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Industry 4.0 and Its Implications on Human Resource Management Practices: A Systematic Literature Review and Bibliometric Analysis

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Abstract: *The integration of digital technology into diverse industries and service sectors is revolutionizing workplaces and reshaping human resource practices. The incorporation of cutting-edge technologies associated with the Fourth Industrial Revolution, commonly known as Industry 4.0, is redefining the dynamics of work, learning, leadership, management, recruitment, and interpersonal interactions. This paper aims to provide an in-depth understanding of Industry 4.0 and its implications on human resource management (HRM), promoting directions for HRM professionals and academics to confront the challenges associated with Industry 4.0. The study utilized a methodology of bibliometrics analysis including network analysis, co-citation network, historiography, cluster analysis, three-field analysis, thematic map, and content analysis (CA) to analyze 269 documents from the Scopus database to identify hitherto research on this topic of HRM and industry 4.0. Additionally, a systematic literature review (SLR) was conducted to propose future research directions in industry 4.0 and HRM practices. The findings suggest that the focus of research in this field is on the impact of Industry 4.0 on various HRM functions such as recruitment, selection, orientation, training and development, performance analysis, and compensation management for human capital acquisition, nurturing, and retention. The study offers managerial insights for organizations to navigate the evolving landscape and leverage digital technology for enhanced HR functions, thereby effectively managing their workforce.*

Keywords: *Systematic Review, Bibliometric Analysis, Industry 4.0, Human Resource Management (HRM)*

1.0 Introduction

Industry 4.0 has materialized within the manufacturing sector owing to the progress of digitalization and robotics, as underscored by prior studies (Castelo-Branco et al., 2019; Matt et al., 2020; Mishra et al., 2023). This revolution encompasses the fusion of physical and cyber systems, achieved through the application of digital technologies like artificial intelligence, the Internet of Things, cyber-physical systems, big data, and cloud computing. The implementation of these technologies has caused significant disruptions to the workforce, leading to a socio-technical revolution. In the midst of the transformative impact of disruptive technologies, it remains crucial to acknowledge that digital transformation relies on fundamental human skills to guarantee the usability and effectiveness of digital technologies. Several studies have underscored the significance of intrinsic human skills in the successful execution of digital transformation (Kraus

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et al., 2021; Matt et al., 2015; Mishra et al., 2023; Vial, 2021). Consequently, the labor market needs to adjust to these demands, as the surge in technological intelligence and the generation of intricate data necessitate a more qualified workforce capable of making decisions across various work domains. This shift is driven by the integration of advanced technologies such as artificial intelligence, robotics, the Internet of Things, and cloud computing into industrial processes. This integration is expected to result in significant changes to the way businesses operate, including improvements in efficiency, productivity, and profitability. Nevertheless, these changes also entail implications for human resource management (HRM) practices. The adoption of Industry 4.0 technologies is expected to influence the skills and competencies demanded of employees, along with altering the very nature of work itself (Ammirato et al., 2023; da Silva et al., 2022; Erro-Garcés & Aramendia-Muneta, 2023; Omrane et al., 2023).

Attaining successful digital transformation necessitates a comprehensive understanding of how digital technology envisions changes in HRM. Traditional HRM involves managing individuals in organizations through various techniques to keep them qualified and aligned with stakeholder expectations. This includes activities such as professional training, learning, and development. Additionally, HRM also involves improving communication, defining organizational structure, and promoting ethical and social principles. The emergence of Industry 4.0 has introduced substantial changes, prompting the need for an understanding of their implications for HRM. A notable shift is the integration of digital technologies into HRM, giving rise to the concept of Human Resources Management 4.0 (HRM 4.0 or Smart HR 4.0). This innovative approach harnesses Industry 4.0 technologies to enhance HRM agility, prioritize worker well-being, address labor market demands, and unlock the full potential of human resources for new responsibilities (Ammirato et al., 2023; Rehman et al., 2023). To achieve this, HRM 4.0 requires the development of a digital culture among employees, with training in digital tools and skills that increase productivity.

As far as we know, there are currently three existing literature reviews that focus on the field of Industry 4.0 and HRM. First, providing a digital trend of HRM practices resulting from Industry 4.0(da Silva et al., 2022). Second, Teixeira and Tavares-Lehmann (2023) explore a strong relationship of Industry 4.0 and HRM with sustainability. Third, Kipper et al. (2021)suggest a subtle indication of skill sets requirement for HR professionals with the impacts of Industry 4.0. Although these reviews have contributed significantly to the existing body of knowledge, it is argued that conducting a systematic review using rigorous quantitative bibliometric techniques can provide additional insights. These techniques, including co-citation network analysis, enable us to map the knowledge boundaries of the current literature, and identify established and emerging research areas. Therefore, the objective of this study is to review the literature on Industry 4.0 and HRM systematically, gather insights, evaluate the current state of the art, and identify research gaps to enrich the body of knowledge by directing future research avenues. The contribution of this study is to analyze the current state of research on Industry 4.0 and its impact on HRM practices, including the key themes, trends, and research gaps. It is also explored the various approaches and strategies that organizations are using to manage the transition to Industry 4.0, including training and development programs, recruitment and retention strategies, and the use of technology to enhance HR processes.

The remainder of the paper is organized as follows: Section 2 delves into the background of the study. Section 3 delineates the methodology employed. Section 4 presents the findings, succeeded by a discussion on these findings in Section 5. Section 6 provides a summary of the findings. The implications of the findings for practitioners and academia are explored in Section 7. Furthermore, the study's limitations are addressed, and suggestions for future research are discussed in the concluding section of the paper.

Background of the Study

The Fourth Industrial Revolution recounts the digitalization of the value chain increasingly through the real-time data exchange by the interconnection of systems, objects, and people. Consequently, Artificial Intelligence is used to equip the interconnection of products, machines, and processes, as well as these, are enabled to adjust with the independent spontaneous changes which are derived from the work environment. In the manufacturing industries, new strategic approaches are required for holistic HRM to cope with the competence of challenges and the knowledge related to processes and technologies of industrial 4.0 (Ammirato et al., 2023; Hecklau et al., 2016).

The working methods for human resources are reshaped by industry 4.0 and digital transformation. It is stated by the experts that automation and process simplification and the resulting improved decision-making can assist significantly to boost human resource efficiency. HR analytics tools and Artificial Intelligence (AI) can be utilized to enable HR managers to manifold the cabalistic or relevant meaningful patterns to collect the data from the employee database of the organization and to offer personalized and professional career development planning and the learning programs that are undertaken to influence employees experience, learning patterns, behavior, personality, and skills. Social intranets are referred to as the use of IoP (The Internet of People), as per the corporate context, which permits the manager and employees to communicate more freely and reciprocally with each other and to minimize the gap of communication among leadership, employees, and middle-management. Organizations scrutinize the specific job position and find out the most and best suitable candidates among the existing pool of talents who have required competencies through the implementation of Artificial Intelligence and predictive analytics. Numerous socio-economic and sustainable opportunities for instance, thorough corporate efficiency and productivity of employees, are offered by the digitally-enabled initiatives of human resource development (Ghobakhloo, 2020). Working environment and structure of the work organization along with including the workers who are involved with the industrial work group are influenced by a strong impact of industrial 4.0. Implementation of organizational and technological possibilities, identifying abilities and required competencies, and defining converted requirements regarding training and development that are improved and used to qualify or develop the skills of employees by industrial 4.0 (Schneider, 2018).

The blockchain can ensure the right person has been recruited within a shorter time. It accelerates the decision-making process with precision by encompassing information on various aspects of employees, including payroll details, performance reports, security access codes, and even psychometrics. Big data can help to retain the most talented employees to the organization by

identifying their performance records and find out the employees who are likely to be walked out from the organization. It can also assist in personalizing the benefits packages of employees by having their employment history and personal life background (Majam & Jarbandhan, 2022).

The IR4.0 technologies can detect the employees who are performing below the standards and what type of skills are needed to for them. At the same time, this system can ascribe the employees who are performing beyond the standards and how much should be extra paid. By utilizing production data, an organization can design its compensation system, taking into account factors such as individual task performance, tenure, joining date, managers' ratings, peers' ratings, and even predict the likelihood of an individual's intention to leave. This e-compensation system can provide transparent reward system with accurate evaluation based on their performance data (Margherita & Bua, 2021).

Despite the positive aspects there are some challenges, i.e., the scarcity of skilled manpower and develop competency of the current employees would be major challenge for the companies. HR may face difficulties in developing the skills sets required for future jobs as it is volatile and new techs are arriving every time. Designing appropriate training program may arise a complex task for HR as they have a few experiences in this field (Pató et al., 2022). HR can face technical barriers to operate data driven HRM because of poor infrastructure availability such as all the domains may not have compatibility with each other. Furthermore, there is always privacy concern and consequently legal barriers for the safety of the data since the possibility of getting hacked the data is high (Majam & Jarbandhan, 2022).

Methods

This paper utilizes a systematic literature review and bibliometric analysis approaches to fulfil its stated research objectives. A systematic literature review is a type of research method that aims to identify, analyze, and summarize all of the relevant literature on a specific research question. It is a rigorous and comprehensive approach to reviewing the existing literature in a field, which involves a structured process of searching and screening studies, extracting and synthesizing data, and evaluating the quality of the studies included in the review(Raghuram et al., 2010; Sahabuddin et al., 2023; Sakib et al., 2023; Saunders et al., 2009).On the other hand, bibliometric is a quantitative analysis of published literature, which involves the use of statistical and mathematical methods to analyze and measure the characteristics and impact of published literature. Bibliometric analysis involves the collection, analysis, and interpretation of data related to publications, authors, journals, and citations(Mering, 2017; Sahabuddin et al., 2023).This paper follows PRISMA framework, developed and coined by Moher et al. (2015), to collect, screening, and filtering data from the Scopus database for performing bibliometric and systematic literature review. Figure 1 represents a synopsis of the PRISMA of this paper.

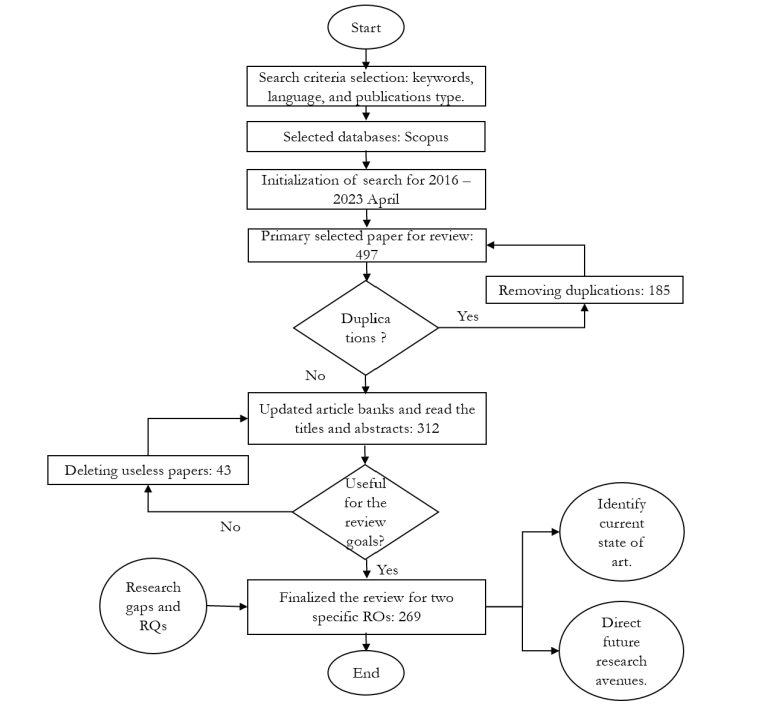

Figure 1: PRISMA framework (Moher et al., 2015)of this study

Further search protocol has been used for this study for collecting, screening, filtering data from the Scopus database, depicted in Table 1.

Table 1: Search protocol

Search Keywords (Title, abstract, and keywords)	"Industry 4.0" AND "Human Resource Management" – 138 documents "Industry 4.0" AND "HRM" – 37 documents "Industry 4.0" AND "Human Resources" – 210 documents "Industry 4.0" AND "Personnel Management" – 21 documents "Industry 4.0" AND "HR" – 35 documents "Industry 4.0" AND "Human capital management" – 26 documents "Industry 4.0" AND "Talent management" – 20 documents
Database	Scopus
Publication type	Research paper, review paper, research note, and book chapter
Language	English
Search Period	2016 – 2023 April 6
Subject area	Business, management, and accounting

Scopus database has been used for collecting data for this study as it is mostly popular, reliable, and recognized database among scientific scholar community having more 20,000 peer-reviewed journals, including arts, humanities, engineering, business, social science, and technology (Fahimnia et al., 2015; Sahabuddin et al., 2023). The database is considered more broad, comprehensive, inclusive than Web-of-Science (Yong-Hak, 2013). The search period for this study is 2016 to 2023 April. 2016 is considered the beginning point of industry 4.0 and HRM research. For bibliometric analysis, the bibliometrix package of "R software" has been utilized(Aria & Cuccurullo, 2017), and the bibliographic data and network have been analyzed using VOSviewer(Van Eck & Waltman, 2010).

Analysis and Findings

4.1 Summary statistics

This section summarizes the results of a rigorous bibliometric analysis conducted for the research on HRM and Industry 4.0. As presented in Table 2, the analysis considered 184 sources, including journals and books from domestic and international publishers. The contributions of 774 authors were recognized, and the results indicate that 28 authors were single authored. The authors collectively produced 163 articles, 4 books (with 28 book chapters), 54 conference papers, 2 conference reviews, 1 editorial, and 17 reviews between 2016 and April 2023.

Table 2: Summary statistics

Description	Results
Timespan	2016 to 2023 April
Sources	184
Documents	269
Annual Growth Rate %	14.52
Average Citations Per Doc	9.234
Authors	774
Single-Authored Docs	32
Co-Authors Per Doc	3.14
International Co-Authorships %	23.79
Article	163
Book	4
Book Chapter	28
Conference Paper	54
Conference Review	2
Editorial	1
Review	17

4.2 Performance analysis

After analyzing the performance of the field, it was found that the first document that coined the area was published in 2016. The total number of documents 269 retrieved from the Scopus Database published in the field and interval suggest that the annual publication numbers are accelerating and spread consistently across almost six years which is illustrated in Figure 2.

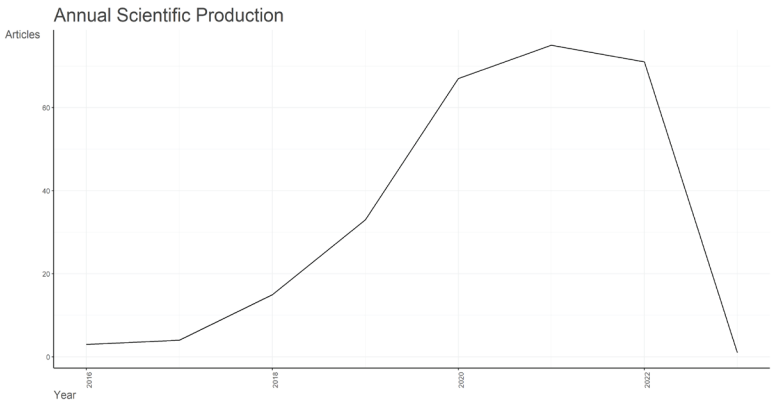

Figure 2: Trends in annual scientific productions

4.3 Contribution by countries

The bibliometric analysis of the field identified the contributions made by individuals from various nations. This diversity of author nationalities highlights the global impact of Industry 4.0 and the potential for cross-cultural collaboration. As a rapidly evolving field, Industry 4.0 and HRM have attracted authors from all over the globe, demonstrating the broad implications and interest in the development and implementation of associated technologies.

The top nine countries in terms of total publications in the discipline of Industry 4.0 are presented in Table 3. China's 21 published articles demonstrate its dedication to advancing the field and embracing the potential of Industry 4.0 in various industries. The accompanying Figure 3 depicts the trajectory in the number of publications for each country, providing a visual representation of the expansion and participation of these nations in the field. The graph identifies accelerated research and publication periods and countries that have made significant contributions to the field over time.

Table 3: Total publications numbers of the countries

Country	Articles
China	21
Australia	20
Germany	17

Spain	17
India	14
USA	14
Italy	13
United Kingdom	13
Brazil	12

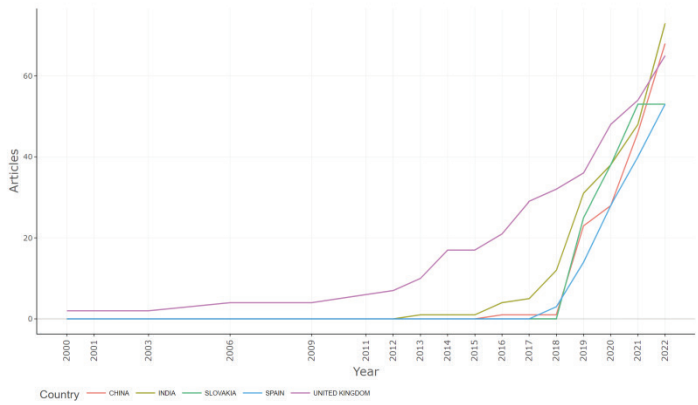

Figure 3: Trend in the publication numbers of the countries

4.4 Contribution by authors

As mentioned earlier, the bibliometric analysis conducted for this research identified a total of 774 authors. However, the analysis also identified the top 10 authors based on the number of documents published in the academic field of Industry 4.0 and HRM listed in Figure 4. Grencikova A, Sahu AK, and Vrchota J have been ranked as the highest contributors, with each author publishing four documents within the specified period and listing them in the Scopus Database.

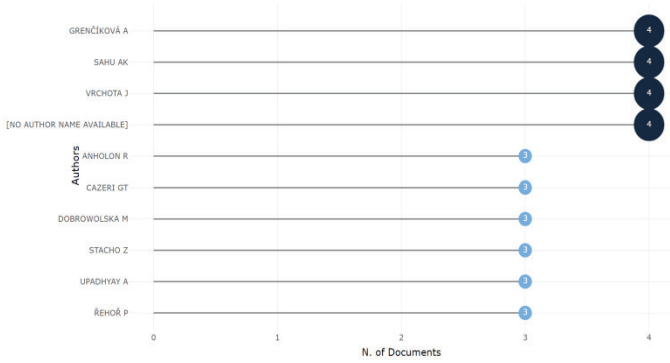

Figure 4: Publication Numbers of the Authors

4.5 Bibliographic links of the academic journals by cluster analysis

Bibliometric analysis identified conceptual clusters in the scholarly field. As illustrated in Figure 5, these clusters are not noticeably different. The bigger cluster (colored red in the Figure 5) is primarily about information systems. This cluster also includes research sub-areas: manufacturing, industrial development, human resource, conceptual framework, human resource management, economic and social effects of industrial enterprise, resource management, sustainability, systematic literature review, and smart manufacturing. Another cluster (colored blue in the Figure 5) comprises research sub-areas resource allocation and natural resource management. The clusters indicate that the existing scientific works focus more on organizational resources and capabilities identified in the researched documents. Potential researchers can contribute to these sub-areas to diversify the research clusters.

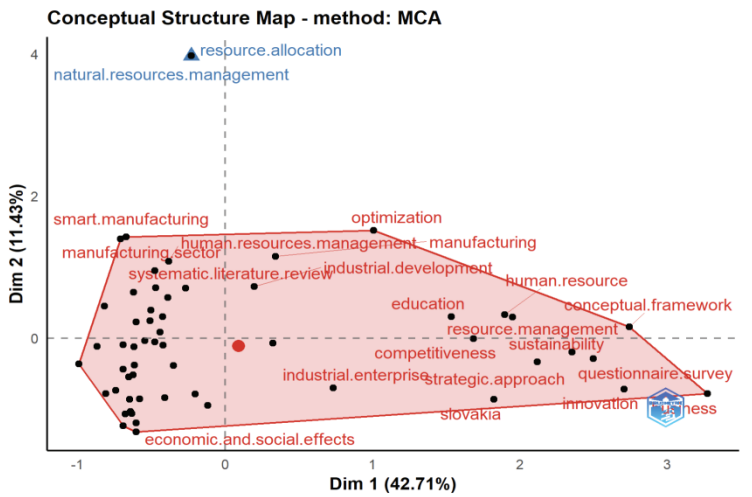

Figure 5: Cluster Analysis in Industry 4.0

4.6 Themes in the academic products

According to the thematic map illustrated in Figure 6, the thematic analysis conducted for this study has identified several dominant themes. The majority of documents in the field concentrate on Industry 4.0, human resource management, and industrial research, as indicated by the map. These terms are frequently used by contributors, indicating that they substantially impact the academic field. The second central theme consists of embedded systems, learning systems, and big data, which are essential components of Industry 4.0. The importance of the manufacturing, industrial development, and industrial enterprise themes reflects the close relationship between Industry 4.0 and the manufacturing sector. Sustainability, business, and conceptual frameworks also emerge as prominent themes, highlighting the growing significance of eco-friendly practices and strategic planning in Industry 4.0. In addition to these central themes, numerous subthemes are evident, such as education, information management, industrial robots, risk assessment, and ergonomics. The thematic mapping reveals a rich and varied field of study as researchers

investigate numerous facets of Industry 4.0 and its effects on various industries. Overall, the thematic map for Industry 4.0 and HRM reveals a vast array of research interests, reflecting the subject's complexity and diversity. As more researchers investigate various facets of Industry 4.0, a more comprehensive understanding of this swiftly evolving field is anticipated to emerge.

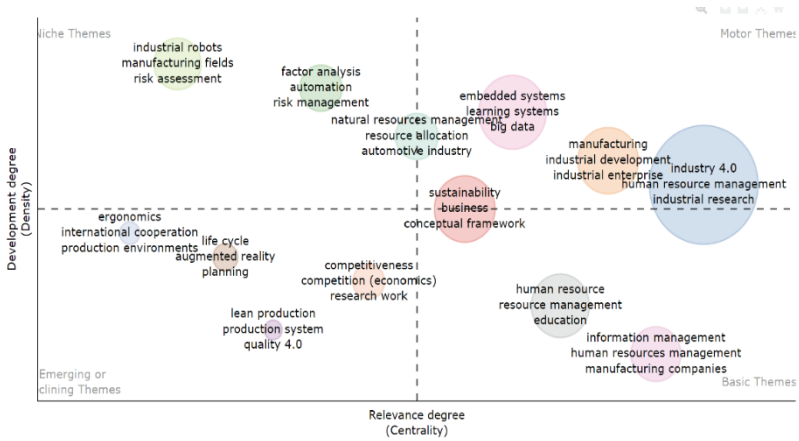

Figure 6: Thematic Map in Industry 4.0

4.7 Country collaboration map

By analyzing the frequency of collaborations between different nations, it can be obtained insight into the international dynamics of knowledge exchange and collaboration in the study of Industry 4.0 and HRM. The data presented in Figure 7 reveals a wide variety of collaborations, with numerous nations partaking in cooperative research. For example, Australia and Hong Kong, Brazil and Australia, and Brazil and Canada all collaborate. These partnerships suggest that researchers from various continents are cooperating to resolve the complex issues associated with Industry 4.0 and HRM. Some nations, such as Brazil and Canada, have multiple collaborations, indicating that they are active participants in the global Industry 4.0 and HRM research landscape.

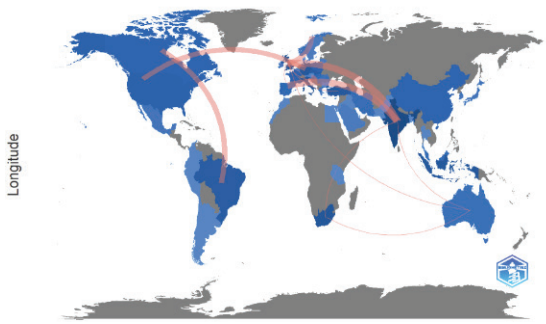

Figure 7: Collaboration by Countries

4.8 Co-occurrence network

The Co-occurrence network provides valuable insight into the relationships and interconnections between the various research topics within a particular field. By analyzing the co-occurrence of keywords as depicted in Figure 8, it can be identified the main thematic clusters and comprehend the dominant, overarching themes in the industry 4.0 and HRM research landscape. The largest segment, denoted in red, covers a wide variety of topics pertaining to manufacturing industries, supply chains, industrial management, project management, competition, natural resources management, and industrial enterprise. This cluster represents the fundamental aspects of Industry 4.0 and HRM, emphasizing the significance of these topics in defining the research direction and the field. The second-largest segment, indicated in blue, covers decision-making, manufacturing companies, human resource management (HRM), industrial development, the manufacturing sector, and human engineering. This cluster highlights the importance of management and human factors in Industry 4.0 research, highlighting the interaction between technology and human capital within the context of industrial development. The green segment represents the third-largest segment, focusing on big data, data analysis, embedded systems, and factor analysis. This cluster emphasizes the importance of data and analytics in Industry 4.0, highlighting the expanding significance of data-driven decision-making and the incorporation of advanced technologies in contemporary industrial settings.

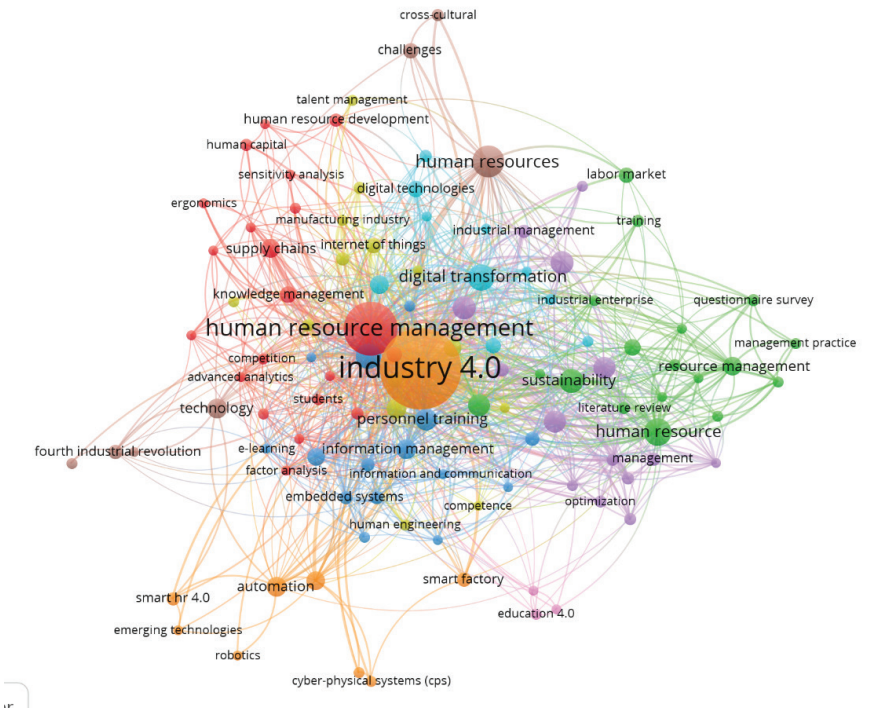

Figure 8: Co-occurrence Network

4.9 Most relevant sources

The bibliometric analysis conducted in Industry 4.0 and HRM has revealed a proliferation of reliable and adequate resources, despite the numerous documents published in this field. Among the available sources, Sustainability (Switzerland) is the most prolific publisher, with 20 documents deemed the most effective source. The International Journal of Manpower follows with 8 documents, the second largest relevant publication source.

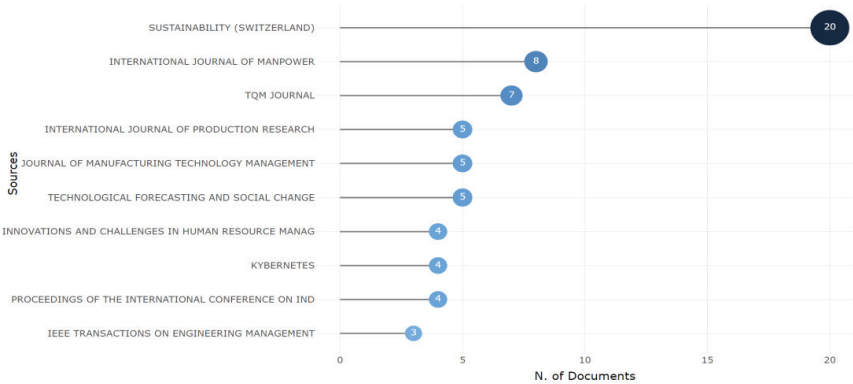

Figure 9: Most relevant sources of publication

4.10 Treemap

The bibliometric analysis undertaken in the field of Industry 4.0 and HRM sheds light on the number and percentage of documents published in this field in Figure 10. Industry 4.0 has the highest number of documents, comprising 15% of the total publications, which is relatively high compared to other fields. However, despite this relatively high percentage, the number of documents and studies in this area need to be increased. The second-highest number of documents is in human resource management, with 69 publications, accounting for 14% of the total publications. Industrial research follows with a percentage of 14%, but the number of documents is only 20, indicating a need for more research in this area.

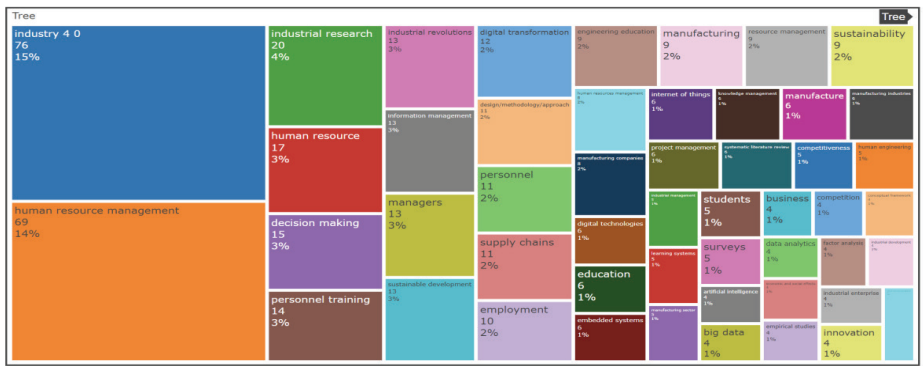

Figure 10: Tree map

4.11 Trend's frequency

Throughout the year 2021 and beyond, the terms "managers," "supply chains," and "knowledge management" were frequently utilized which is shown in Figure 11. Specifically, "Industry 4.0" and "human resource management" were the most commonly employed terms in 2021 and remained in use in subsequent years. Although "industrial research" was also utilized, it was not as prevalent as the aforementioned terms. In the year 2020, "human resource," "information management," and "industrial revolution" were the most frequently used terms, which continued to be in use throughout 2021. However, "industrial revolution" had already been utilized before 2020, specifically in 2019. Finally, the terms "learning systems" and "human engineering" were primarily used in 2019 and continued to be utilized up to 2020.

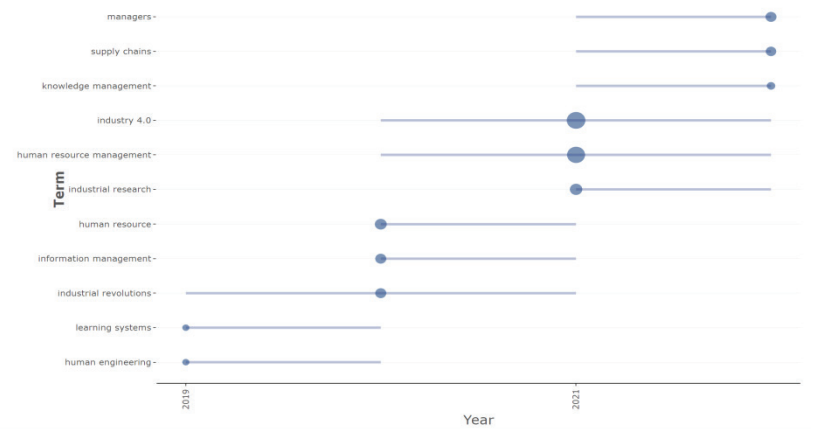

Figure 11: Trend's Frequency

Discussions

Industrial Revolution 4.0 (IR 4.0) has dramatically changed the global manufacturing system and organizations are needed to focus on people management to overcome the new challenges. Instead of following traditional recruitment, selection, training and development of people, organizations should be focusing on inventing new model for human resource management (Liboni et al., 2019).Recruitment and Selection process has been changed as new digital technologies has emerged and to operate them, the professionals' skills requirements has also transmitted. In this case, IR 4.0 technologies are assisting instead of following the traditional method, such as big data and artificial intelligence which are facilitating the process of finding the actual needs of the organization from existing data. Moreover, they are helping to meet with the best candidates those who have more probable skills to fulfill the job requirements (da Silva et al., 2022). Another breakthrough technology of IR 4.0 is Blockchain Technology by which an organization can collect data about prospective employees and analyze the data to identify the best match for any job (Rhemananda et al., 2020).

In the era of IR 4.0, organizations are introducing their training program in an innovative way which may enlarge the capability of the employees. As new trends have come to the industry, the training program is focusing on team building, problem solving and ongoing feedback system (Shamim et al., 2016). New technology of IR4 can be used for training program such as Virtual Reality (VR) by which training can be provided in a virtual environment with less risk and more efficiency (da Silva et al., 2022). The big data analytics can be used as knowing how many employees need to train, which skills are lacking, and which tools need to be used (Majam & Jarbandhan, 2022).With the help of data analytics, performance appraisal and reward systems are transforming from traditional methods to data-driven methods. Compensations are given based on the performance of the employees instead of seniority-based pay. The companies are encouraging for self-learning with monetary and nonmonetary incentives to reduce the cost of training for those skills (da Silva et al., 2022). The compensation in industry 4.0 must be based on individual, group, and organizational performance (Parham & Tamminga, 2018). As new technologies will be invented from time to time, the reward system must identify the need for innovation by giving different facilities such as profit sharing or additional incentives pay. The management should practice on going feedback system on employee's performance for enhancing their capabilities and promoting innovation (Shamim et al., 2016).

Table 4: Comprehensive review of industry 4.0 and HRM papers

No.	Authors	Title	Research methodology	Area of focus	Type of analysis and/or type of respondents	Theoretical framework	Major findings
1.	(Pio et al., 2021)	"Human Resources and Industry 4.0: an exploratory study in the Brazilian business context"	Qualitative	Examining how companies across various sectors are shaping their human resources practices within the framework of Industry 4.0	National level	Evidence-based	The companies under analysis are at various stages of evolution in terms of how they are adapting their HRM practices to the context of Industry 4.0.

2.	(Mukhuty et al., 2022)	"Strategic sustainable development of Industry 4.0 through the lens of social responsibility: The role of human resource practices"	Non-Empirical	Assessing obstacles related to humans in the context of Industry 4.0 and critically examining how HRM can effectively navigate and overcome these barriers	National level	Evidence-based	The study identified various barriers to change, including resistance to change, digital skills gaps, employment threats, socio-economic inequalities, lack of industry collaboration, and leadership and organizational culture challenges.
3.	(Mikhalkina & Nikitaeva, 2022)	"Trends, Factors, and Guidelines for the Development of Human Resources for Industry 4.0"	Non-Empirical	HRM development for Industry 4.0	Organizational level	Evidence-based	Demographic trends, technological advancements, and the transformation of labor market due to digitalization
4.	(Karimulla et al., 2020)	"Industry 4.0 and the role of human resource development in the south african fabrication and construction industry"	Quantitative: comprehensive survey process	Exploring Industry 4.0 technologies and examining the role of human resource development in the South African fabrication and construction industry.	National level	System based	The South African construction and fabrication industry experiences moderate impact from human resource development aligned with Industry 4.0, with effective employee development positively influencing industry productivity and efficiency.
5.	(Tuegeh et al., 2021)	"Industry 4.0 and human resource in Indonesia: A systematic literature review"	Qualitative	The impact of Industrial Revolution 4.0 and the challenges it poses to the job market.	National level	System based	The consequences of the 4.0 industrial revolution on the labor market and its impact on higher education.

6.	(Buchelt et al., 2020)	"The organizational aspect of HRM as a determinant of the potential of Polish hospitals to manage medical professionals in healthcare 4.0"	Empirical	Exploring the relationship between HRM practices in healthcare entities and the paradigm of healthcare 4.0	National level with 1425 respondents	System based	In effectively addressing the challenges posed by Healthcare 4.0, a notable impediment is the absence of managerial competence. Organizational solutions currently do not sufficiently bolster the strategic role of HR specialists, and their integration into existing structures constrains the capacity to facilitate the necessary changes for transitioning towards Healthcare 4.0
7.	(Virmani et al., 2021)	"Analyzing Roadblocks of Industry 4.0 Adoption Using Graph Theory and Matrix Approach"	Qualitative	Identified roadblocks of Industry 4.0	Organizational level	Evidence-based	The impediments to Industry 4.0 progress have been classified into five categories: management, operational, human resource, procedural, and behavioral roadblocks.
8.	Verma et al., 2020)	"Industry 4.0: reshaping the future of HR"	Qualitative	Highlighting the significance of Smart HRM practices in the context of Industry 4.0	Organizational level-based	Evidence-based	Implementing Smart HR 4.0 is crucial for addressing the challenges of Industry 4.0. The overhaul of HR processes at Tech Mahindra resulted in enhanced productivity, cost reduction, decreased manual workload, a more intelligent workforce, talent retention, and a competitive advantage.
9.	(Cimini et al., 2020)	"How do Industry 4.0 technologies influence organizational change? An empirical analysis of Italian SMEs"	Non-Empirical	The organizational implication of embracing Industry 4.0 technologies lies in directing specific attention towards operations	National level	Evidence-based	A streamlined organizational structure facilitates the successful implementation of Industry 4.0 technologies. The introduction of these technologies is associated with the creation of a novel job profile known as the "Autonomous Operative Job Profile." Greater levels of technology adoption amplify the demand for non-technical competencies.

10.	(Pavlíček & Novák, 2018)	"Social Media and Industry 4:0 - Human Resources in the Age of LinkedIn"	Empirical method	Focus on how professional recruiters use LinkedIn and face problems	Organizational Level	Evidence-based	The key findings imply that LinkedIn is not as essential to sustainable recruiting.
11.	(Souza et al., 2022)	"Total quality management 4.0: adapting quality management to Industry 4.0"	Qualitative method	Concentrating on the evolving concept of TQM 4.0	Organizational level	System based	The integration of Total Quality Management (TQM) into 4.0 technologies creates an ecosystem that facilitates the seamless integration of technology, quality, and human elements within an industrial setting.
12.	(Grenčíková et al., 2021)	"The impact of Industry 4.0 on education contents"	Empirical method	Focus on identifying areas on which education content should focusin the future regarding Industry 4.0.	National Level	Evidence-based	The anticipated positive educational changes need to be translated into the implementation of vocational training within companies and structural reforms within the Slovak educational system.
13.	(Koropets & Plutova, 2020)	"The impact of global risks of Industry 4.0 on the psychological safety of workers: Content analysis on the internet"	Qualitative method	Emphasize the identification of trends in shaping public opinion and awareness regarding capabilities, as well as potential socio-economic risks.	National Level	Evidence-based	The study explores potential global threats that could impact employees' psychological safety within the context of Industry 4.0.

14.	(Tjiptady, 2019)	"Work-based learning through life-based learning in vocational education to reduce unemployment rates in the Industry 4.0 era"	Qualitative method	Focused on analyzing those human skills mainly solicited by the workload of a worker's task during his working activity.	Organizational level	Human performance model	A wide range of performances reflecting different skill levels between workers helps allocate workers in the assembly line by using the Human Performance model.

Conclusion

The paper offers guidance for organizations to adapt to changing HR landscapes, utilize digital technology for improved HR functions, and manage the workforce effectively. It emphasizes the significance of understanding the impact of Industry 4.0 on HRM practices and provides direction for professionals, the sector, and the workforce to tackle the challenges. The study also highlights the need for future research to fill gaps in literature and provides more comprehensive insights into the implications of Industry 4.0 on HRM practices.

Implications for Practitioners and Academia

7.1 Practical Implications

The practical implications of the study are several. First, organizations need to adapt to the changing landscape brought about by Industry 4.0 and invest in digital technology to improve HR functions. Second, HR professionals need to develop new skills to manage the changing workforce and the integration of technology into HRM. Third, organizations need to recognize the importance of human capital acquisition, nurturing, and retention and invest in the development of their employees. Fourth, organizations need to ensure that they have a diverse and inclusive workforce to meet the demands of the changing workplace. Fifth, organizations need to provide training and development opportunities for their employees to keep up with the changing technologies. Finally, organizations need to adopt a strategic approach to HRM and integrate it with the overall strategy of the organization to achieve its goals.

7.2 Theoretical Implications

The integration of digital technology in HRM practices has opened up new avenues for research, particularly in the areas of organizational behavior, strategic management, and innovation management. The study provides a theoretical framework for understanding the impact of Industry 4.0 on HRM practices, which can be used to guide future research. One of the key theoretical implications of this study is the need to develop new theories to explain the relationship between digital technology and HRM. The study highlights the importance of understanding how digital technology is changing HRM practices and the implications of these changes for organizations and their employees. This can help researchers to develop new

theories that better explain the relationship between technology and HRM.Another theoretical implication is the need to integrate HRM and technology theories. The study shows that the integration of digital technology in HRM practices requires a deep understanding of both HRM and technology. Therefore, researchers need to integrate theories from both domains to develop a comprehensive understanding of the impact of Industry 4.0 on HRM.Finally, the study highlights the need to adopt a multi-disciplinary approach to research on HRM and Industry 4.0. The study shows that research on this topic requires knowledge and expertise from multiple disciplines, including HRM, technology, organizational behavior, and innovation management. Therefore, researchers need to adopt a multi-disciplinary approach to research to develop a comprehensive understanding of the implications of Industry 4.0 for HRM.

7.3 Managerial Implications

The managerial implications of the adoption of Industry 4.0 on HRM include: first, organizations need to invest in digital technology to improve HR functions such as recruitment, selection, and performance analysis. This will help organizations to manage their workforce effectively, and to identify and acquire the right talent. Second, organizations need to ensure that their workforce has the necessary skills to operate in a digital environment. This involves upskilling existing employees and recruiting new talent with the right skills. Third, the digital environment is constantly evolving, and organizations need to encourage continuous learning and development for their workforce. This will help employees stay relevant and adapt to new technologies and practices. Fourth, the integration of Industry 4.0 necessitates HR professionals to assume a more strategic role within the organization. Their focus should shift towards aligning HR practices with business objectives, recognizing workforce trends, and leveraging data analytics to facilitate informed decision-making. Fifth, organizations need to encourage a culture of innovation to stay competitive in a digital environment. This involves empowering employees to generate and implement new ideas and rewarding them for their contributions. Sixth, the adoption of digital technology increases the risk of data breaches and cyber-attacks. Organizations need to ensure that they have robust data privacy and security policies in place to protect their employees' personal information and the organization's confidential data.

Limitations and Future Research Directions

The reliability and validity of the findings in a study can be significantly influenced by the quality and quantity of data available, as these factors can impact the accuracy and robustness of the findings, potentially limiting the results of the bibliometric analysis and systematic literature review. The study may be limited by the availability of time to complete the research and the number of articles that can be analyzed within the given timeframe. The results of the study may be affected by publication bias, as the researchers may have only included certain articles that are relevant to their research question, which could result in missing important information. The interpretation of the results may be limited by the bias of the researchers who conducted the analysis, and their subjective interpretation of the data.

Based on the current findings, the future research directions in the area of HRM and Industry 4.0 could be: *first*, future research could explore the effects of Industry 4.0 on employee well-being,

including physical, mental, and emotional health. As the use of technology in the workplace increases, it may have both positive and negative impacts on employee well-being, and it is essential to understand these effects to mitigate any adverse effects. *Second*, the integration of Industry 4.0 technology across various industries and service sectors may require cultural adaptation. Future research could investigate how cultural differences affect the adoption of technology in the workplace, and how HRM professionals can facilitate this adaptation process to ensure a smooth transition. *Third*, industry 4.0 technologies such as artificial intelligence, machine learning, and big data analytics raise ethical concerns related to data privacy, transparency, and bias. Future research could explore these ethical considerations and suggest best practices for HRM professionals to ensure ethical and fair use of technology in HR practices. *Fourth*, the integration of Industry 4.0 technologies may lead to changes in job design, requiring new skills and competencies from employees. Future research could investigate the impact of Industry 4.0 on job design and identify the skills and competencies required for employees to succeed in this new environment. *Fifth*, the incorporation of Industry 4.0 technologies may empower HRM professionals to adopt a more innovative approach to HRM. Future research could explore the role of HRM in driving innovation within organizations and how HRM professionals can leverage technology to improve HRM practices and enhance organizational performance.

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