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The Convergence of Artificial Intelligence, Sustainability and Industry 4.0 in Human Resource Management: An Integrated Bibliometric Review and Research Agenda

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Artificial Intelligence; Human Resource Management; Industry 4.0; Sustainability; Bibliometric Analysis

ABSTRACT
This study presents an integrated bibliometric review examining the evolution of research on artificial intelligence, sustainability and Industry 4.0 within the domain of human resource management and organizational behaviour. Drawing on bibliographic data retrieved from the Scopus database, the analysis covers peer-reviewed journal articles published between 2010 and 2024 and employs established bibliometric techniques, including performance analysis and science mapping. The study systematically explores annual publication trends, influential journals, authors, institutions and countries, as well as citation structures and thematic patterns. Keyword co-occurrence and thematic evolution analyses reveal a substantial acceleration of scholarly output in recent years, reflecting growing academic attention to digital transformation and sustainable workforce management. The findings indicate that early research primarily focused on human-centric and occupational issues, which gradually evolved toward technology-enabled HRM under Industry 4.0, and more recently converged into integrated frameworks emphasizing artificial intelligence, sustainability and employee well-being. The results further highlight the interdisciplinary nature of the field, with impactful contributions spanning management, sustainability, engineering and applied technology journals. By mapping the intellectual structure and thematic evolution of this rapidly expanding literature, the study provides a comprehensive and up-to-date overview of digital and sustainable HRM research and offers valuable insights for scholars, practitioners and policymakers seeking to understand and shape the future of human resource management in the digital era..

1. INTRODUCTION

The face of HRM is changing dramatically as a result of explosive digitalization and the deepening penetration of advanced technologies in organizational realm. The transactional and administrative components have now transcended into strategic, analytics-driven and technology-enabled processes which facilitate making fact-based decisions, creating value of the long-term. Today, digital platforms, human resources information systems (HRIS) and data analytics tools have become central to the management of talent, employee experience and workforce skills that align with business objectives. This tendency corresponds to a more general move away from an efficiency-based HRM Design towards a strategic, humanoids approach which focuses on agility, innovativeness and organisational persistence amid increased competition [1].

The advent of artificial intelligence (AI), sustainable needs and Industry 4.0 did boost the change in HRM further. AI

haste, HR stereotyping Tools (ML based hiring recommendation tools) these predictions are significant beyond the speed and noted blind spots of human interaction between the employee's long professional journey in an organisation [2]. Meanwhile, Sustainable HRM has gained popularity in practicing organizations as organizations have begun to have insight into the fact that social responsibility, employee well-being ethical governance and long term human capital development contribute towards sustainable competitive advantage [3].

This revolution has disruptive implications for jobs, skills and work design through cyber-physical systems automation, big data and digital connectivity (Industry 4.0/5.0) that push the HR function to the center stage of organizational digital transformation by requiring constant reskilling, agile leadership enhanced fusing human with technological capabilities [4]. This is the case since AI, sustainability and the Fourth Industrial Revolution are interrelated drivers that influence HRM practices and organizational behaviour suggesting an interdisciplinary scholarly approach.

This emerging literature on AI-based HRM and sustainable HR practices/Industry 4.0-induced workforce transformation and has become quite explosive in recent years. However, this literature is fragmented across various disciplines (management, information systems, engineering or organizational psychology). As a result, relatively high degree of coherence and thematic development as well as the great influences in this field remain to be synthesized. A convergent bibliometric review is also a systematic, objective and quantitative method of identifying wide scale scientific communication networks, subject areas as well as dynamics among players via academic collaborative research and thematic chronology [5]. This is crucial as digital HRM research is an interdisciplinary and emergent field.

While previous review studies examine certain dimensions (e.g. AI in HR analytics or sustainable HRM), most adopt narrative or systematic review approaches that have limited capability to map the intellectual structures and research development. Also, there is little specific research to address the intersection of AI and sustainability as well as Industry 4.0 aspects within an integrated analytical framework too. Such fragmentation has implications for theoretical integration and for articulation of a systematic research program. Spurred by this dearth of empirical data, the present paper seeks to present a comprehensive analysis of Scopus-indexed GC research that synthesizes these three important streams and unpacks their joint effect on HRMandOB.

Objectives and Contribution of the Paper

- To analyze the growth and distribution of scholarly publications on AI, sustainability and Industry 4.0 in HRM
- To uncover dominant and emerging thematic clusters through science-mapping techniques.
- To propose a future research agenda that addresses theoretical, methodological and practical gaps.

The remainder of the paper is structured as follows. Section 2 presents the conceptual background related to AI, sustainability and Industry 4.0 in HRM. Section 3 describes the research methodology, including data collection and bibliometric techniques. Section 4 reports the results of the bibliometric analysis, followed by a discussion of key findings in Section 5. Section 6 outlines the future research agenda, while Section 7 discusses theoretical and practical implications. Section 8 highlights the limitations of the study and Section 9 concludes the paper.

2. Conceptual Background

2.1 Artificial Intelligence in Human Resource Management

AI is a game changer in HRM as it empowers data-driven, predictive and decision making automatization across fundamental HR tasks. Modern AI applications include algorithms to screen resumes, chatbots for interacting with employees, models of turnover and performance prediction and personalized learning systems. These capabilities drive operational efficiency and consistency while enabling strategic workforce planning through augmented analytics and real-time transparency. For example, recent work stresses that use of AI in HRM is more than automation but also human judgment and subjective decision quality improve and scalable personal thanks to a personalized service [6], [7]. But fears about algorithmic bias, transparency, explainability and data privacy persist, raising awareness toward governance mechanisms and ethical design guidelines in AI-driven HR systems [8].

2.2 Sustainable Human Resource Management

Sustainable Human Resource Management (Sustainable HRM) refers to sustainability-oriented change in human resource management which purports to assist integrating values and actions that focus on what human beings and other forms of life can do to draw forth a world where life not only survives but thrives. Thus, in contrast to the traditional efficiency-oriented HRM, a sustainable HRM consists of (1) employee well-being, (2) inclusion, (3) employability and life-long learning and (4) responsible leadership while becoming resilient. Contemporary research has emphasized HRM for the promotion of sustainability agendas via green recruitment and training, ethical performance management, and supportive work environments for stimulating engagement and retention [9]. A sustainable HRM perspective bring to the fore a normative and ethical framework for assessing digital HR practices, for instance in face of contexts where AI-based

decisions may impact fairness, diversity and employee trust [10].

2.3 Industry 4.0 and HR Transformation

Industry 4.0 is the new age of industrial development which involves machine learning, intelligent automation, artificial intelligence, cyber-physical systems, the Internet of things and big data analytics. These technologies have transformed the nature of work itself - how we work, what jobs look like and what skills are essential - putting a premium on lifelong learning, digital fluency and agile leadership. HRM is in turn identified to have a key role in managing this transition through re-skilling campaigns, reforming performance systems and providing flexible and technology-supported work [11]. Recent empirical studies indicate that society's organizations leaders in Industry 4.0 adoption combine technological innovation with a human-centric focus on HR practices, leading to increased productivity as well as employee outputs [12].

2.4 Integration of AI, Sustainability and Industry 4.0

While AI, sustainability and Industry 4.0 have frequently been studied in isolation, recent research increasingly acknowledges their combined effect on modern HRM. Artificial intelligence (AI) technologies support Industry 4.0 by enabling smart decisions which in turn, sustainable HRM is the required ethical and human-oriented approach making it possible to responsibly regulating technology use. Through the integration of these four perspectives, companies are able to harness technological innovations whilst also protecting employee welfare, fairness and long-term capability development [13]. Academically, such a unification requires interdisciplinary theories that may describe technological, organizational and societalaspects at the same time. Understanding this intersection is a prerequisite to the development of theory, as well as practice, in digital and sustainable HRM.

Whereas the previous part built up conceptual pillars for transformation artificial intelligence, sustainability and Industry 4.0 meeting in HRM, a systematic and transparent method needs to be followed in order to understand how these themes have come into being within the academic literature. Owing to the multidisciplinary and burgeoning nature of this field, conventional narrative reviews cannot capture the structural trends, intellectual connections and thematic trajectories in previous work. To meet this objective of the paper and guarantee rigorous, impartial and replicable results, we present the research methodology including data sources, search strategy, selection criteria and bibliometric techniques that were used to perform the integrated bibliometric review in the following section.

2. 3. RESEARCH METHODOLOGY

3.1 Research Design

This study adopts an integrated bibliometric review design to systematically analyze and synthesize the scholarly literature at the intersection of artificial intelligence, sustainability, Industry 4.0 and human resource management. Bibliometric analysis is particularly suitable for examining large and multidisciplinary bodies of literature, as it enables objective evaluation of publication patterns, intellectual structures and thematic evolution over time. By combining performance analysis with science-mapping techniques, the present study provides a comprehensive overview of the knowledge domain and supports the development of a robust future research agenda [14].

3.2 Data Source and Search Strategy

The bibliometric dataset for this study was retrieved from the Scopus database, selected for its extensive coverage of high-quality, peer-reviewed journals across management, engineering and interdisciplinary research domains. To capture both the longitudinal development and recent acceleration of scholarship on digital and sustainable human resource management, the analysis was restricted to journal articles published between 2010 and 2024. This period reflects the emergence of digital HRM research and its subsequent evolution in response to artificial intelligence, sustainability imperatives and Industry 4.0 transformations.

A systematic search strategy was employed using a combination of keywords related to artificial intelligence, sustainability, Industry 4.0, and human resource management. The search string was constructed using Boolean operators to ensure precision while maintaining adequate breadth. The final search query applied in Scopus was as follows:

(TITLE-ABS-KEY ("artificial intelligence" OR "AI" OR "machine learning" OR "algorithmic management")AND TITLE-ABS-KEY ("human resource management" OR "HRM" OR "digital HR" OR "e-HRM")AND TITLE-ABS-KEY ("Industry 4.0" OR "digital transformation" OR "automation")AND TITLE-ABS-KEY ("sustainability" OR "sustainable HRM" OR "employee well-being"))

The search was further refined by applying the following inclusion criteria:

- Document type limited to peer-reviewed journal articles;
- Language restricted to English; and
- Publication years confined to 2010-2024.

3.3 Data Screening and Selection Process

The initial search results were subjected to a multi-stage screening process to refine the dataset. First, duplicate records were removed. Second, titles and abstracts were reviewed to exclude studies that did not explicitly address HRM or organizational behaviour in relation to AI, sustainability or Industry 4.0. Third, full-text screening was conducted to confirm thematic relevance and methodological suitability. This systematic selection process followed established review protocols to enhance transparency and replicability and the final dataset constituted the basis for subsequent bibliometric analyses [15].

3.4 Bibliometric Techniques and Analytical Tools

The analysis was conducted in two complementary stages. Performance analysis was employed to examine publication trends, citation patterns and the most influential authors, journals, institutions and countries in the field. Science mapping techniques-including co-authorship analysis, co-citation analysis, bibliographic coupling and keyword co-occurrence analysis-were used to visualize intellectual structures and identify dominant and emerging research themes.

To implement these analyses, specialized bibliometric software tools were utilized. VOSviewer was employed for network visualization and clustering, while Biblioshiny (based on the Bibliometrix R-package) was used for descriptive statistics and thematic evolution analysis. The combined use of these tools enhances analytical robustness by allowing cross-validation of findings and providing multiple perspectives on the development of the research domain [16].

For thematic evolution analysis, the overall study period spanning 2010-2024 was divided into three distinct time slices2010-2014, 2015-2019 and 2020-2024to capture the progressive development and shifting research focus within the digital and sustainable human resource management literature.

Having established the research design, data sources and bibliometric techniques employed in this study, the next step is to present the empirical outcomes derived from the analysis. Accordingly, the following section reports the results of the bibliometric analysis, offering a systematic overview of publication trends, influential contributors, citation structures and thematic clusters within the literature on artificial intelligence, sustainability and Industry 4.0 in human resource management. These results provide the empirical foundation for subsequent interpretation and discussion of the field's intellectual structure and evolutionary patterns.

4. Results of the Bibliometric Analysis

4.1 Descriptive Analysis of Publications

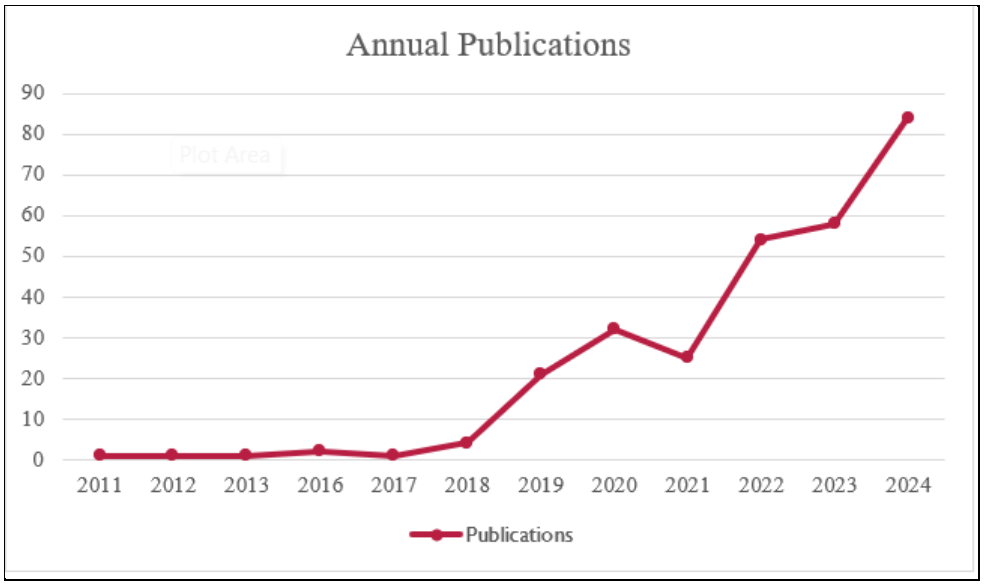

Figure 01: Annual Publication Growth (Authors work)

The figure 01 illustrates a clear and accelerating growth trend in scholarly publications related to the convergence of artificial intelligence, sustainability, Industry 4.0 and human resource management over the study period. During the initial years, publication activity remained minimal and sporadic, indicating that research in this domain was nascent and fragmented. A noticeable upward shift begins around 2018, followed by a substantial increase from 2019 onwards, reflecting growing academic attention to digital transformation and its implications for HRM.

Although a slight decline is observed around 2021, the overall trajectory remains strongly positive, with a sharp surge in

publications during the subsequent years. The period from 2022 to 2024 shows the most pronounced growth, culminating in the highest number of publications in 2024. This pattern suggests that the field has entered a phase of rapid expansion and consolidation, driven by intensified interest in AI-enabled HR practices, sustainability concerns and post-pandemic organizational transformation. Overall, the trend confirms the increasing relevance and maturity of this research area within contemporary HRM and organizational behaviour literature.

4.2 Influential JournalsInstitutions

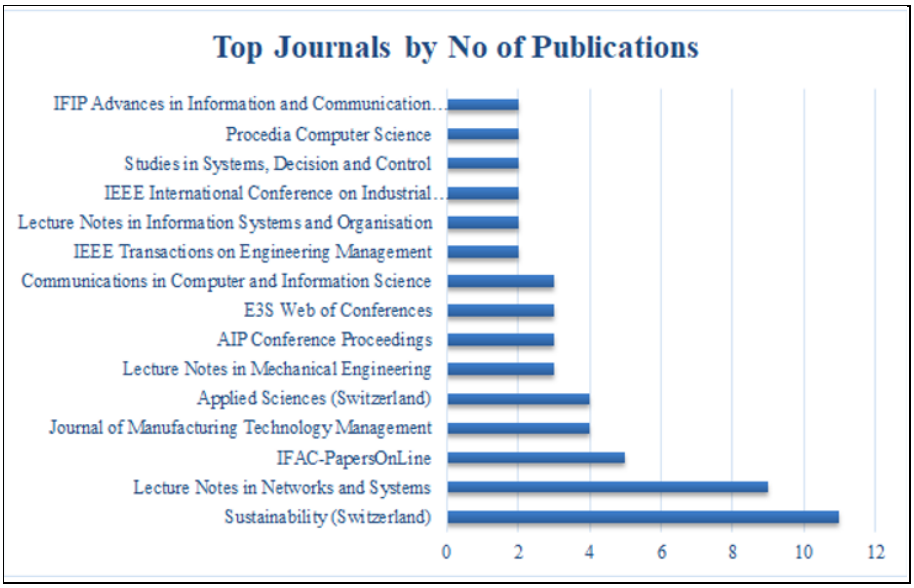

Figure 02: Most Influential Journals (Authors work)

The performance analysis identifies a small number of journals that serve as primary outlets for research on digital and sustainable HRM. These journals exhibit high citation impact and consistent publication activity, indicating their central role in shaping scholarly discourse. Similarly, author-level analysis reveals a group of influential researchers whose work has significantly contributed to theoretical development and empirical understanding in this domain.

Institutional and country-level analyses show that research output is concentrated in technologically advanced and innovation-driven economies, with notable contributions from Europe, North America and parts of Asia. Cross-country collaboration patterns suggest increasing international cooperation, reflecting the global relevance of AI adoption, sustainability challenges and Industry 4.0driven workforce transformation.

4.3 Influential Authors

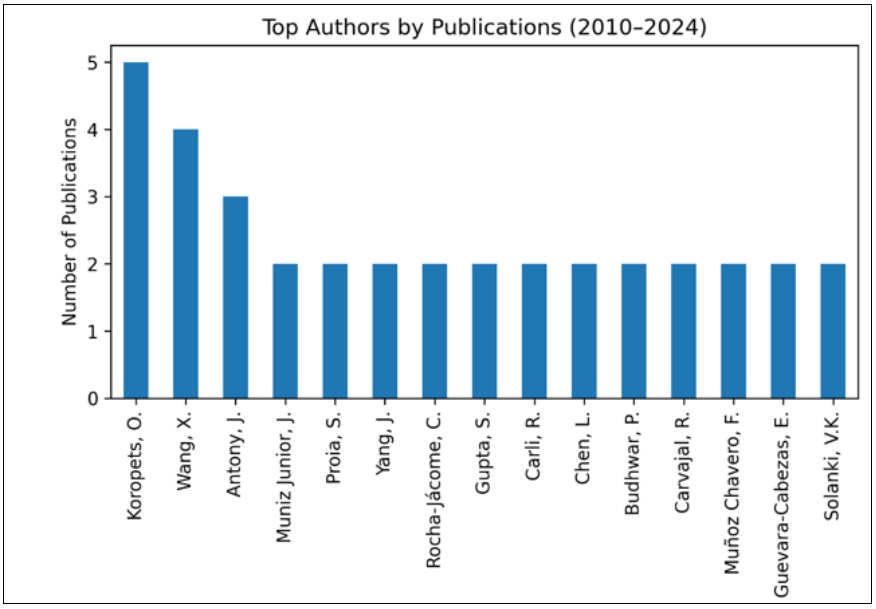

Figure 03: Top Authors by Publication (Authors work)

The figure 03 depicts the most influential authors based on the number of publications in the field spanning artificial intelligence, sustainability, Industry 4.0 and human resource management during the period 2010-2024. A small group of authors demonstrates relatively higher research productivity, with Koropets, O., Wang, X., and Antony, J. emerging as the most prolific contributors. Their higher publication counts indicate sustained engagement and leadership in advancing research within this interdisciplinary domain.

At the same time, the distribution shows that many authors have contributed a moderate number of publications, reflecting a broad and dispersed authorship structure rather than dominance by a few individuals. This pattern suggests that the field is collaborative and still evolving, attracting contributions from scholars across diverse geographical and disciplinary backgrounds. Overall, the authorship distribution highlights both the presence of emerging research leaders and the inclusive nature of scholarly participation in digital and sustainable HRM research.

4.4InfluentialCountries

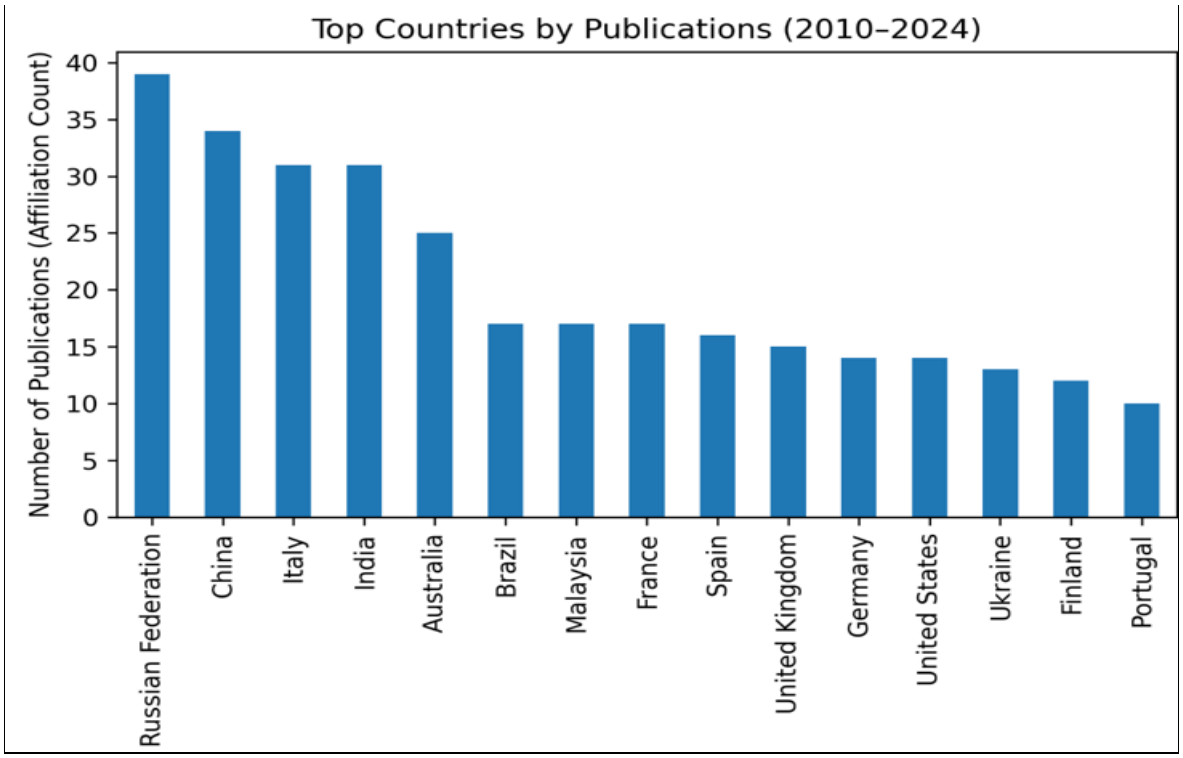

Figure 04: Top Countries (Authors work)

The figure 04 illustrates the geographical distribution of scholarly output based on authors' affiliations, highlighting the most influential countries contributing to research on artificial intelligence, sustainability, Industry 4.0, and human resource management between 2010 and 2024. The Russian Federation emerges as the leading contributor, followed by China, Italy, and India, indicating strong research engagement from both emerging and developed economies. This pattern suggests that digital transformation and sustainable HRM are globally relevant themes, attracting substantial academic attention across diverse regional contexts.

Moreover, the presence of countries such as Australia, Brazil, Malaysia, and several European nations reflects a broad international participation in this research domain. The relatively balanced spread across continents underscores the multidisciplinary and global nature of the field, with contributions shaped by varying industrial structures, technological adoption levels, and institutional frameworks. Overall, the distribution highlights increasing cross-national scholarly involvement and reinforces the global significance of AI- and Industry 4.0–driven HRM research.

4.5 Influential Journal by Citations

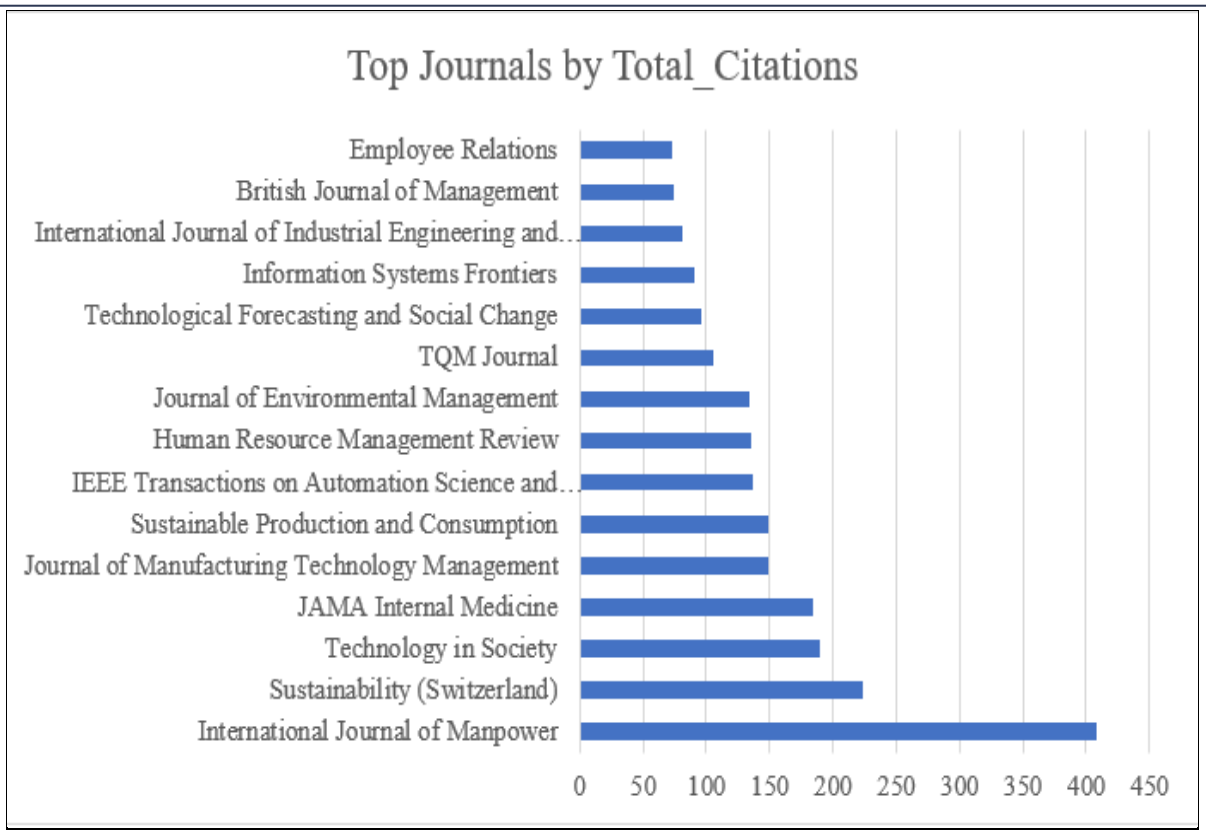

Figure 05: Top Journals by Citations (Authors Work)

The figure 05 presents the most influential journals based on total citation counts, reflecting the scholarly impact and visibility of research published in the area of artificial intelligence, sustainability, Industry 4.0 and human resource management.Furthermore, the International Journal of Manpower stands out as the most cited journal and suggests it is central to framing theoretical debates or advancing research on labor change, digitalization age and technological work studies. Similarly, the Sustainability (Switzerland) and Technology in Society show high citation impact that highlights a solid integration of both sustainability and socio-technical perspective.

In addition, a number of high-impact journals including JAMA Internal Medicine, Journal of Manufacturing Technology Management, IEEE Transactions on Automation Science and Engineering and Human Resource Management Review also have the strong citation influence, showing the wide spread to management, human resource studies, engineering construct field and health sections. Not only is traditional HRM journals covered, but IT-based outlet can even be found deployed here, indicating that highly cited science has already been moving across disciplines in order to deal with complex organizational concerns. Generally, citation distribution shows that truly influential work is published in journals which reach a good blend of human, technical and sustainability perspectives.

4.3 Citation and Co-Citation Analysis

Citation analysis reveals those key research papers that have influenced the intellectual structure of the discipline. These are the most cited works that concentrate on digital HRM systems, ethical considerations related to AI in people's management and strategic human resource management (HRM) in Industry 4.0. The co-citation analysis also identified clusters of related contributions, suggesting the existence of separate but linked schools of thought.

The discovered co-citation networks indicate that the literature is rooted in a hybrid view of strategic HRM theory, technology adoption models and sustainability-centred organizational perspectives. This intellectual framing emphasizes the integrative character of this field, where technology developments are increasingly interrogated through a human-centered and ethical situatedness.

4.4 Keyword Co-Occurrence and Thematic Clusters

Figure 06:Keyword Prominence Visualization (Authors Work)

The figure 06, provides a keyword prominence visualization highlighting the most frequently occurring concepts in the literature on artificial intelligence, sustainability, Industry 4.0 and human resource management.The prevalence of words like human resource, sustainable, Industry 4.0, artificial intelligence and employee suggests that the current literature is highly focused on innovation in digital methods in conjunction to sustainable peoples' management practice. The centrality of methodological concepts such as bibliometric, analysis and thematic also indicate the increasing reliance on systematic and data-driven review methodologies to structure and synthesize this fastgrowing body of knowledge.

Furthermore, keywords for decision making and data indicates a growing focus on evidence-based HRM and analytics towards workforce management performance. New concepts such as fairness, transparency and trust also emerge in the visualization, evidencing a rising attention of scholars to ethical and responsible aspects of AI-enabled HR practices. On the whole, this figure confirms of the thematic interrelationship among digital transformation, sustainability and human-centered HRM, together strengthening still further from a multidisciplinary perspective and by way of an integrative approach to research agenda connected with it.

Emerging themes such as algorithmic fairness, employee well-being in digital workplaces and ethical governance of AI systems point to a more responsible and inclusive way forward for digital HRM. These are all signs that the field is outgrowing a narrative based on efficiency toward one of long-term sustainability and social progress.

4.5 Thematic Evolution of the Literature

In order to analyse how research themes evolved over time, we divided the bibliometric database for 2010-2024 into three sections (2010-2014; 2015-2019; and 2020-2024), each of which corresponds with phases of development in digital and sustainable HRM research, i.e. emergence, expansion and consolidation.

Analysis of thematic evolution or change describes how the research interest has evolved over time. In the early years, there was much of a focus between automation and adoption of HR information systems, as well as technology adoption. Recent publications have shown an increasing emphasis on strategic integration, sustainability outcomes and the human aspects of innovative methodologies. This transition also signifies a shift in emphasis from technologies and digital advantage to a more balanced consideration of technology capability, ethical responsibility, and employee centric values relevant to successful HRM in the digital age.

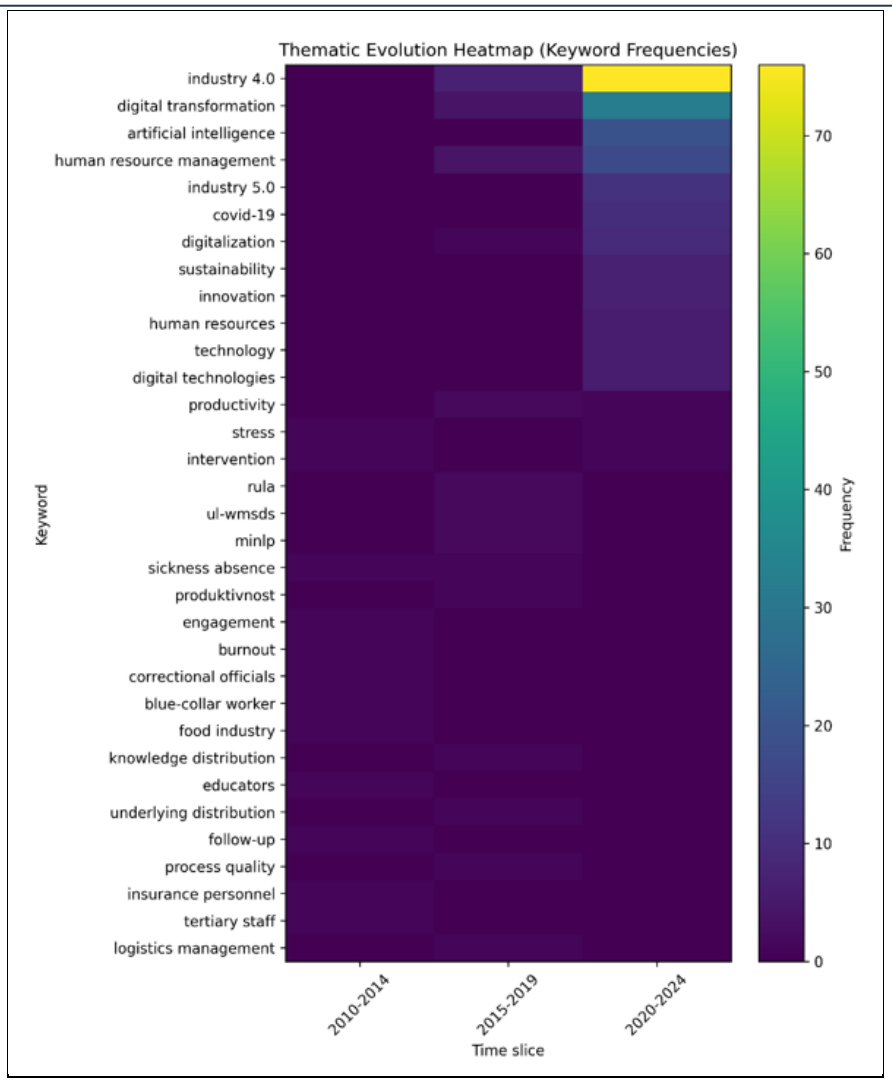

Figure 06: Thematic Evolution (Authors work)

The thematic evolution heatmap illustrates the temporal progression of dominant research themes in the literature on artificial intelligence, sustainability, Industry 4.0 and human resource management across three time slices (2010-2014, 2015-2019, and 2020-2024). During the early period (2010-2014), keyword frequencies are generally low and dispersed, with limited emphasis on advanced digital concepts, indicating an emergent and exploratory phase of research. The focus during this stage is largely confined to traditional workforce-related issues such as stress, engagement, productivity and occupational contexts, reflecting a predominantly human-centric orientation with minimal integration of digital transformation narratives.

In the intermediate period (2015-2019), the heatmap shows a gradual intensification of themes related to digitalization and organizational change, particularly Industry 4.0, digital transformation and human resource management. This shift signals a transitional phase in which HRM research increasingly engages with technological advancements and their implications for organizational processes and workforce management. The most recent period (2020–2024) exhibits a pronounced concentration of high-frequency keywords, notably Industry 4.0, artificial intelligence, sustainability and digital transformation, indicating thematic consolidation and maturity. The strong presence of these terms demonstrates a clear convergence toward AI-enabled, technology-driven and sustainability-oriented HRM frameworks. Overall, the heatmap confirms a systematic evolution from fragmented, human-focused themes to integrated digital and sustainable HRM paradigms, highlighting the growing strategic relevance of technology and sustainability in contemporary HRM research.

3. 5. DISCUSSION

The findings of the bibliometric analysis provide important insights into how research on artificial intelligence, sustainability and Industry 4.0 has evolved within the domain of human resource management and organizational behaviour. The observed growth in publications and the diversification of research themes indicate that HRM is increasingly positioned as a strategic enabler of digital transformation rather than a purely administrative function. This

shift aligns with contemporary views that emphasize the centrality of human capital in leveraging advanced technologies for organizational competitiveness and resilience.

One of the key insights emerging from the results is the central role of AI as a catalyst for HRM transformation. The dominance of AI-related keywords and citation clusters suggests that scholars are primarily concerned with how algorithmic tools reshape recruitment, performance management, learning and decision-making processes. However, the co-citation patterns also reveal growing scholarly concern regarding ethical risks, transparency and bias associated with AI-enabled HR systems. This indicates a gradual movement away from technology-centric optimism toward more balanced and critical perspectives that recognize both the opportunities and limitations of AI in people management [17].

The results further demonstrate that sustainability has transitioned from a peripheral concern to a core research theme in digital HRM literature. The increasing co-occurrence of sustainability-related keywords with AI and Industry 4.0 reflects an emerging consensus that technological advancement in HRM must be guided by social responsibility, employee well-being and long-term workforce development. This integration supports the argument that sustainable HRM provides a normative framework capable of mitigating the unintended consequences of digitalization, such as work intensification, job insecurity and skill obsolescence [18]. Consequently, sustainability serves not only as an outcome but also as a governance mechanism for digital HR practices.

From an Industry 4.0 perspective, the discussion highlights HRM's evolving role in managing structural changes in work design, skills and organizational culture. The thematic clusters related to reskilling, digital competencies and adaptive leadership suggest that HRM is increasingly tasked with enabling continuous learning and facilitating human-technology collaboration. This finding reinforces the view that successful Industry 4.0 implementation depends on aligning technological systems with human capabilities and organizational values rather than relying solely on automation and efficiency gains [19].

Importantly, the bibliometric evidence indicates a convergence of AI, sustainability and Industry 4.0 into an integrated research stream, although this integration remains conceptually underdeveloped. While studies increasingly acknowledge their interdependence, the literature lacks comprehensive theoretical frameworks that explain how these forces jointly shape HRM outcomes. This fragmentation highlights the need for interdisciplinary theorizing that combines strategic HRM, socio-technical systems theory and sustainability perspectives to better capture the complexity of digital work environments.

Overall, the discussion underscores that the future of HRM research lies in moving beyond siloed investigations toward integrative and human-centric approaches. By interpreting bibliometric patterns through a theoretical lens, this study demonstrates that digital HRM is no longer solely about technological adoption but about responsible, sustainable and inclusive workforce management. These insights set the stage for the development of a structured research agenda, presented in the following section, to guide future scholarly inquiry in this rapidly evolving field.

6. Research Agenda and Future Directions

Building on the bibliometric findings and their interpretation, this section proposes a forward-looking research agenda to advance scholarship on the convergence of artificial intelligence, sustainability and Industry 4.0 in human resource management. The agenda is organized around key thematic, theoretical, methodological and contextual directions that address gaps identified in the existing literature and respond to emerging organizational challenges.

6.1 Advancing Integrative and Multilevel Theoretical Frameworks

Future research should move beyond fragmented examinations of AI, sustainability and Industry 4.0 by developing integrative theoretical frameworks that capture their joint influence on HRM outcomes. Multilevel perspectives linking individual, team, organizational and institutional levels remain underdeveloped. Integrating socio-technical systems theory, dynamic capabilities and sustainable HRM perspectives can help explain how technological systems and human agency co-evolve in digital workplaces [20], [21]. Such frameworks would enable scholars to theorize not only efficiency gains but also long-term human and social consequences of digital HRM.

6.2 Ethical, Responsible and Trustworthy AI in HRM

A prominent avenue for future inquiry concerns the ethical governance of AI-enabled HR practices. While recent studies acknowledge risks related to algorithmic bias and opacity, empirical research examining how organizations design, implement and monitor responsible AI systems in HRM remains limited. Future studies should investigate accountability mechanisms, explainable AI models and employee perceptions of algorithmic decision-making to better understand trust formation and legitimacy in digital HR systems [22], [23].

6.3 Sustainability Outcomes and Employee Well-Being

Although sustainability is increasingly discussed, its outcomes at the employee level require deeper empirical validation. Future research should examine how digital HRM practices influence employee well-being, work–life balance, employability and psychological safety over time. Longitudinal and mixed-method studies are particularly needed to assess

whether AI-driven HR systems support or undermine sustainable work practices in Industry 4.0 contexts [24], [25].

6.4 Skills, Reskilling, and Lifelong Learning in Industry 4.0

The rapid diffusion of Industry 4.0 technologies necessitates continuous skill development and workforce adaptability. Future research should focus on the role of HRM in facilitating reskilling, upskilling and lifelong learning ecosystems, particularly through AI-enabled learning platforms and personalized training systems. Comparative studies across industries and regions would provide insights into how contextual factors shape skill strategies and workforce resilience [26], [27].

6.5 Methodological Advancements in Digital HRM Research

From a methodological standpoint, the literature remains dominated by cross-sectional designs and conceptual analyses. Future studies should adopt advanced methodological approaches, including longitudinal designs, experimental methods and computational social science techniques. The integration of HR analytics, digital trace data and qualitative insights can enrich understanding of complex human-technology interactions and improve the explanatory power of HRM research in digital environments [28], [29].

6.6 Contextual and Cross-Cultural Perspectives

Finally, future research should expand beyond developed economies to explore contextual and cross-cultural variations in digital and sustainable HRM adoption. Differences in institutional frameworks, labor market regulations and cultural values may significantly influence how AI and Industry 4.0 technologies are implemented and perceived by employees. Comparative and emerging-economy studies are essential for developing globally relevant theories and practices [30], [31].

7. Theoretical and Practical Implications

7.1 Theoretical Implications

This study offers several theoretical contributions to the literature on human resource management and organizational behaviour. First, by synthesizing research on artificial intelligence, sustainability and Industry 4.0 through an integrated bibliometric lens, the paper advances conceptual clarity in a fragmented research domain. The findings support the argument that digital HRM should be theorized as a socio-technical and sustainability-oriented system, rather than as a purely technological or managerial innovation [32]. This perspective extends strategic HRM theory by emphasizing the co-evolution of technology, human agency and ethical governance.

Second, the study contributes to emerging debates on algorithmic management by highlighting the need to integrate ethical and sustainability considerations into HRM theorizing. The convergence identified in the literature suggests that future theory development must move beyond efficiency-driven narratives and incorporate fairness, transparency and employee well-being as central constructs [33]. Finally, the bibliometric evidence supports the development of interdisciplinary frameworks that draw from information systems, organizational psychology and sustainability studies, thereby enriching HRM theory in the context of digital transformation [34].

7.2 Practical Implications

Practically, the results provide valuable depth regarding actionable implications for HR managers, as well as organizational leaders and policymakers. The findings underscore the need for people-centred design and ongoing employee engagement when implementing AI and Industry 4.0 technologies in HRM. Companies, therefore, need to invest in reskilling programs, transparency and ethical AI governance mechanisms if they are to maintain employee trust and corporate viability over the long term [35].

Policymakers should develop approaches that include regulation informed by algorithms — from data privacy, to algorithmic accountability and workforce development. Policymakers are advised to line up digital HR strategies with sustainability objectives so that technology-driven innovations actually enhance employee well-being and organizational robustness rather than intensify social disparities or job insecurity [36].

Limitations of the Study

Notwithstanding its contributions, this research has the following limitations that deserve to be recognized. First, the study is based solely on the Scopus database; although this is extensive, it could be that other relevant studies not indexed in Scopus are missed. Second, bibliometric methods focus mainly on publication and citation patterns, which may not ascertain the qualitative depth or contextual richness of individual studies [37]. Third, hall-dwellings research is mainly based on published English language material, which may restrict findings discussion of the non-English and practitioner inquiry.

4. CONCLUSION

This paper attempts to conduct a kind of integrated bibliometric paper on research with the focus on the intersection of AI, sustainability and Industry 4.0 in HRM domain. The paper shows that following a pattern of sense making, cognitive

framing and reactive rationalization on the path to seeking relevance, HRM research has gradually become more strategic, ethical and human-oriented in digital times. The results highlight the need of conciliating innovation in technology with principles and guidelines for sustainability, to assure a responsible and inclusive management of workforce.

By providing a disciplined research agenda and theoretical sources, the article seeks to contribute to deepened academic knowledge and support in digital HRM also as an area of future respectable research. With the continued and rapid pace of technological change encountered by organizations, the understanding provided by this study will help to develop robust, ethical and sustainable HRM systems that can align technological potential with human values.

Declarations

Conflict of Interest Statement

The author(s) declare that there is no conflict of interest regarding the publication of this paper.

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Author Contributions

Data Availability and Transparency

The data used in this study were obtained from the Scopus database and consist of bibliographic records of peer-reviewed journal articles published between 2010 and 2024. The dataset was generated using a documented search strategy and inclusion criteria described in the methodology section. Due to database licensing restrictions, the raw data cannot be publicly shared; however, the data can be accessed directly through Scopus by replicating the search query provided in the paper. All analytical procedures were conducted using established bibliometric tools, ensuring transparency and replicability of the results..

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