to ensure that only high-quality, peer-reviewed sources were included. However, future reviews could benefit from incorporating other databases like Web of Science or EBSCO to broaden the research scope. Additionally, this review concentrated on workforce agility within service and organizational contexts, but future studies might want to investigate agility in other sectors such as agriculture, manufacturing, and public systems. Given the fast-paced changes in workplace technologies, digital ecosystems, and organizational behavior, it's essential to periodically update this review to keep up with new developments and maintain the relevance of agility research.

11. Declaration of Competing Interest

The authors declare no conflict of interest.

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