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Human Resource Management and Artificial Intelligence: A Bibliometric Exploration

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Abstract

The concept of artificial intelligence, a driving force behind human resource management, has recently gained popularity in the academic community. This study explores the intellectual structure of this field using the Scopus database in the subject area of business, management and accounting. Bibliographic analysis, a recent and rigorous method for delving into scientific data, is used in this investigation. The approach used is a structured and transparent process divided into four steps: (1) search criteria; (2) selection of database and documents; (3) selection of software and data pre-processing; and (4) analysis of findings. We employ bibliometric mapping to observe their numerous linkages and performance evaluation to learn about their structure. A total of 67 articles were collected from the Scopus database between 2015 and 2022 using certain keywords (artificial intelligence, expert systems, big data analytics, and human resource management) and some specific filters (subject–business, management and accounting; language-English; document–article, review articles and source-journals). Ten research clusters were identified: Cluster 1: multi-agent system; Cluster 2: decision support system; Cluster 3: internet of things; Cluster 4: active learning; Cluster 5: decision tree; Cluster 6: optimisation; Cluster 7: software design; Cluster 8: data mining; Cluster 9: cloud computing; Cluster 10: human-robot interaction. The findings could be helpful for researchers and practitioners in the HRM field to extend their knowledge and understanding of AI and HRM research. This study can provide

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notable guidance and future directions for quite a few firms in expanding the use of AI in HRM.

Keywords: *Artificial intelligence, human resource management, bibliometric analysis*

Introduction

In the digital business era, Artificial intelligence (AI) has become a more transformative force in redefining management and firm strategic practices (Kshetri, 2021; Vrontis et al., 2021). In this vein, AI-related technology executions are becoming more prevalent in firms and facilitate firms in reforming management models (Ghosh and Rajan, 2019). Past literature shows that AI has a groundbreaking impact on organisational decision-making and firm performance (Jarrahi, 2018; Thomas et al., 2016; Abdeldayem and Aldulaimi, 2020). Scholars define AI as an extensive range of technologies that let a computer execute activities that require human intellect, such as adaptive decision-making (Parry and Tyson, 2011; Kaushal et al., 2021). In emerging countries, businesses face tremendous pressure to craft an exclusive approach to cope with the global market's economic and exponential competition (Kshetri, 2021; Ghosh and Rajan, 2019).

Researchers claim AI is a salient contributor to effective Human Resource Management (HRM) (Kamaruddin et al., 2019; Tambe et al., 2019; Malik et al., 2021; Kshetri, 2021). In the hyper-competitive environment (Abdeldayem and Aldulaimi, 2020; Vrontis et al., 2021), integrating AI with HRM can emerge as a vital mechanism for organisational success (Abdeldayem and Aldulaimi, 2020; Ancarani et al., 2019; Vrontis et al., 2021). The potential use of AI to enhance HRM strategy and performance is being recognised in both developed and developing economies. Integrating AI with HRM assists managers in achieving better inter-generational relationships (Kshetri, 2021) and aids in attracting high-potential talent and forecasting the candidate, which are the primary tasks of the HR functional area (Kamaruddin et al., 2019). Similarly, the deployments of AI in HRM have dramatically evolved in several HR areas, such as recruitment, selection, training, development, and induction, to mitigate the time and cost that aims to improve the firm's operational efficiency (Tambe et al., 2019; Malik et al., 2021; Kshetri, 2021).

AI technology enables computers to learn from and suggest actions based on previously obtained data and could be used to simplify operations and enhance

HRM efficiency in various ways. While firms are incorporating AI into their HR functions at varying speeds, it is apparent that as the technology becomes more broadly embraced, it will have a long-term influence on the firm (Kshetri, 2021). As a result, HR professionals must prepare for these changes by knowing what technology is and how it is used across different roles (Qamar et al., 2021; Maduravoyal, 2018; Strohmeier and Piazza, 2015).

Academic contribution to AI-enabled HRM has rapidly increased. Notwithstanding, the concept is grounded in HRM literature, it is located at the intersection of HRM research and information management (IM) research (Bondarouk and Brewster, 2016; Bondarouk et al., 2017). Thus, this topic is inherently multidisciplinary, blending concepts from different disciplines. Extending knowledge about the significance of AI in HRM is critical for practitioners to craft effective HR-oriented strategies to cope with those challenges (Vrontis et al., 2021). Ultimately, a comprehensive and in-depth study is warranted to gain a holistic view of the research domain (Michie et al., 2017; Oswald et al., 2020; Votto et al., 2021; Yeh et al., 2017).

Exploring AI's role in the HRM domain significantly assists organisational practitioners and researchers in improving the breadth and depth of the knowledge to craft compelling HRM strategies. Ironically, the research on the link between AI and HRM domain is dearth and requires powerful explorations to understand the research domain better (Votto et al., 2021; Yeh et al., 2017). Improving HRM productivity through AI technology has prompted a strong interest in the future development of this operational area; traditional narrative literature reviews make significant contributions; however, they are insufficient to provide a comprehensive overview of a specific domain. As a result, science mapping, which uses bibliometric methods to visually present a specific field overview, is gaining popularity (Bondarouk et al., 2017; Abraham et al., 2019). Hence, this paper aims to analyse AI and HRM using a bibliometrics method to identify the major research forces such as influential authors, journals, articles and countries, collaborations between countries, hot topics, conceptual structure, and the evolution of research themes).

Given the above research aim, this study is intended to identify: a) the evolution of the domain; b) influential authors; c) influential research articles; d) countries; e) important keywords; f) clusters. The paper is folded into four sections. Section two presents the research methodology and data statistics

adopted in this study. Section three provides data analysis and findings, and finally, section five provides the conclusion.

Methodology and Data Statistics

An in-depth analysis of chosen papers adds considerably to the current body of literature. Keyword relevance is crucial to the success of a systematic literature review. It's a methodical procedure with five distinct phases: filtering, collecting, compiling, organising, and lastly, presenting the outcomes (Tatham et al., 2017). Similarly, in the current study, a similar procedure was used to discover distinct topics based on chosen keywords, followed by a forecast of future work scope related to AI and HRM.

Methods

The bibliometric technique employs data from publications to create structural images of scientific subjects, identifying the present research trend and future approaches (Li et al., 2017). The present study aims to perform a bibliometric analysis of the articles published in the Scopus database relating to AI and HRM. Bibliometric analysis is gaining considerable attention in management and social science research (Donthu et al., 2021). It is a rigorous approach that aid researchers in exploring a specific research domain more comprehensively through bibliometric indicators to analyse the most critical literature from a specific research field. Donthu et al. (2021) state that bibliometric analysis is a common and thorough approach for examining and interpreting vast amounts of scientific data. It allows us to unveil the evolutionary subtleties of a particular discipline while also offering light on emerging topics in that field. The bibliometric methodology encapsulates the application of quantitative techniques (i.e., bibliometric analysis—e.g., citation analysis) on bibliometric data (e.g., units of publication and citation) (Broadus, 1987).

Data analysis tools

VOSviewer is a knowledge mapping program that includes co-occurrence analysis and co-citation analysis. Nodes of various categories and lines connecting nodes are coloured differently, allowing the co-occurrence mapping to illustrate the links between nodes. The VOS aims to provide a "low-dimensional visualisation in which objects are located in such a way that the distance between any pair of objects reflects their similarity as accurately as possible" (Van Eck and Waltman, 2007). In a similar vein, CiteSpace is a

popular social network analysis program. CiteSpace, like VOSviewer, can do knowledge unit analysis. As a result, this research utilised VOSviewer and CiteSpace to create a co-occurrence map and a timeline map of keywords to examine the hotspots and evolution trends of AI and HRM.

Primary keywords and search results

Quality of data is of greater importance to produce authentic quantitative results. Selecting one of the accessible databases is used to conduct systematic literature reviews. Scopus, Web of Science, and ScienceDirect are among the most popular online databases. The study team chose the Scopus database for the current piece of research. The availability of the biggest number of papers published in about 22,000 journals (Emerald, Taylor & Francis, Wiley, Elsevier, and Springer) in contrast to other online databases is a contributing factor (Web of Science with 14,000 journals approximately). The majority of accessible papers are from diverse fields (business management and accounting, econometrics, social sciences, information systems, decision sciences, materials science, etc.).

At first, the researcher chose some keywords at random, that includes "artificial intelligence", big data analytics", "expert systems". The next step involves combining each of these keywords with human resource management with different combinations encompassing (1) artificial intelligence AND human resource management, (2) big data analytics and human resource management, (3) expert systems and human resource management. Below is a list of all the articles assigned to certain keywords (refer to Table I). The extraction of articles from Scopus led to 4817 articles towards each relevant combination, i.e. artificial intelligence AND human resource management (2317 articles), big data analytics and human resource management (285 articles), expert systems and human resource management (2,215 articles). This extract comprises items published in 2015 and 2021. In addition, the research team focuses on the category of complete publications. The identified papers include information on the author(s), publication year, article source, article affiliation, and abstracts.

Refining of initial results

Next, specific filters are applied to the main search results to refine them (Subject–business, management and accounting; Language–English and Source-journals). Further, exclusively designed inclusion criteria were used to select the most pertinent research articles and eliminate unnecessary articles not covering

the research topic. The criteria include: a) articles published only in journals, b) articles only in English, c) literature reviews and empirical articles, d) articles published in Business, Management and Accounting only, e) Articles with DOI, and (f) articles published between 2015 and 2022. In this study, conference papers, books, and book chapters were eliminated. This rigorous process led to identifying 67 articles (see table 2) for the bibliometric analysis. This paper focuses only on AI and its tight relationship with HRM. The study team will eventually discuss discovered clusters in the following sections.

Table 1 Primary search results

Keywords	Search results (no. of articles)
Artificial intelligence AND human resource management	2317
Big data analytics AND human resource management	285
Expert systems AND human resource management	2215
Total	4817

Source: Scopus database, 2015–2022 and authors' compilation

Table 2 Filtered results

Keywords	Search results (no. of articles)
Artificial intelligence AND human resource management	31
Big data analytics AND human resource management	15
Expert systems AND human resource management	21
Total	67

Source: Scopus database, 2015-2022 and authors' compilation

Results and Discussion

This section presents a descriptive analysis of the retrieved data. The data is processed and analysed using the R Bibliometric tool (biblioshiny for bibliometrix) to discover bibliometric information about the study domains (table 3). It shows that 27 journals have published 67 research articles on AI and HRM. Further, 121 authors were identified in the data, with 131 author appearances. In the documents, 141 keywords plus 121 author keywords were identified. Average years from publication, Average citations per document, and Average citations per year per doc are 2.1, 10.83, and 2.987, respectively (see table 3).

Table 3 the synopsis of the data

Description	Results
Main information about data	
Timespan	2015:2021
Sources (Journals)	27
Documents	67
Average years from publication	2.1
Average citations per documents	10.83
Average citations per year per doc	2.987
References	1830
Document contents	
Keywords Plus (ID)	141
Author's Keywords (DE)	121
Authors	
Authors	121
Author Appearances	131
Authors of single-authored documents	4
Authors of multi-authored documents	117
Authors collaboration	
Single-authored documents	6
Documents per Author	0.248
Authors per Document	4.03
Co-Authors per Documents	4.37
Collaboration Index	4.88

Source: Biblioshiny for bibliometrix, 2015–2022 and authors' compilation

Documents per year

Figure 1 discloses the evolution of scientific production in the field. The total number of documents per year was generated (from 2015 to 2021) using the Scopus database. It is possible to observe an increasing interest in the topic. As shown in Figure 1, the research on the link between AI and HRM continues to evolve. It is apparent that from 2015 to 2018, stagnant growth can be identified (2015- 5 articles, 2016-3 articles, 2017-4 articles, 2018-4 articles). However, from 2018 there is, rapid growth can be observed (2019- 14 articles, 2020-17 articles). It can be noted that in 2021, 38 documents were published. According to the result, it can be noted that the researcher's attention to the link between AI and HRM continues to evolve. HRM digitisation has resulted in AI being more common in Human Resource Management Systems (HRMS) and HR

Information Systems (HRIS). AI is increasingly being used in tactical operations like recruiting, employee performance assessment and satisfaction, salary and benefit analysis, best practice analysis, disciplinary management, and employee training and development systems.

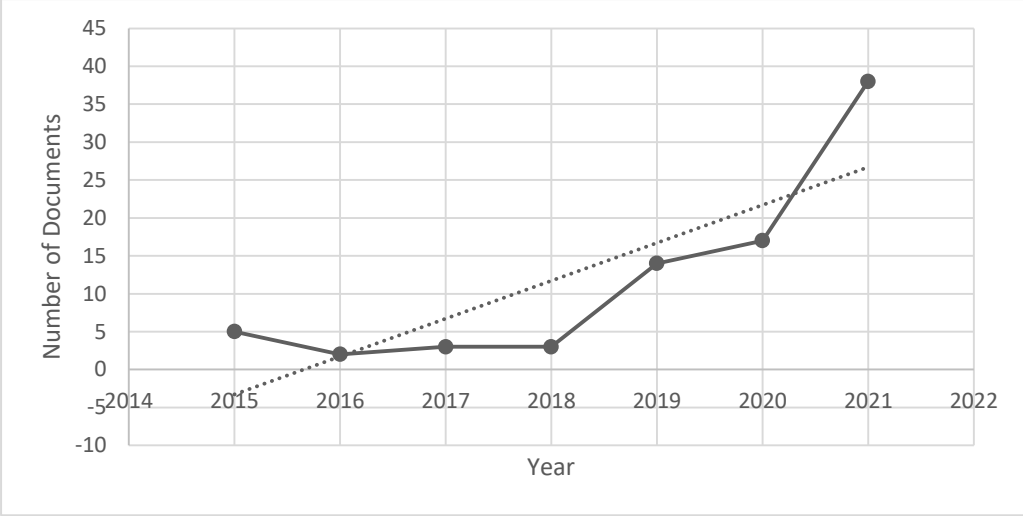

Figure 1: Documents by year

Thematic evolution map of AI and HRM

The next phase was the analysis of the key theme evolution reflecting the main research sub-areas in the AI and HRM literature. The study was carried out throughout a five-time periods: 2015-2016, 2017-2018, 2019-2020, 2021-2021, and 2021-2022. The results are shown in figure 23.

As shown in figure 2, during the 2015-2016 period, the research was chiefly focused on several sub-areas: HRM, project management, cloud computing, information management, data mining, integration, decision support systems, and automation.

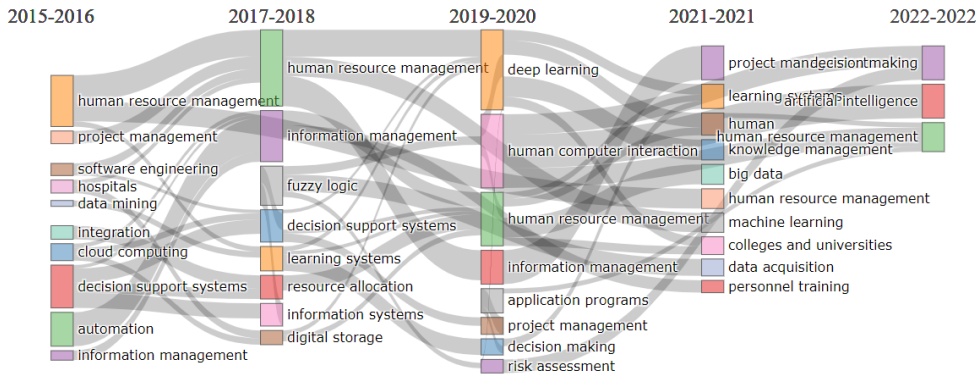

Figure 2: Thematic evolution of AI and HRM

In the second period (2017-2018), new topics emerged: information management, fuzzy logic, learning systems, resource allocation, and digital storage. In the third period (2019-2020), additional sub-areas emerged: deep learning, human-computer interaction, application programs, decision-making, and risk assessment. In 2021, learning systems, knowledge management, big data, machine learning, data acquisition and personnel training emerged. The present research focuses on the topic of HRM and AI. In 2022, HRM, and AI were found.

Co-citation analysis

Co-citation analysis is a scientific method for investigating and organising fundamental themes and the knowledge structure of a field. Co-citation analysis is based on the notion that the greater the frequency with which two things are cited together, the stronger the likelihood that their content is connected. Document co-citation analysis, author co-citation analysis (McCain, 1990; White & Griffith, 1981; White & McCain, 1998), and journal co-citation analysis are only some of the many forms of co-citation that may be used (McCain, 1990). Co-citation links documents, authors, or journals based on how scholars utilise them. Subject-matter experts use this strict grouping strategy regularly mentioning articles they find essential and/or fascinating. Because the publishing process takes time, the co-citation picture shows the condition of the field at one point in time, not necessarily how it appears today or tomorrow. It is a dynamic metric that evolves over time. Co-citations may also be used to

discover shifts in paradigms and schools of thinking across time (Pasadeos, et al., 1998).

Co-citation analysis is a scientific mapping approach that presumes that articles often cited together are thematically identical (Hjrland, 2013). The analysis may disclose the intellectual structure of a research domain, such as its underlying themes (Rossetto et al., 2018). The advantage of utilising co-citation analysis is that business academics may also identify thematic clusters in addition to locating the most important publications. Figure 3 depicts the co-citation analysis of the authors.

Table 4. Top 10 clusters based on the size in AI and HRM

Cluster ID	Size	Silhouette score	Label (LLR.)	Mean (Cite year)
0	89	0.65	Multi-agent system	2022
1	76	0.845	Decision support systems	2019
2	73	0.756	Internet of things	2021
3	64	0.735	Active learning	2021
4	46	0.702	Decision tree	2019
5	46	0.77	Optimisation	2018
6	42	8.569	Software design	2017
7	37	8.760	Data mining	2016
8	29	9.03	Cloud computing	2015
9	17	0.740	Human-robot interaction	2015

The timeline map shows the temporal spans of clusters and how these clusters are intertwined. As illustrated in Figure 4, 10 clusters formed. The nodes in each line represent terms in each cluster, and the connections reflect the relationships between them. Furthermore, linkages between clusters demonstrate that all ten clusters are inextricably linked. According to Zhou et al. (2019), "the colour of the citation tree-rings transitions from cool to warm means the continuous advancement of scientific knowledge intuitively. Yellow citation tree-rings are the current research hotspot". The main clusters are categorised by index terms from their citers and are abridged with '#' on the right side of Figure 4. These extracted key clusters with '#' eco the research frontiers of the discipline's growth. Cluster 0 is the most populous since it has the most items (18). The cluster's activeness was shown by the successive massive nodes and extensive linkages and the label of cluster 0 on behalf of the cluster's most noteworthy theme. Clusters 1 to 7 also have large nodes, demonstrating that they are

relatively prominent themes in AI and HRM research. The research hotspots of AI and HRM in the past decade comprise: 'multi-agent system', 'decision support system', 'internet of things', 'active learning', 'decision tree', 'optimisation', 'software design', 'data mining', 'cloud computing', 'human-robot interaction' are the main research areas in the AI and HRM domain.

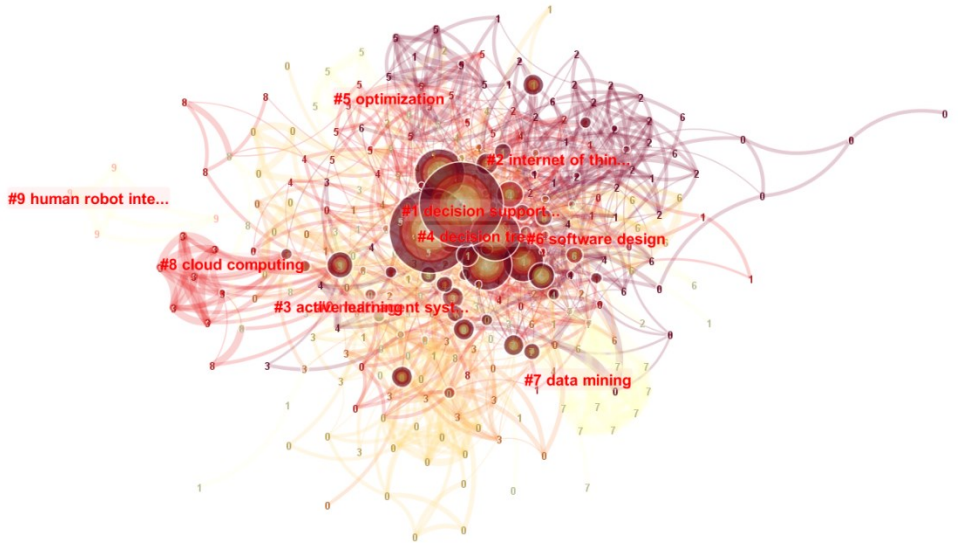

Figure 3: Clusters in AI and HRM

A synthesised document co-citation network of the AI and HRM along with cluster labels and overlays of main paths of direct citations (red lines) and core references (yellow lines). CiteSpace configuration: LRF = 3, LBY = 10, e = 2.0, g-index (k = 20). Network: 985 references and 3,327 co-citation links

Table 4 summarises the findings of the top 10 clusters in detail. Size refers to the quantity of articles in the cluster. Cluster (#0) has 96 member references, whereas cluster (#1) contains 82 member references. Silhouette is an indicator used to quantify the homogeneity of a cluster; the greater the silhouette score, the more homogeneous the cluster. When the silhouette score is equal to 0.7, the clustering result is deemed to be very trustworthy. The clustering result is satisfactory when the silhouette score is more than 0.5.

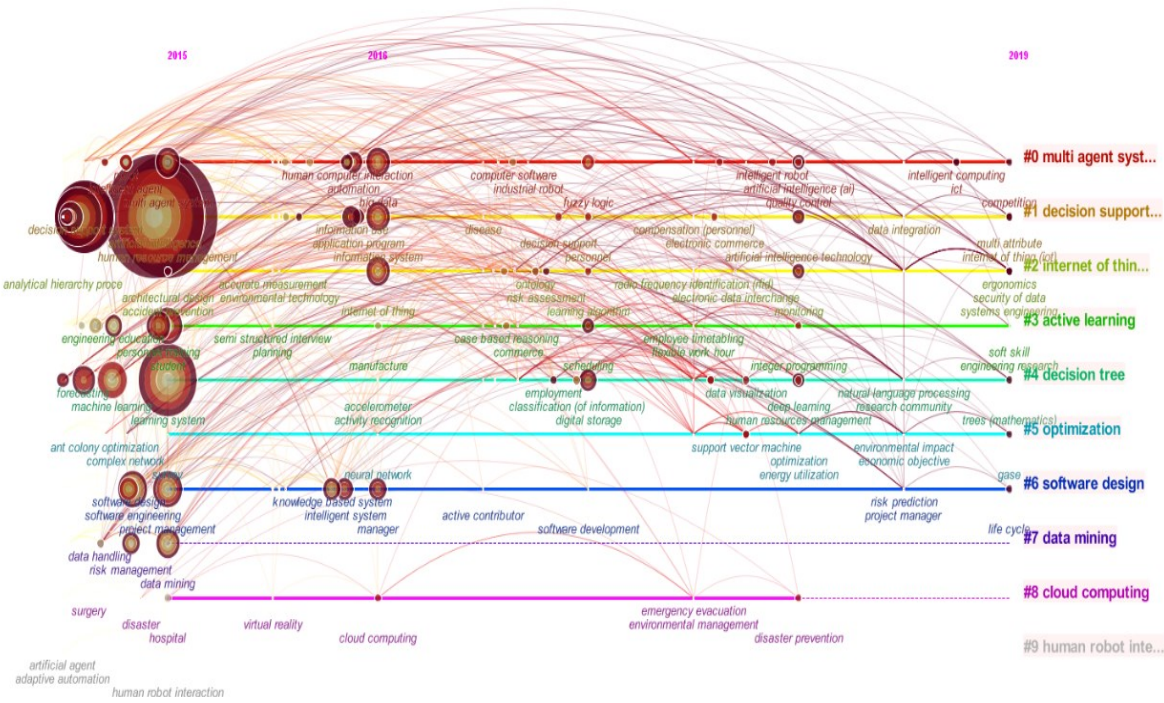

Figure 4: Timeline map of AI and HRM

The silhouette scores of Table 4's ten largest clusters are all more than 0.7, indicating that these clusters are effective and compelling. The mean shows the average year of publication for the cluster's papers. It could be employed to determine if a cluster is fresh or old (Yu and Xu, 2017). Cluster (#0) is the most recent, suggesting that 'Multi-agent system' is a current research hotspot.

Keyword analysis

The co-occurrence of terms reveals the literature's hidden conceptual structure. Used text mining in VOSviewer to determine the key themes in their titles. Baker et al. (2020) discovered that VOSviewer is incredibly useful in mapping analysis. It uses standardised weights, such as the number of occurrences and the total link strength, to indicate the relevance and strength of a relation in a nodal network involving the authors, keywords, institutions, or countries (Baker et al., 2020; Van Eck & Waltman, 2017; Bastian et al., 2009). Figure 5 depicts a network representation of the author's keywords. The colour, square size, font size, and thickness of the connecting lines are employed to illustrate the links between the keywords.

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As shown in Fig. 5, the author utilised Bibliometrix to call the VOSViewer program (Van Eck and Waltman, 2010) to display the co-occurrence network of the top 50 high-frequency keywords in the AI and HRM literature with temporal information. The total distance between terms in the co-occurrence network reveals their relatedness. The analysis's result Overlay visualisation (see figure 5) indicates that the keywords classified by the uppermost total link strength were: machine learning, talent management, deep learning, decision support system, internet of things, and project management. This reveals that those concepts are explored extensively in AI and HRM research. It helps researchers and organisational practitioners to craft compelling HRM strategies by embracing those discovered concepts. The findings of the research also indicate that the use of IoT in HRM is viewed as a potential future trend. The findings also reveal numerous HRM repercussions of the Internet of Things. Generally, the closer the two terms are, the greater their link (Van Nunen et al., 2018). Each keyword's colour denotes the average publication year, calculated by averaging the publication years of all articles with the keywords in their titles or abstracts. The size of the nodes in the map is used to reflect the weight of each word and the width of the lines indicates the number of these co-occurrences (the larger the width, the greater the number). The colours indicate the affiliation of words to particular clusters. The keywords used towards 2021 are displayed in red, and those used more towards 2017 are reflected in blue. For instance, keywords with the same colour were frequently listed together. Therefore, in this study, task allocation, blockchain technology, HR analytics, team cognition, and algorithmic management have a similar colour, which is red. This suggests that these keywords have a close relation and usually co-occur together.

The results also revealed that some keywords are still in the evolution process: chatbot, agile, intelligent decision, machine learning, business process, emergency management blockchain technology. This suggests that future research should focus on these keywords.

The individual clusters representing the research sub-areas (see figure 5) in the AI and HRM literature encompassed themes such as:
Cluster 1: active learning, artificial neural networks, building information modelling, data analysis, digital marketing, education, expert system, information technology, knowledge extraction, machine learning, network technology, personalised learning, project management, project-based learning, and team-based learning. Cluster 2: computational intelligence, data mining,

data science, decision tree, genetic algorithm, incident management, text mining, automation, collaboration, command and control, digitisation, e-HRM, human-machine interaction, intelligent systems, recruitment, skills. Cluster3: blockchain, business simulation game, case-based reasoning, change management, decision support systems, digital transformation, discriminant analysis, enterprise resource planning, innovation, supply chain management, usability, and user-centred design. Cluster4: business intelligence, data integration, deep learning, edge computing, the internet of things, network security, neural networks, object detection, human-autonomy teaming, human-computer interaction, productivity, reinforcement learning, simulation, task allocation, and team cognition. Cluster5: HR 4.0, HR analytics, performance appraisal, corporate governance, employee engagement, employee experience, disaster management, emergency management, information security, risk-based decision-making, digital economy, intellectual capital, leadership, quality, and tacit knowledge. Cluster6: cloud computing, crowdsourcing, team coordination, knowledge transfer, ambient intelligence, ambient assisted living, personnel selection, talent management, communication, big data, ethics, agile, explainable AI, intelligent system, business processes, distributed computing. Cluster 7: augmented intelligence, industry 4.0, quality management, algorithmic management, competency, job performance.

Table 5 tabulates the top 20 keywords used in the AI and HRM research. The influential keywords are based on the Strongest Citation Bursts, machine learning, decision support system, and the Internet of things.

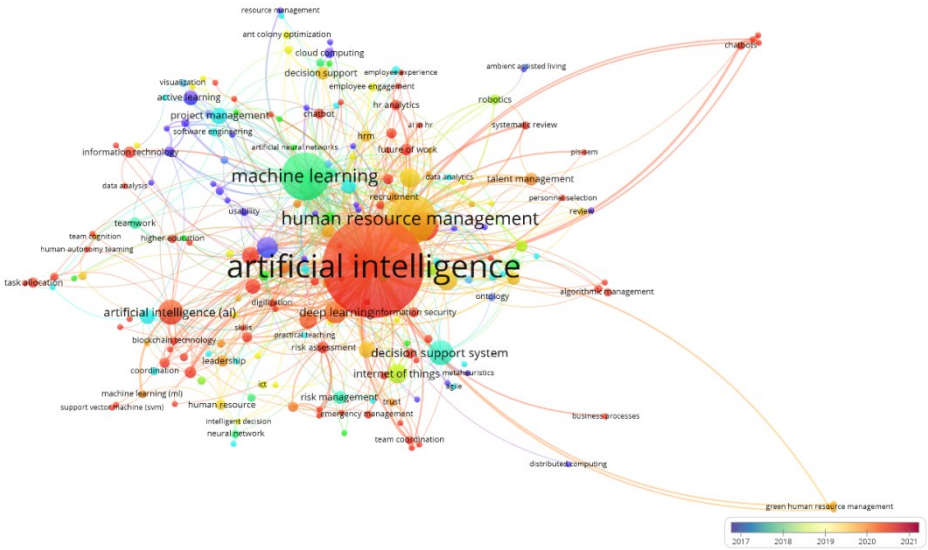

Figure 5: Co-occurrence of keywords in AI and HRM

Notes: Unit of analysis = Author Keywords; Counting method = Full counting; Minimum number of occurrences of a keyword = 5

Country-wise publications

A total of forty-six (n=46) countries have published at least one articles in this domain (see figure 6). United States (18 articles), United Kingdom (14 articles), India (12 articles), China (10), Germany (10 articles), Australia, France and Italy (9 articles). The top three countries were identified in AI and HRM fields. The county with the highest number of publications in the US, followed by the UK, and India is third. Further, the result showed that three countries had published three articles, eleven countries published two articles, and 21 countries published one article. Regarding the highest number of citations received by countries in the Scopus database, Denmark stands out in first place (TC:137, AAC:137.0), followed by Italy (TC:75, AAC:10.71), followed by Sweden (TC:67, AAC: 67.0), followed by Chile (TC:51, AAC:25.5), followed by USA (TC:31, AAC:6.2), France (TC:30, AAC:7.5). Note (TC: total citation, AAC: average article citation).

Table 5: Top 20 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2012 - 2022
1. Decision support system	2015	33.46	**2012**	2017	
2. machine learning	2015	6.97	**2012**	2017	
3. decision support system	2015	6.5	**2012**	2018	
4. Internet of things	2015	5.98	**2012**	2019	
5. Deep learning	2016	6.06	**2013**	2019	
6. Decision making	2015	5.94	**2013**	2015	
7. Distributed computer system	2017	5.72	**2013**	2017	
8. HR analytics	2017	5.69	**2013**	2016	
9. Decision making process	2016	5.52	**2013**	2018	
10. Cloud computing	2015	10.59	**2014**	2017	
11. Project management	2015	7.05	**2014**	2017	
12. Human computer interaction	2018	6.6	**2014**	2017	
13. Complex network	2018	6.32	**2014**	2018	
14. Learning system	2018	19.64	**2015**	2018	
15. Intelligent agent	2015	5.91	**2015**	2019	
16. Pattern recognition	2015	5.54	**2015**	2019	
17. Enterprise resource management	2016	8.83	**2016**	2019	
18. Administrative data processing	2016	5.67	**2016**	2018	
19. Block chain technology	2017	6.23	**2017**	2019	
20. Risk management	2020	9.02	**2020**	2022	

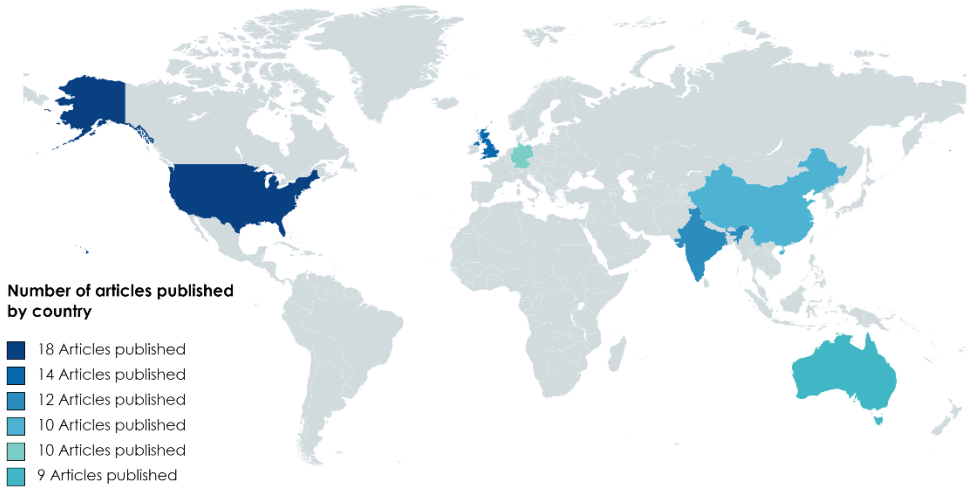

Figure 6: County publications

Table 6. Top 10 most relevent corresponding author's country

Country	Articles	Freq	SCP	MCP	MCP_Ratio
China	7	0.1186	3	4	0.571
Italy	7	0.1186	3	4	0.571
Germany	5	0.0847	4	1	0.200
India	5	0.0847	5	0	0.430
USA	5	0.0847	5	0	0.201
France	4	0.0678	3	1	0.250
Australia	3	0.0508	2	1	0.333
UK	3	0.0508	0	3	1

Note: SCP: single country production, MCP: multiple countries production, MCP-ratio: proportion of MCP in total articles.

To further understand the information of AI and HRM domain at the county level, the top ten most relevant corresponding author's countries are identified and presented in table 6. Table 6 indicates that China (Freq: 0.1186), Italy (Freq: 0.1186), Germany (Freq: 0.0847), India (Freq: 0.0847), and the USA (Freq: 0.0847) are the dominating nations in terms of corresponding authors. The MCP ratios show the transnational collaboration among countries. According to the result (see table 6), Germany (0.200), India (0.430), USA

(0.201), France (0.250), Australia (0.333) is less than 50%, which demonstrates that transnational collaboration is not enough.

Multidimensional scaling analysis

The multidimensional scaling analysis of keywords was performed to discover the research domain's conceptual structure. According to Shi et al. (2020), multidimensional scaling analysis is an exploratory analytical approach that demonstrates the interconnections among many constructs in two dimensions view and is beneficial for determining the spatial distribution of themes in a specific research domain.

In Figure 7, keywords are dispersed as points in two-dimensional space because their distributions are increasingly similar the closer they are displayed in the conceptual structure map. Bibliometrix constructs eight keyword clusters automatically, as seen in Fig. 11. The biggest cluster (red) includes 42 keywords dots, the second cluster (blue) third cluster (green) has eight keywords (blue).

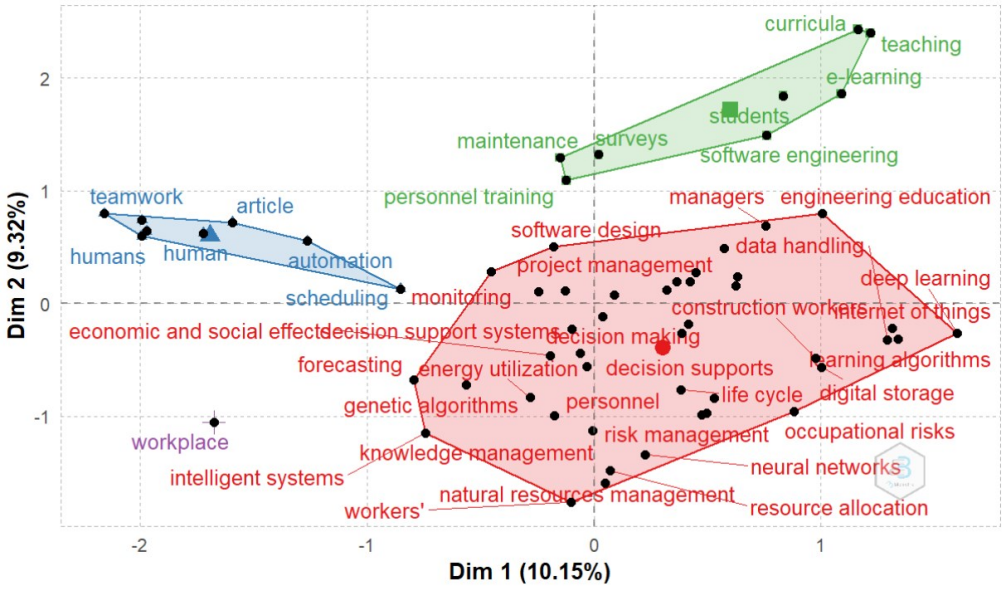

Figure 7: Conceptual structure map

Table 7: Top 20 articles with highest citations

Paper	Title	Total Citations	TC per Year	Normalised TC	LCS	GCS
Mauro et al., 2018	HR for big data professions: a systematic classification of job roles and required skill sets	94	18.8	1.694	1	94
Strohmeier & Piazza, 2015	AI techniques in HRM—a conceptual exploration	40	5	1	2	40
Caputo et al., 2019	Innovating through digital revolution: the role of soft skills and big data in increasing firm performance	33	8.25	3.164	0	33
Vrontis et al., 2022	AI, robotics, advanced technologies and HRM: a systematic review	23	11.5	4.746	1	23
Pham et al., 2018	The impact of robotics and automation on working conditions and employment	17	3.4	0.306	0	17
Pillai and Sivathanu, 2020	Adoption of AI for talent acquisition in it/ITES organisations	14	4.667	2.579	1	14
Berhil et al., 2020	A review paper on AI at the service of HRM	12	3	1.151	0	12
Kong et al., 2021	Influences of AI awareness on career competency and job burnout	11	5.5	2.27	0	11
Nawaz, 2019	AI interchange human intervention in the recruitment process in indian software industry	11	2.75	1.055	0	11
Pan et al., 2022	The adoption of AI in employee recruitment: the influence of contextual factors	8	4	1.651	0	8
Johnson et al., 2020	The benefits of e-HRM and AI for talent acquisition	6	2	1.105	0	6
Vinichenko et al., 2019	Using natural and AI in the talent management system	6	1.5	0.575	1	6
Góes et al., 2020	A process for HR performance evaluation using computational intelligence: an approach using a combination of rule-based classifiers and supervised learning algorithms	5	1.667	0.921	0	5
Sánchez-Medina et al., 2020	Applying AI to explore sexual cyberbullying behaviour	5	1.667	0.921	0	5
Sahota and Ashley, 2019	When robots replace human managers: introducing the quantifiable workplace	5	1.25	0.479	0	5
Arslan et al., 2021	AI and human workers interaction at the team level: a conceptual assessment of the challenges and potential HRM strategies	4	2	0.825	0	4
Strich et	What do I do in the world of AI? investigating the impact of	4	2	0.825	0	4

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al., 2021	substitutive decision-making ai systems on employees' professional role identity					
Long et al., 2020	AI manages congenital cataracts with individualised prediction and telehealth computing	4	1.33 3	0.737	0	4
Malik et al., 2021	Impact of AI on employees working in industry 4.0 led organisations	3	1.5	0.619	0	3
La Torre et al., 2021	Team formation for human-AI collaboration in the workplace: a goal programming model to foster organisational change	3	1.5	0.619	0	3

Note: LCS—Local Citation Score; GCS—Global Citation Score

Cluster 1 studies the topics such as decision support systems, digital storage, engineering education, deep learning, the internet of things, learning algorithms, knowledge management, intelligent systems, economic and social effect, risk management, monitoring, occupational risks, data handling, resource allocation, like a cycle, energy utilisation, genetic algorithms. Cluster 2 contains teamwork, automation and human and scheduling. Cluster 3 involves personnel training, software engineering, maintenance, teaching, and e-learning.

Country's collaboration

As shown in Figure 8, networks of the top 25 highly cited countries and regions are indicated. By employing bibliometric analysis, according to the national and regional collaboration, 13 academic clusters have been generated. The countries with the highest link strength were: the United States, United Kingdom, India, and Germany, identified as the most influential countries in the AI and HRM domain. Four scientific communities are published in AI and HRM, and their most important representatives are the *green cluster*: the United States, Chile, Argentina, Brazil, and South Korea. *Red cluster*- United Kingdom, India, Qatar, Australia, Finland, New Zealand and Denmark. *Yellow cluster*: Hong Kong, Singapore, Netherlands. *Blue cluster*: Malaysia, Indonesia, Germany, Poland, Morocco and Canada (Figure 8). As demonstrated, the UK and the USA are the strongest among all the links, indicating that the two nations have most dynamically collaborated in this field. The UK also shared strong collaboration links with many other countries, such as Italy, India, China, France, Australia and Malaysia. Similarly, the USA shared strong collaboration links with Australia, China, France, Italy, South Korea, and Singapore. China has strong collaboration links with Germany, the UK, the USA, Australia, and Singapore. At the global level, it is clear that solid collaborations between countries or territories occur primarily between highly developed countries, such as the United States and England, which share the strongest collaboration link.

Discussion

With the advent of widespread digitalisation, even HRM's traditionally manual procedures have undergone a radical transformation. HRM has figured out how to use technological advances like the computer and the internet to their advantage, leading to greater production, cost efficiency, and market competitiveness (Hmoud and Várallyai, 2020). The study's review has important HRM implications.

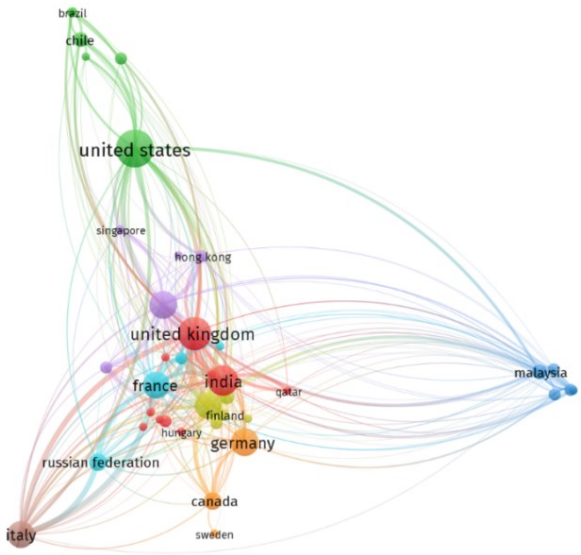

Figure 8: Country collaboration network

As an example, researchers and practitioners could encourage research into some areas that haven't been explored much yet, such as data mining, 'cloud computing, human-robot interaction, and active learning. Unambiguously, this study delivers several emerging research topics for HRM and AI. Specifically, this research analyses ten areas that are gaining attention after examining the various publications. According to the findings, the research hotspots of AI and HRM in the past decade comprise: 'multi-agent system', 'decision support system', 'internet of things', 'active learning', 'decision tree', 'optimisation', 'software design', 'data mining', 'cloud computing', 'human-robot interaction' are the main research areas in the AI and HRM domain.

A multi-agent system (cluster 0#) is the predominant area in AI and HRM. This area includes several themes, such as human-computer interaction, automation,

industrial robot, and intelligence computing. Decision support systems (cluster #1) contain themes of information use, information system, application program, decision support personnel, compensation (personnel), AI technology, and data integration. Internet of things (cluster #2) includes themes of analytical hierarchy process, environmental technology, risk assessment, electronic data interchange, ergonomics, security of data and systems engineering. Active learning (cluster #3) contains engineering education, personnel training, planning, employee timetabling, and flexible work hour. The decision tree (cluster#4) consists of forecasting, machine learning, earning system, employment classification, digital storage, data visualisation, deep learning, and research community. Optimisation (cluster #5) colony optimisation, complex network, energy utilisation, optimisation, environmental impact, economic objective. Software design (cluster#6) software engineering, project management, knowledge-based system, intelligence system, risk prediction and lifecycle. Data mining (cluster #7) data handling, risk management. Cloud computing (cluster #8) virtual reality, emergency evacuation, disaster prevention. Human-robot interaction (cluster #9).

However, current trends for controlling and monitoring electric power systems' performance are shifting toward using automated agent technologies, also known as 'multi-agent systems. The multi-agent system has become an increasingly potent instrument for developing complex systems that exploit agent qualities such as autonomy, sociality, responsiveness, and proactivity. The multi-agent system is autonomous because it functions independently of human involvement. The multi-agent system is social in that the agents communicate with one another using an agent communication language. Additionally, the agents observe and respond to their surroundings. Finally, the multi-agent system is proactive because its agents may display goal-oriented behaviour by taking the initiative. Empirical and theoretical research is needed to explore how the components of a multi-agent system, such as autonomy, sociality, responsiveness, and proactivity, impact HRM performance.

The decision support systems (DSSs) field has recognised the critical responsibilities that computer-based information systems play in assisting managers with semi-structured or unstructured decision-making processes. Leaders at every echelon of an organisation's hierarchy should be able to rely on decision-support tools to help them make serious decisions. With the advent of the internet and corporate intranets, there is now a greater opportunity to develop decision support systems to address issues of a global nature. Global

decision support systems are emerging as the new frontiers in the management information systems field as we reach the era of the global village when geographical and temporal barriers are quickly diminishing. Some questions arise from this area: How do computer-based information systems assist managers with semi-structured or unstructured decision-making processes? How do the Internet and corporate intranets offer opportunities to develop decision support systems to address issues? The Internet of Things (IoT) is often cited as a key component of the future internet, which would include billions of smart, communicative "things." IoT is a term for the connections between physical things, usually using the internet as the network's backbone. One of the most important things about the IoT is that machines are seen as customers and service providers. Deep learning is popular right now to make AI more analytical, but AI shouldn't be limited to any method. The Internet of Things (IoT) will give new abilities to things that are connected to it.

According to Settles (2009, p. 3), "active learning (also called "query learning," or sometimes "optimal experimental design" in the statistics literature) is a subfield of machine learning and, more generally, AI". The core tenet of active learning is that giving a machine learning algorithm some control over the data it uses for training allows it to improve its performance while using a smaller sample of labelled training examples. Active learning is well-motivated in many contemporary machine learning tasks since unlabeled data may be plentiful, but labels are time-consuming and costly to acquire. Currently, the quantity of data saved in databases is expanding rapidly. These databases conceal information for performance enhancement. Classification is a data mining and knowledge management approach used to group together comparable data elements. There are a variety of categorisation algorithms described in the literature, but the decision tree is the most often used due to its simplicity of implementation and intuitiveness. Some questions arise from this area: how a decision tree helps to improve performance? How should firms adopt decision trees to enhance HRM performance?

Human-robot interaction (HRI) is concerned with the planning, analysing, and assessing of robotic systems in which people and robots exchange information and perform tasks together. Research may deliberate on comprehending the nexus of Human-robot interaction and HRM performance. Research may also concentrate on How HRI theory can be applied to practice? Emerging cloud computing has become the most popular trend in only a few short years. The phrase cloud computing is one of the most ambiguous in the history of

technology. One reason is that cloud computing may be employed in a variety of applications, and the other is that many organisations use cloud computing as a marketing tool. Research may include distillate on understanding: e.g., how computing technology assists managers in recruitment and selection? How do cloud computing facilities in marinating the personal records of employees?

Conclusion

The role of AI in promoting and facilitating HRM functions has been progressively acknowledged. Most of the explorations on the evolution of AI and HRM take the traditional literature review, which is inadequate to provide a comprehensive overview of the research domain. Thus, the present science mapping study visually presents an exhaustive and extensive overview and the AI and HRM domain evolution. Furthermore, in this study, dominant countries, influential articles, authors, journals, thematic evolution of the research domain, important research clusters, influential keywords, and conceptual structure were identified and presented. In the countries analysis, this study finds that the USA, UK, China and India are the most influential and productive academic nations in AI and HRM. To identify the research theme clusters and the evolution of topics, thematic evolution analysis and cluster analysis are performed; a thematic map and timeline view are presented. The thematic analysis result shows that research frontiers are "cloud computing", "decision support system", "information management", "automation", "digital storage", "big data", "machine learning", etc. Importantly, ten research clusters were identified: "multi-agent system", "decision support system", "internet of things", "active learning", "decision tree", "optimisation", "software design", "data mining", "cloud computing", "human-robot interaction". The present study findings could be helpful for researchers in AI and HRM to extend their knowledge and understanding of AI and HRM research.

Limitations and suggestions for further research

While this research contributes to the HRM literature by shedding light on how AI technologies have developed in HRM, it has certain limitations that should be pointed out. First, there isn't any guarantee that keywords won't introduce prejudice. Additional investigation may use additional keywords to examine other ideas connected to emerging technology. Second, the bibliometric study relies on previously published and referred-to research. The authors are cognizant of the fact that they did not highlight any particularly "hot issues" in

technology as promising avenues for further study. Finally, other research methods, such as correspondence analysis, might be combined to create even more significant knowledge.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

References

Abdeldayem, M. M., & Aldulaimi, S. H. (2020). Trends and opportunities of artificial intelligence in human resource management: Aspirations for public sector in Bahrain. *International Journal of Scientific and Technology Research*, *9*(1), 3867-3871.

Abraham, R., Schneider, J., & Vom Brocke, J. (2019). Data governance: A conceptual framework, structured review, and research agenda. Inter*national Journal of Information Management*, *49*, 424-438.

Ancarani, A., Di Mauro, C., Legenvre, H., & Cardella, M. S. (2019). Internet of things adoption: a typology of projects. *International Journal of Operations & Production Management*, *40* (6), 849-872.

Arslan, A., Cooper, C., Khan, Z., Golgeci, I., & Ali, I. (2021). Artificial intelligence and human workers interaction at team level: a conceptual assessment of the challenges and potential HRM strategies. *International Journal of Manpower*.

Baker, S. R., Farrokhnia, R. A., Meyer, S., Pagel, M., & Yannelis, C. (2020). How does household spending respond to an epidemic? Consumption during the 2020 COVID-19 pandemic. *The Review of Asset Pricing Studies*, *10*(4), 834-862.Bastian, M., Heymann, S., & Jacomy, M. (2009, March). Gephi: an open source software for exploring and manipulating networks. In *Proceedings of the international AAAI conference on web and social media, 3*(1), 361-362.

Bastian, M., Heymann, S., & Jacomy, M. (2009, March). Gephi: an open source software for exploring and manipulating networks. In *Proceedings of the international AAAI conference on web and social media, 3*(1), 361-362.

Berhil, S., Benlahmar, H., & Labani, N. (2020). A review paper on artificial intelligence at the service of human resources management. *Indonesian Journal of Electrical Engineering and Computer Science*, *18*(1), 32-40.

Bondarouk, T., & Brewster, C. (2016). Conceptualising the future of HRM and technology research. *The International Journal of Human Resource Management*, *27*(21), 2652-2671.

Bondarouk, T., Harms, R., & Lepak, D. (2017). Does e-HRM lead to better HRM service?. *The International Journal of Human Resource Management*, *28*(9), 1332-1362

Broadus, R. N. (1987). Toward a definition of "bibliometrics". Scientometrics, *12*(5-6), 373-379.

Caputo, F., Cillo, V., Candelo, E., & Liu, Y. (2019). Innovating through digital revolution: The role of soft skills and Big Data in increasing firm performance. *Management Decision*, *57*(8), 2032-2051.

De Mauro, A., Greco, M., Grimaldi, M., & Ritala, P. (2018). Human resources for Big Data professions: A systematic classification of job roles and required skill sets. *Information Processing & Management*, *54*(5), 807-817.

Donthu, N., Kumar, S., Pattnaik, D., & Lim, W. M. (2021). A bibliometric retrospection of marketing from the lens of psychology: Insights from Psychology & Marketing. *Psychology & Marketing*, *38*(5), 834-865.

Ghosh, S., & Rajan, J. (2019). The business case for SDGs: an analysis of inclusive business models in emerging economies. Internati*onal Journal of Sustainable Development & World Ecology*, *26*(4), 344-353.

Góes, A. S. D. O., & De Oliveira, R. C. L. (2020). A process for human resource performance evaluation using computational intelligence: an approach using a combination of rule-based classifiers and supervised learning algorithms. *IEEE Access*, *8*, 39403-39419.

Hjrland, B. (2013). Theories of knowledge organization: theories of knowledge. *Knowledge Organization*, *40*(3), 169-198.

Hmoud, B. I., & Várallyai, L. (2020). Artificial intelligence in human resources information systems: Investigating its trust and adoption determinants. *International Journal of Engineering and Management Sciences*, *5*(1), 749-765.

Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organisational decision making. *Business Horizons*, *61*(4), 577-586.

Johnson, R. D., Stone, D. L., & Lukaszewski, K. M. (2020). The benefits of eHRM and AI for talent acquisition. *Journal of Tourism Futures 7*(1), 40-52.

Kamaruddin, N., Rahman, A. W. A., & Lawi, R. A. M. (2019). Jobseeker-industry matching system using automated keyword selection and visualisation approach. *Indonesian Journal of Electrical Engineering and Computer Science, 13*(3), 1124-1129.

Kaushal, N., Kaurav, R. P. S., Sivathanu, B., & Kaushik, N. (2021). Artificial intelligence and HRM: identifying future research Agenda using systematic literature review and bibliometric analysis. *Management Review Quarterly*, 1-39.

Kong, H., Yuan, Y., Baruch, Y., Bu, N., Jiang, X., & Wang, K. (2021). Influences of artificial intelligence (AI) awareness on career competency and job burnout. *International Journal of Contemporary Hospitality Management*, *33*(2), 717-734.

Kshetri, N. (2021). Evolving uses of artificial intelligence in human resource management in emerging economies in the global South: some preliminary evidence. *Management Research Review*, *44*(7), 970-990.

La Torre, D., Colapinto, C., Durosini, I., & Triberti, S. (2021). Team formation for human-artificial intelligence collaboration in the workplace: a goal programming model to foster organizational change. *IEEE Transactions on Engineering management*.

Li, C., Wu, K., & Wu, J. (2017). A bibliometric analysis of research on haze during 2000–2016. *Environmental Science and Pollution Research*, *24*(32), 24733-24742.

Long, E., Chen, J., Wu, X., Liu, Z., Wang, L., Jiang, J., & Liu, Y. (2020). Artificial intelligence manages congenital cataract with individualized prediction and telehealth computing. *NPJ digital medicine*, *3*(1), 1-10.

Maduravoyal, C. (2018). Artificial intelligence in human resource management. *International Journal of Pure and Applied Mathematics*, *119*(17), 1891-1895.

Malik, N., Tripathi, S. N., Kar, A. K., & Gupta, S. (2021). Impact of artificial intelligence on employees working in industry 4.0 led organizations. *International Journal of Manpower*, *43*(2), 334-354.

McCain, K. W. (1990). Mapping authors in intellectual space: A technical overview. *Journal of the American Society for Information Science* (1986-1998), *41*(6), 433.

Michie, S., Thomas, J., Johnston, M., Mac Aonghusa, P., Shawe-Taylor, J., Kelly, M. P., & West, R. (2017). The Human Behaviour-Change Project: harnessing the power of artificial intelligence and machine learning for evidence synthesis and interpretation. *Implementation Science*, *12*(1), 1-12.

Nawaz, N. (2019). Exploring artificial intelligence applications in human resource management. *Journal of Management Information and Decision Sciences*, *23*(5), 552-563.

Oswald, F. L., Behrend, T. S., Putka, D. J., & Sinar, E. (2020). Big data in industrial-organisational psychology and human resource management: Forward progress for organisational research and practice. *Annual Review of Organizational Psychology and Organizational Behavior*, *7*, 505-533.

Pan, Y., Froese, F., Liu, N., Hu, Y., & Ye, M. (2022). The adoption of artificial intelligence in employee recruitment: The influence of contextual factors. *The International Journal of Human Resource Management*, *33*(6), 1125-1147.

Parry, E., & Tyson, S. (2011). Desired goals and actual outcomes of e-HRM. *Human resource management journal*, *21*(3), 335-354.

Pasadeos, Y., Phelps, J., & Kim, B. H. (1998). Disciplinary impact of advertising scholars: Temporal comparisons of influential authors, works and research networks. *Journal of Advertising*, *27*(4), 53-70.

Pham, Q. C., Madhavan, R., Righetti, L., Smart, W., & Chatila, R. (2018). The impact of robotics and automation on working conditions and employment. *IEEE Robotics & Automation Magazine*, *25*(2), 126-128.

Pillai, R., & Sivathanu, B. (2020). Adoption of artificial intelligence (AI) for talent acquisition in IT/ITeS organizations. *Benchmarking: An International Journal*, *27*(9), 2599-2629.

Qamar, Y., Agrawal, R. K., Samad, T. A., & Jabbour, C. J. C. (2021). When technology meets people: the interplay of artificial intelligence and human resource management. *Journal of Enterprise Information Management*, *35*(5), 1339-1370.

Rossetto, D. E., Bernardes, R. C., Borini, F. M., & Gattaz, C. C. (2018). Structure and evolution of innovation research in the last 60 years: Review and future trends in the field of business through the citations and co-citations analysis. *Scientometrics*, *115*(3), 1329-1363.

Sahota, N., & Ashley, M. (2019). When robots replace human managers: Introducing the quantifiable workplace. *IEEE Engineering Management Review*, *47*(3), 21-23.

Sánchez-Medina, A. J., Galván-Sánchez, I., & Fernández-Monroy, M. (2020). Applying artificial intelligence to explore sexual cyberbullying behaviour. *Heliyon*, *6*(1), e03218.

Settles, B. (2009). Active learning literature survey.

Shi, J., Duan, K., Wu, G., Zhang, R., & Feng, X. (2020). Comprehensive metrological and content analysis of the public–private partnerships (PPPs) research field: A new bibliometric journey. *Scientometrics*, *124*(3), 2145-2184.

Strich, F., Mayer, A. S., & Fiedler, M. (2021). What do I do in a world of Artificial Intelligence? Investigating the impact of substitutive decision-making AI systems on employees' professional role identity. *Journal of the Association for Information Systems*, *22*(2), 9.

Strohmeier, S., & Piazza, F. (2015). Artificial intelligence techniques in human resource management—a conceptual exploration. In *Intelligent techniques in engineering management,* Springer, pp. 149-172.

Tambe, P., Cappelli, P., & Yakubovich, V. (2019). Artificial intelligence in human resources management: Challenges and a path forward. *California Management Review*, *61*(4), 15-42.

Tatham, P., Spens, K., & Kovács, G. (2017). The humanitarian common logistic operating picture: a solution to the inter-agency coordination challenge. *Disasters*, *41*(1), 77-100.

Thomas, M. S., Forrester, N. A., & Ronald, A. (2016). Multiscale modeling of gene–behavior associations in an artificial neural network model of cognitive development. *Cognitive Science*, *40*(1), 51-99.

Van Eck, N. J., & Waltman, L. (2007). VOS: A new method for visualising similarities between objects. In *Advances in data analysis* (pp. 299-306). Springer, Berlin, Heidelberg.

Van Nunen, K., Li, J., Reniers, G., & Ponnet, K. (2018). Bibliometric analysis of safety culture research. *Safety Science*, *108*, 248-258.

Vinichenko, M. V., Melnichuk, A. V., & Karácsony, P. (2020). Technologies of improving the university efficiency by using artificial intelligence: Motivational aspect. *Entrepreneurship and sustainability issues*, *7*(4), 2696.

Votto, A. M., Valecha, R., Najafirad, P., & Rao, H. R. (2021). Artificial Intelligence in Tactical Human Resource Management: A Systematic Literature Review. International Journal of Information Management Data Insights, *1*(2), 100047.

Vrontis, D., Christofi, M., Pereira, V., Tarba, S., Makrides, A., & Trichina, E. (2021). Artificial intelligence, robotics, advanced technologies and human resource management: a systematic review. *The International Journal of Human Resource Management*, *1*(1)-30.

White, H. D., & Griffith, B. C. (1981). Author cocitation: A literature measure of intellectual structure. *Journal of the American Society for information Science*, *32*(3), 163-171.

White, H. D., & McCain, K. W. (1998). Visualizing a discipline: An author co-citation analysis of information science, 1972–1995. *Journal of the American society for information science*, *49*(4), 327-355.

Yeh, P., Yeh, N., Lee, C. H., & Ding, T. J. (2017). Applications of LEDs in optical sensors and chemical sensing device for detection of biochemicals, heavy metals, and environmental nutrients. *Renewable and Sustainable Energy Reviews*, *75*, 461-468.

Yu, D., & Xu, C. (2017). Mapping research on carbon emissions trading: a co-citation analysis. *Renewable and Sustainable Energy Reviews*, *74*, 1314-1322.

Zhou, S., Tao, Z., Zhu, Y., & Tao, L. (2019). Mapping theme trends and recognising hot spots in postmenopausal osteoporosis research: a bibliometric analysis. *PeerJ*, *7*, e8145.