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Role of Big Data in Human Resource Management: A Review and Bibliometric Analysis

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Abstract: During the last decades, big data has been recognized as a salient enabler of human resource management performance. Although increasing academic attention on big data in human resource management has been generated, there is still a void in this research domain. Due to the increasing academic interest in big data in HRM, a thorough bibliometric analysis of the structure and development of this research topic is required. Correspondingly, classic narrative literature evaluations provide substantial contributions, notwithstanding inadequate to give an exhaustive overview of a particular research area. Consequently, scientific mapping, which garners bibliometric techniques to structure and develop a specific area graphically, is gaining salience. Thereby, the overriding aim of this research is to examine Scopus publications related to big data and human resource management. Bibliometric analysis was performed to explore the growing trends, global distribution, thematic evolution, influential articles, researchers, keywords, and dominating countries in big data and HRM. The cluster analysis results highlight the most important topics for current and future academics in the fields of HRM and AI. Emerged clusters include Cluster1: adoption of HR analytics; Cluster2: decision support systems; Cluster 3: dynamic capabilities; Cluster4: digital innovation; Cluster5: organizational ambidexterity; Cluster6: internet of things; Cluster 7: cloud computing. The result is intended to show academics and practitioners a state-of-the-art and comprehensive view of the diverse and multidimensional phenomena of big data and HRM research.

Keywords: *Big Data, Human Resource Management, Bibliometric Analysis*

Introduction

It is widely recognized that disruptive technologies in Human Resource Management (HRM) are a notable catalyst for positive change throughout the entire HRM sector (Priyashantha et al., 2022). In an era where digitization permeates society and business at a breakneck speed, big data is one of the most notable issues confronting enterprises (Scholz, 2017; Rowley, 2020; Labrinidis and Jagadish, 2012). Li (2021) posits that big data has significantly impacted our lives, and it could be employed strategically in businesses to play a substantial part in development. Big data is known as the "fourth paradigm of science" or the "next management revolution" (Strawn, 2012). Big data is a firm's capacity, encompassing data collection (Gunasekaran et al., 2017), access, analysis, and application (Wan and

Liu, 2021), for organisations and people with production, competition, and innovation (Tien, 2013). Firms use big data to develop new technologies and reinforce their competitive edge, which helps unleash new capabilities and values for their success (Ying et al., 2020; Ghasemaghaei and Calic, 2020). Consequently, developing big data has become a valiant effort for firms to evoke their business operations, increase productivity and gain market opportunities (Ghasemaghaei and Calic, 2020; Wan and Liu, 2021; Scholz, 2017). However, researchers argue that the value of big data depends on its successful integration with other company resources, such as Human Resources (HR) (Zang and Ye, 2015; Zhang et al., 2021; Garcia-Arroyo and Osca, 2021; Wan and Liu, 2021).

Within this context, the resource-based-view (RBV) theory claims that HR is critical in reaping sustained competitive advantage (Kraaijenbrink et al., 2010; Wernerfelt, 1984; Barney, 2021; Freeman et al., 2021). In this vein, big data has been shown to be highly obliged to firms with a premium on human capital (Garcia-Arroyo and Osca, 2019; Buhl et al., 2013). While big data is a critical resource, studies have shown that inadequate integration of HRM methods makes it impossible for businesses to improve their performance (Reibenspiess et al., 2020; Zhang et al., 2021; Nocker and Sena, 2019).

HRM is vastly confronted with massive amounts of complex data (Dahlbom et al., 2019; Garcia-Arroyo and Osca, 2019). Researchers have begun investigating big data's role in HRM (Garcia-Arroyo and Osca, 2019; Scholz, 2017; Zhang et al., 2021; Nocker and Sena, 2019; Li, 2021). Unsurprisingly, HRM research is undergoing a paradigm shift from small data to the approaching era of big data (Reibenspiess et al., 2020). As this tendency continues, HRM research will be shaped by a thorough re-examination and expansion of primary research methods and findings (Shah et al., 2017). Notwithstanding, inadequate big data-based methodologies obstruct the growth of HRM research and practices. While academicians have recognised the value of bringing a big data slant to HRM research, clear advice on connecting the two remains unclear (Zhang et al., 2021; Reibenspiess et al., 2020). HR managers should have a data-driven mindset possess sharp insight capability in talent deployment, foresight awareness in strategy creation, commit themselves to everyday managerial roles, and implement creative and innovative ideas (Ghasemaghaei and Calic, 2020; Nocker and Sena, 2019; Dahlbom et al., 2019; Garcia-Arroyo and Osca, 2019; Noack, 2019; Zhang et al., 2021; Zang and Ye, 2015; Marler and Boudreau, 2017). Erb (2016) postulates that big data and analytics provide unique data-driven HR decision-making and management tactics. By implementing a realistic lens, integrating big data can replenish the current mainstream approach, allowing HRM scholars to bring back human elements and enabling HRM researchers to gain a wide-ranging understanding of the employees' nature and businesses from a broader humanised perspective (Zhang et al., 2021).

Inadequate big data-based methodologies hamper HRM research and practices. Although academics have recognised the relevance of adopting a big data strategy to HRM research, it is unclear how to merge the two (Zhang et al., 2021). Although academic output in big data has increased significantly, some authors argue that big data research is still in its infancy and fragmented (Frizzo-Barker et al., 2016), and questions regarding its use and potential remain (Wenzel & Van Quaquebeke, 2018). As a result, a detailed analysis of this subject is necessary to produce insights into this rising and critical problem. Nevertheless, there continue to be some issues and hurdles; as shown by the following: (1), there is finite research on the link between big data and HRM (Zang and Ye, 2015; Marler and Boudreau, 2017); (2) lack of knowledge and research findings on who to integrate big data and HRM (Zhang et al., 2021; Wan and Liu, 2021); (3) the research standpoint requires to be widened (Zang and Ye, 2015; Garcia-Arroyo and Osca, 2021). Given that big data is a relatively new concept in HRM literature, a comprehensive review of how big data has hitherto been used in HRM practices and how they have contributed to organisational performance will shed light on how it could be used effectively to (Zang and Ye, 2015; Marler and Boudreau, 2017).

Besides, recent academic interest in these issues prompted the author to perform a systematic literature review using bibliometric analysis; this approach is more appropriate to this study than a meta-analysis (Borenstein et al., 2009). Bibliometric is the quantitative analysis of scientific publications, citations, and journals (Pritchard, 1969), provides a retrospective investigation of the research field's structure, development, and current academic activity patterns (Rousseau, 2001). Bibliometric research has aided strategic decision-making (Sachini et al., 2020) and helped discover the relationships between scientific progress and policy changes (Prado et al., 2016; Borgman and Furner, 2002), and are valuable for systematically examining big datasets, inferring trends across time, identifying research topics, and detecting alterations in disciplinary boundaries. Given that big data is a relatively new concept in HRM literature, a comprehensive review of how big data has hitherto been used in HRM practices and how they have contributed to organizational performance will shed light on how it could be used effectively to (Zang and Ye, 2015; Marler and Boudreau, 2017).

Therefore, the underlying aim of this article is to shed some light on exploring the growing trends, global distribution, the thematic evolution of the research field, most influential research articles, influential researchers, influential keywords, and dominating countries in big data and HRM. Furthermore, it also aims to assess how far the line of research on the link between big data and HRM has progressed. The study begins with a bibliometric study based on the big data research paradigm to scientifically visualize and track the nature of current big data and HRM literature. As a result of this, it aims to explore the evolution of the literature concerning

big data and HRM with the underneath research questions:

(RQ1) What is the thematic evolution in the domain of big data and HRM?

(RQ2) What are the key topic words, dominating countries, the total number of articles, evolving trends, and worldwide distribution in big data and HRM?

(RQ3) What is the conceptual structure of the domain of big data and HRM?

(RQ4) What are the influential authors in the big data and HRM field?

The remainder of this article is organised as follows. Section 2 describes the procedures of the surveying methodology for analytical assessment, and Section 3 provides a thorough analysis, investigation, and discussion of the chosen articles on big data and HRM. Future research directions and suggestions are presented in Section 5, while the conclusion is presented in Section 6.

Methodology

Methods

The overriding aim of this study seeks to advance our understanding of HRM and big data. To improve a specific research domain, it is vitally important for researchers to synthesise past research findings. By tradition, researchers have deployed two generic methods to synthesise earlier findings: the qualitative approach of a structured literature review and the quantitative meta-analysis approach. According to Zupic and Čater (2015), the third method of science mapping is grounded on the quantitative approach of bibliometric research methods. It is being growingly deployed to map the structure and growth of scientific domains and fields. Science mapping employs bibliometric methods to assess how disciplines, fields, specialities, and individual papers are linked (Ellegaard and Wallin, 2015). Bibliometrics is a branch of study that use mathematical and statistical approaches to examine publication trends in the spread of knowledge (Donthu et al., 2021; Carvalho et al., 2020). There are two fundamental uses of the bibliometric method: performance analysis and science mapping; performance analysis aims to assess researchers' and institutions' research and publication effectiveness. Science mapping seeks to unveil the dynamics and structure of scientific domains (Cobo et al., 2011). It also permits the identification of the most productive authors and institutions and the presentation of the "grand picture" of a specific study field (Aria and Cuccurullo, 2017). The two primary methodologies for examining a research area in bibliometrics are performance analysis and scientific mapping. Although the first technique is focused on analysing the output and effect of publications, science mapping attempts to exhibit the conceptual, social, and intellectual structure of scientific research and its development and dynamical characteristics (Gutiérrez-Salcedo et al., 2018).

Therefore, bibliometric analysis was performed to explore the research trends, influential keywords, and patterns. Bibliometric methods employ a quantitative approach for describing, evaluating, and monitoring published research. These methods will likely

establish a systematic, transparent and reproducible review process and enhance the review's quality.

Database

Scopus is gaining popularity as a salient database that provides high-quality data for bibliometric explorations. The research was carried out between 2013 and 2022. This study was primarily conducted in the Scopus database, the most reputed database used by scholars internationally. Scopus is the most extensive database of abstracts and citations for peer-reviewed literature covering various topics. Malanski et al., 2021 claim that "an investigation based on the Scopus database could bring a valuable contribution by enriching the previous findings." The study explored the volume, evolving trend, worldwide distribution, influential journals, influential researchers, and dominating nations. Therefore, the initial search was limited to articles that contained "big data" and human resource management" in the title, the keywords, or the abstract. The author tried to consider all possible patterns of words that examined the topic. After the continuous evaluation process, the author categorised research articles, eliminating those grouped under irrelevant classifications such as medicine and computer science and limited to the business management subject area. Later, the remaining articles were carefully evaluated to choose the articles that reflect the research topic (reading each article's abstract, introduction, and conclusion). The articles downloaded were published up to 2022. The author focused on all publications as a vital contribution to research in this domain. Eventually, once the dataset had been produced, the study employed several software packages to explore the stated objectives.

Measurement Tool

Bibliometric mapping is a crucial research topic in bibliometrics (Ellegaard and Wallin, 2015). VOSviewer creates maps of authors or journals based on co-citation data and maps of keywords based on co-occurrence data. The application includes a viewer that enables a detailed examination of bibliometric maps (Van Eck and Waltman, 2010). For analysis, VOS (visualisation of similarity) was used to create maps. VOS viewer makes and displays maps that exploit relevant mapping techniques. Thus, this program could display maps using VOS mapping mechanisms and establishes maps using multidimensional scaling. VOSviewer builds on many hardware and operating system platforms.

Additionally, the bibliometrix R package was installed and loaded through R Studio. The biblioshiny application was then launched by typing biblioshiny () in the R console. This bibliometric study was conducted using biblioshiny: The shiny app for bibliometrix from R Statistical Package (https://bibliometrix.org/Biblioshiny.html). It contains several capabilities that facilitate in-depth bibliometric examination. It is a web-based interface for the bibliometrix utility (https://bibliometrix.org/Biblioshiny.html).

Data Extraction Process

In this study, authors followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Moher et al., 2009) to ensure the quality of the search and selection process of the studies included in the review, detailing how studies were identified, screened, evaluated for eligibility, and included. PRISMA technique has been widely employed in bibliometric studies. The period selected is from 2013 to 2022 to give last year's papers time to be cited. Table 1 shows the exclusively designed research protocol used in this study. The initial investigation led to the identification of 524 documents. These articles were then reviewed to determine the final selection. This approach was followed to exclude items that did not pertain to the subject under investigation (247 duplicated documents were removed). In the screening process stage, irrelevant documents were removed based on the exclusively designed inclusion criteria. The eligibility criteria for choosing the documents were: (a) big data and HRM were the prime focus, (b) articles published only in the English language, (c) literature reviews and empirical studies, and (d) articles published between 2013 and 2022. After this operation, 41 papers remained in the final review database (see Figure 1). The chosen papers were then downloaded as plain text with information on publication year, authors, title, abstract, journal, references, and citation count (see figure 1).

Table 1: Synopsis of Research Protocol

	Description
Search words	Big data and human resource management
Search database	Scopus
Search fields	Titles, abstracts, and keywords
Search items	TITLE-ABS-KEY ("big data and human resource management")
Subject areas	Big data and HRM
Timespan	Up to 2022
Language	English
Software for bibliometric analysis	Biblioshiny and VOSviewer

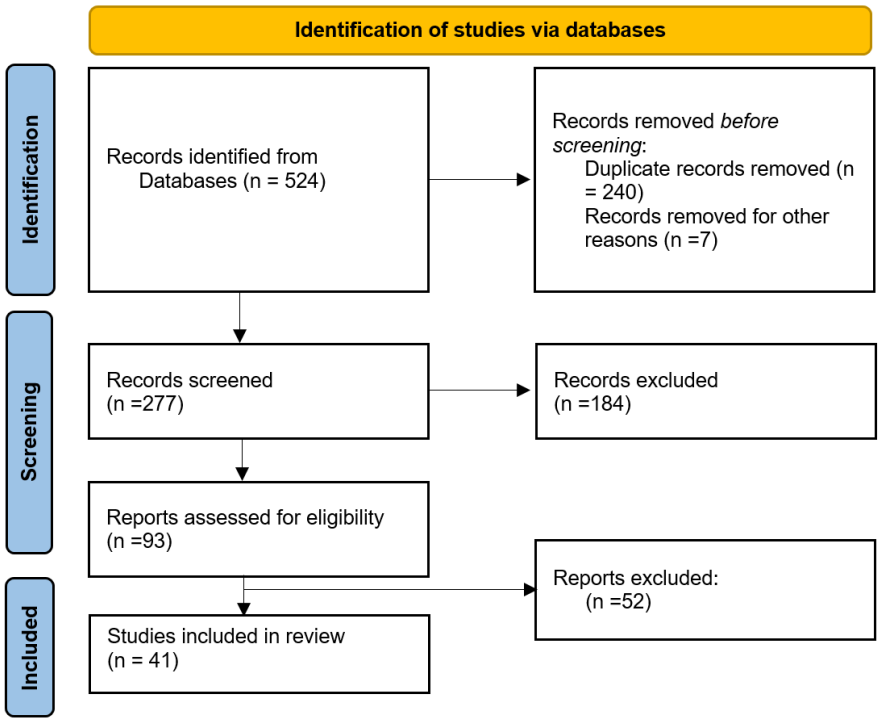

Figure 1: Process of Choosing Articles

Results and Quantitative Analysis

This section outlines a descriptive analysis of the retrieved data. The retrieved data were analysed using the Biblioshiny program to see an overview of the data set. After reviewing all the documents, the Scopus database search returned a total of 41 publications published in 33 journals by 108 authors from 28 different countries. The average number of publications per year is 2, and the average number of citations per document is 27.24. However, the average number of citations per year per document is 7.83. Concerning keywords, a total of 255 keywords plus 172 authors' keywords were discovered. The number of articles per document is about 2.63; the collaboration index is 2.86. This information is shown in Table 2.

Table 2: Synopsis of the Data

Description	Results
Main Information About Data	
Timespan	2013:2022
Sources	33
Documents	41
Average years from publication	2
Average citations per document	27.24
Average citations per year per doc	7.83
References	2423
Document Types	
Article	41
Document Contents	
Keywords Plus (ID)	255
Author's Keywords (DE)	172
Authors	
Authors	108
Author Appearances	111
Authors of single-authored documents	5
Authors of multi-authored documents	103
Authors Collaboration	
Single-authored documents	5
Documents per Author	0.38
Authors per Document	2.63
Co-Authors per Documents	2.71
Collaboration Index	2.86

Annual Scientific Production

According to the selected 41 articles, this study drew the graph of annual publication number, global citations, and growth rule of big data and HRM (see Figure 1). Published research articles on big data and HRM have risen over time. However, from 2013 to 2015, the annual publication number of big data and HRM was fluctuating, with an average annual publication number of only 2. In 2021, the total reached 13. In just eight years, the quantity of publications on big data and HRM topics has increased significantly. 2016 (4 articles) marks a turning point, and 2021 stands out as the year with the highest number of articles produced (13 articles). According to the number of citations, articles published in 2019 have received the most citations, followed by those published in 2020. Notwithstanding, it can be observed that there is a decline in the 2020 and 2021 spans. Figure 2 below illustrates its growth.

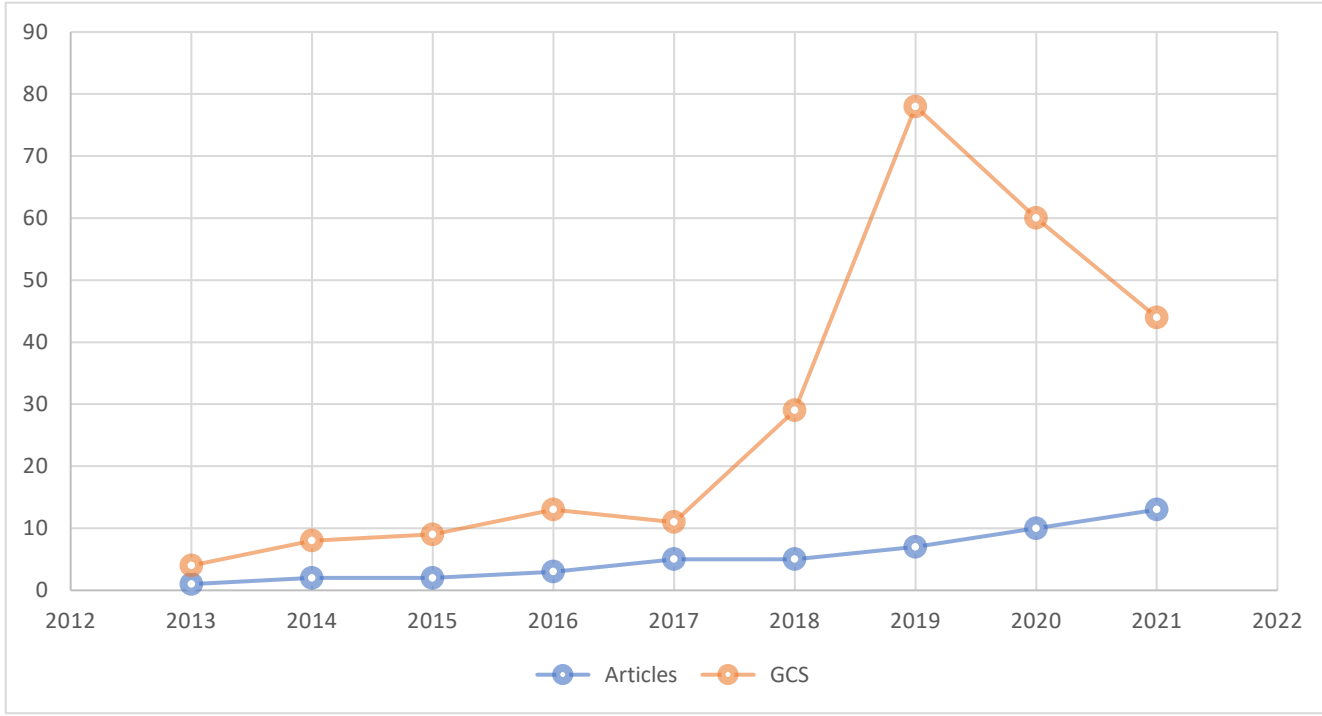

Figure 2: Evolution of articles and the number of global citations (2013–2022)

Thematic Evolution of Big Data and HRM Domain

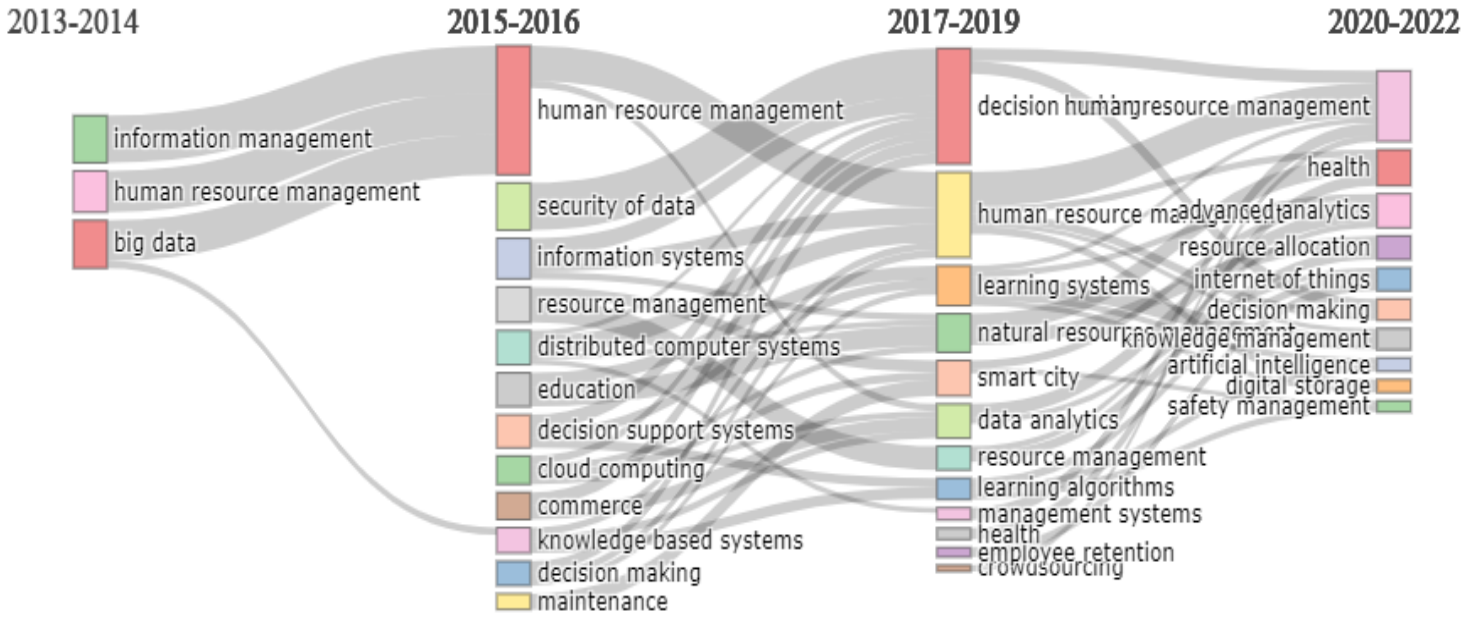

Figure 3: Thematic evolution of the big data and HRM literature

Themes deployed in articles are the object of research that continues to evolve, specifically when comparing newly released articles to those published for a long time. Further, topic trends are also included in this study, where figure 3 indicates the evolution of the topic and concepts from time to time with the category per year. Hence it shows what topics have been studied for a long time and what topics have been used in recent times.

The analysis was conducted for four-time spans: 2013–2014; 2015–2016; 2017–2019; 2020–2022. In general, the number of linkages between topics rises with time. Specific themes have persistently grown, while others have gained prominence and emerged in the last sub-period. In the early stage (2013- 2014) of big data and HRM exploration, research was chiefly focused on three subdomains: big data, information management and HRM.

In the second period (2015-2016), some of the themes that appeared throughout this period were significantly grown from the previously used themes and had a link to their content; for instance, new topics emerged like "cloud computing", "knowledge-based systems", "distributed computer systems", "security of data", "resource management", "decision making", "education", and "commerce". In the subsequent period (2017-2019), different sub-domains appeared, such as "learning systems", "smart cities", "natural resources", "management systems", "crowdsourcing", "employee retention", "learning algorithms", and "data analytics". The present research (2020-2022) includes ten themes listed with different sizes depending on the quantity of use of the theme, such as "safety management", "digital storage", "artificial intelligence", "the Internet of things", "advanced analytics", "HRM", "health", "knowledge management", and "decision making".

In the subsequent stage of the study, a comprehensive examination of the growth of the thematic maps was performed by separating the themes into four forms of clusters: motor, basic, niche, emerging, and declining (Figure 4). As evidenced by the findings of the analysis:

- Three key topics were identified in the nine papers on big data and HRM published between 2013 and 2014: "big data and information management" belong to the motor theme, and "HRM" belongs to the basic theme.
- During the 2015-2016 period, 12 themes were found in the 14 articles on big data and HRM. The result indicates that 5 of them belong to the motor theme: (1) knowledge-based systems, (2) information systems, (3) distributed, (4) computer systems, and (5) decision-making cloud computing. Furthermore, four sub-areas were designated as the emerging or declining themes, and they were represented by topics such as (1) resource management, (2) maintenance, (3) security of data, and (4) education. HRM is identified as the basic theme.

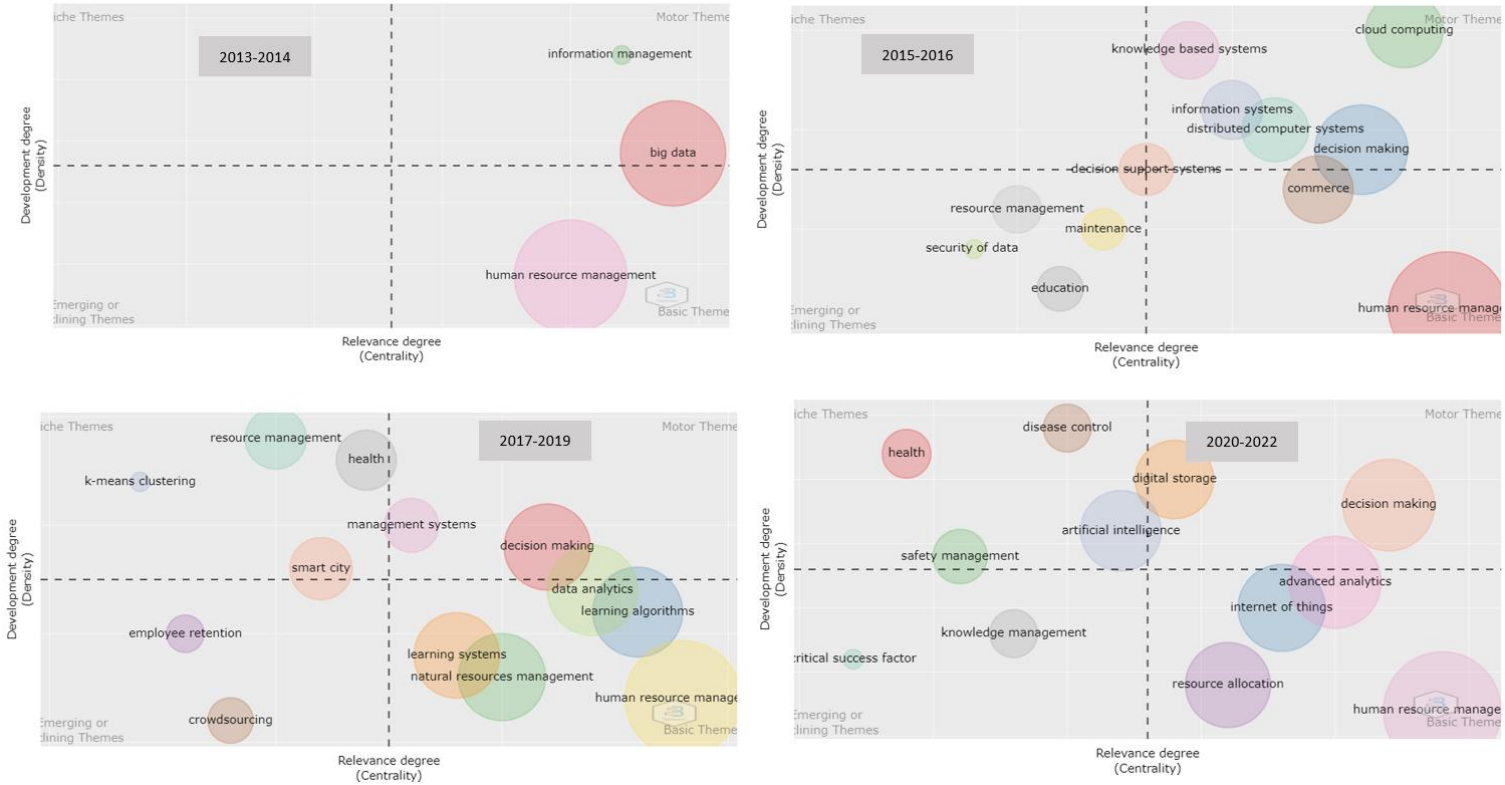

Figure 4: Thematic maps of the big data and HRM literature

- In the 2017-2019 period, thirteen themes were identified in the 21 big data and HRM publications published in those years. Further, (1) resource management, (2) smart city (3) health fall under niche themes. The following were indicated as the motor themes: (1) management systems and (2) decision making. The five basic themes in those years were: (1) data analytics, (2) learning algorithms, (3) learning systems, (4) HRM (5) natural resources management. Additionally, employee retention and crowdsourcing were identified as emerging or declining themes.
- During the 2020-2022 span, 12 themes were found from 18 research articles. Importantly, niche themes consist of four themes: (1) health, (2) disease control, (3) artificial intelligence (4) safety management. Knowledge management and critical success factor belong to the emerging or declining themes. In the basic theme, four themes were found: (1) advanced analytics, (2) internet of things, (3) resource allocation (4) HRM Digital storage and decision-making were the themes that belong to the motor theme.

Table 3: Most Global Cited Documents

Authors	Article	Total Citations	TC per Year	Normalised TC
El-Kassar A-N, 2019	Green innovation and organizational performance: The influence of big data and the moderating role of management commitment and HR practices	258	64.5	4.4637
De Mauro A, 2018	Human resources for Big Data professions: A systematic classification of job roles and required skill sets	111	22.2	3.6755
Hamilton Rh, 2020	The questions we ask: Opportunities and challenges for using big data analytics to strategically manage human capital resources	44	14.667	6.7692
Calvard Ts, 2018	Developing human resource data risk management in the age of big data	22	4.4	0.7285
Wang L, 2018	Beyond Moneyball to social capital inside	17	3.4	0.5629

Authors	Article	Total Citations	TC per Year	Normalised TC
	and out: The value of differentiated workforce experience ties to performance			
Nocker M, 2019	Big Data and Human Resources Management: The Rise of Talent Analytics	16	4	0.2768
Martin-Rios C, 2017	Teaching HRM in contemporary hospitality management: a case study drawing on HR analytics and big data analysis	15	2.5	1
Garcia-Arroyo J, 2021	Big data contributions to human resource management: a systematic review	14	7	4.5
Zehir C, 2020	The Transformation of Human Resource Management and Its Impact on Overall Business Performance: Big Data Analytics and AI Technologies in Strategic HRM	11	3.667	1.6923
Dahlbom P, 2020	Big data and HR analytics in the digital era	10	3.333	1.5385
Verma S, 2020	Do big data-driven HR practices improve HR service quality and innovation competency of SMEs	8	2.667	1.2308
Rodríguez-Sánchez J-L, 2019	The Opportunity Presented by Technological Innovation to Attract Valuable Human Resources	7	1.75	0.1211
Shet Sv, 2021	Examining the determinants of successful adoption of data analytics in human resource management – A framework for implications	5	2.5	1.6071
Nair K, 2019	Overcoming today's digital talent gap in organizations worldwide	4	1	0.0692
Manad O, 2019	Enhancing Talent Search by Integrating	4	1	0.0692

Authors	Article	Total Citations	TC per Year	Normalised TC
	and Querying Big HR Data			
Karwehl Lj, 2021	Traditional and new ways in competence management: Application of HR analytics in competence management	3	1.5	0.9643
Yuan S, 2021	Building prediction models with grouped data: A case study on the prediction of turnover intention	3	1.5	0.9643
Hung-Yi T, 2021	Research on the Application of Big Data in Enterprise Human Resource Management	2	1	0.6429

Table 4: Top 10 corresponding authors' countries of big data and HRM research

Country	Articles	SCP	MCP	MCP_Ratio
China	10	2	0	0
Germany	7	2	0	0
Italy	6	1	1	0.5
Spain	5	2	0	0
Denmark	4	0	1	1
Finland	3	1	0	0
India	2	0	1	1
Iran	2	1	0	0
Ireland	1	0	1	1
Netherlands	1	1	0	0

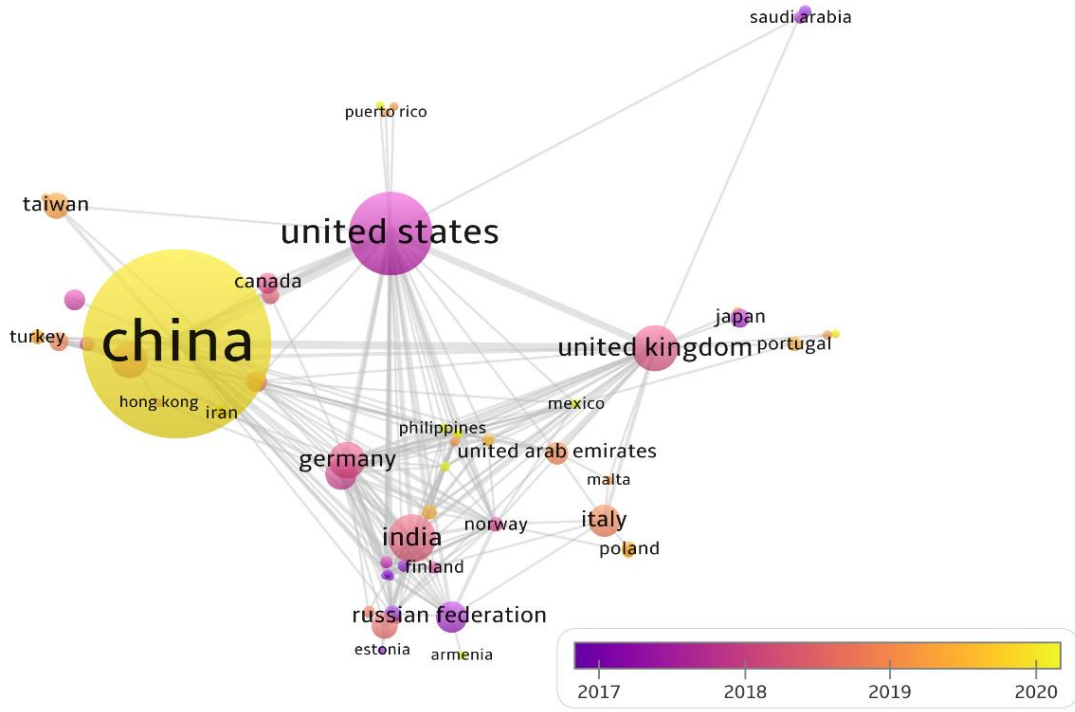

Figure 5: Country collaboration network

Further, the study of the specifics of the big data and HRM research at the county level, Table 4 presents the top 10 countries of corresponding authors, and Figure 5 depicts the significant nations publishing big data and HRM articles and their collaboration links. Table 4 demonstrates that China, Germany, Italy, and Spain are the top nations in terms of corresponding authors, suggesting their dominance in the big data and HRM research domain. The country's MCP-Ratios are less than 50%, which indicates that the transactional collaboration between counties is inadequate to some degree. Further, VOSviewer identified four dominant county clusters in the collaboration network (Figure 5). Cluster 1 comprises five countries, including China, Taiwan, Turkey, Hong Kong, and Iran. Cluster 2 comprises two counties comprising the USA, Canada, and Saudi Arabia. Cluster 3 encompasses the UK, Portugal, and Japan. Cluster 4 includes Germany, India, Russia, Poland, Norway, etc. In cluster 1, the strongest collaboration occurs between China and Taiwan (frequency: 36), followed by China and Turkey (frequency: 29). The strongest cooperation relationship in cluster 2 befalls between the USA and Canada (frequency: 31). Accordingly, in cluster 3, the strongest cooperation relationship was found between the UK and Japan (frequency: 31), followed by UK and Portugal (frequency: 24). In cluster 4, the strongest collaboration was found between India and Germany (frequency: 27).

Multidimensional Scaling Analysis

This study employed the conceptual structure-function of Bibliometrics to create the conceptual structure map. This function principally performs a multidimensional scaling analysis of keywords to illustrate the conceptual structure of the research field. Multidimensional scaling analysis is an exploratory analysis technique that exhibits the connection among multi-constructs in the two-dimensional space and facilitates exploring the spatial distribution of topics. In this data, the region is separated into two halves, the red section and the blue section; each section includes terms connected to the other. According to the illustration below, the red region has an increasing number of diverse terms; this indicates that several research publications link the words mentioned in this area. Each word is placed according to Dim 1 and Dim 2 to produce a mapping between terms whose values do not differ much.

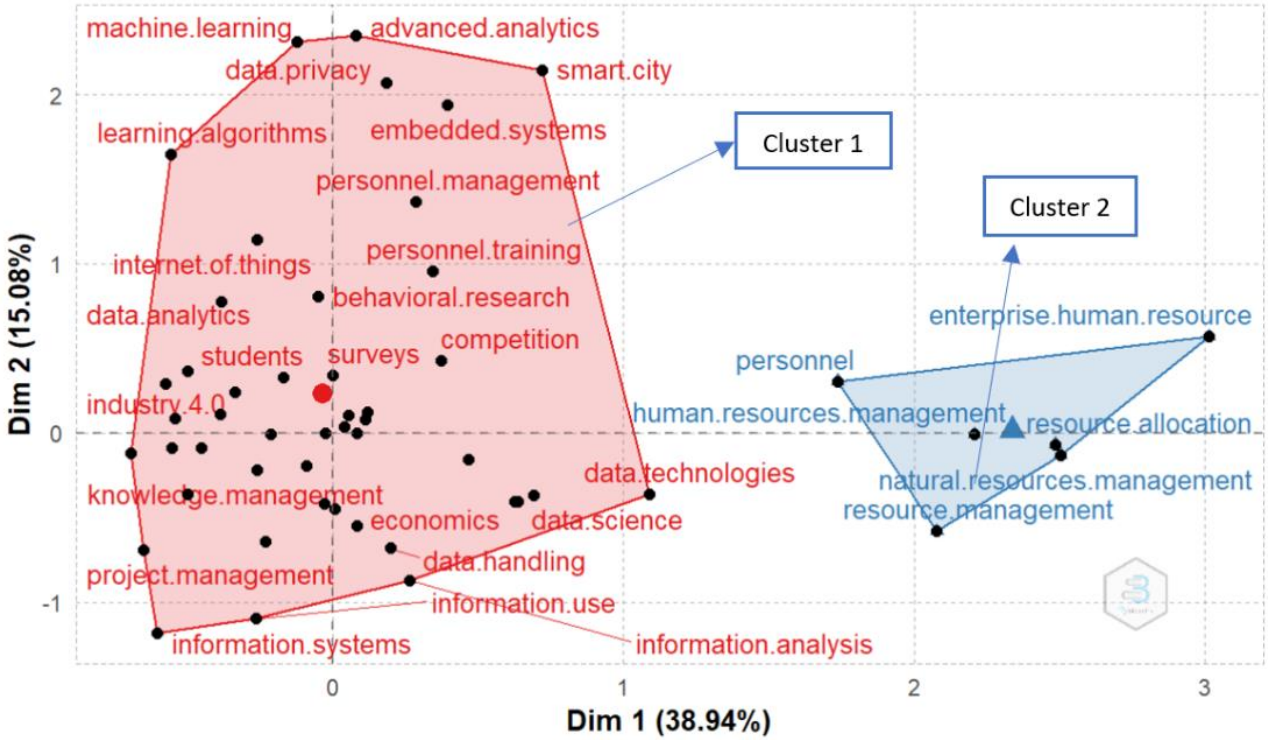

Figure 6: Conceptual structure map of the big data and HRM research field

This paper aims to uncover links and patterns that emerge from studies on the impact of big data on human resource management. This verification is accomplished via correspondence analysis (CA), which uses dimensionality reduction methods to create a conceptual structure map of the field and group similar ideas (Figure 6). According to figure 6, Bibliometrix automatically produces two keyword clusters. Cluster 1 (red) is composed of twenty-four keywords such as "Machine learning", "smart city", "data privacy", "advanced analytics", "learning algorithms", "embedded systems", "personnel management", "personnel training", "Internet of things", "behavioural research", "competition", "surveys", "data analytics", "industry 4.0", "knowledge management", "project management", "data handling", "information systems" and "information use".

In this cluster, "internet of things", "data analytics", and "machine learning" are severely studied, and the "embedded systems", "knowledge management", "data technologies" are the hot topics. In order to provide further data from this cluster, relevant articles from this cluster are additionally explored.

Sestino et al. (2020) investigated the role of the Internet of Things (IoT) and Big Data in the digital transformation management of enterprises. The study contends that the proliferation of IoT and Big Data has led to a plethora of unorganised knowledge. The findings indicate that IoT and Big Data are mostly reengineering elements for corporate processes, goods, and services; nevertheless, a lack of general adoption and expertise has caused research to proceed along different, inconsistent routes. Five major clusters of HR practice systems have been identified by (Garcia-Arroyo and Osca, 2021), with the greatest concentration of papers in the clusters of data, learning and knowledge and strategy, efficiency, and performance, indicating a pattern in the studies that can be explained by the nature and characteristics of big data. The primary trend in big data publications is the connection between big data and information management, learning, and knowledge. Several studies emphasise the advantages of BD for knowledge management and decision-making (Roberts, 2013; Smith Jr, 2018). Concerning knowledge management, Giacumo and Breman (2016) analysed in a systematic literature review how BD and analytics were being used in institutionally based formal workplace learning, talent-development efforts, and training departments. According to the research, there was limited evidence of BD analytic approaches in workplace training and performance improvement programs, although BD and analytics might enhance training interventions. Several studies (Hausknecht & Li, 2015; Tippins et al., 2021; Landers & Schmidt, 2016; Morrison & Abraham, 2015) show the use of BD in staff selection and explain how the different properties of BD impact this process. The volume, pace, and diversity of data broaden and diversify the possible talent pool from which future workers might be pulled, lowering the costs associated with talent selection considerably.

Cluster 2 (blue) contains six items that mainly focus on resource management research. It comprises themes such as "resource allocation", "resource management", "human resource management", and "enterprise human resource management".

In business growth, BD has been used extensively in enterprise human resource (HR) management. Human resource management is the enterprise's main impetus, necessitating the ongoing enhancement of the management level. To improve the efficacy and quality of corporate operations and management, businesses must enhance the use of information system BD in human resources. Human resource management is the focus and linchpin of enterprise management, which plays a crucial role in the sustainable growth of businesses and the enhancement of economic returns. Numerous applications of BD exist in business HR management, and its viability is primarily indicated. Initially, the HR management department of an organisation creates a vast quantity of materials and data, such as personnel files, training records, compensation, performance evaluation, etc. Second, BD can give an enterprise HR management talent pool in the age of networks and multimedia.

Countries

Researchers from 24 nations (n=24) have published at least one article on big data and HRM research (see figure 7). Using Biblioshiny analysis, figure 6 shows the number of documents per country. As shown in figure 6, big data and HRM are dominated by China, which has a higher number of records (18), Germany- (10), the USA (9), India (8), Australia (6), Brazil (5), Canada (5), Italy (5), Finland (4), Switzerland (4), UK (4), Iran (3), Pakistan (3), Poland (3), Argentina (2), Chile (2), France (2), Lebanon (2), Malaysia (2), Spain (2). The top three countries were identified. The county with the highest number of publications in China, Germany, and the USA is third. Further, the result showed that 11 countries had published more than three articles, eight countries have published at least two articles, and five countries have published one article implying that there is still much room for big data and HRM research in these countries. Regarding the highest number of citations received by countries in the Scopus database, India stands out in first place (TC:279, AAC:93.000), followed by Malaysia (TC:139, AAC:139.000), followed by China (TC:116, AAC: 9.667), followed by USA (TC:71, AAC:17.750), followed by Italy (TC:29, AAC:14.500), Canada (TC:16, AAC:16.000), Switzerland (TC:14, AAC:14.000). Note (TC: total citation, AAC: average article citation).

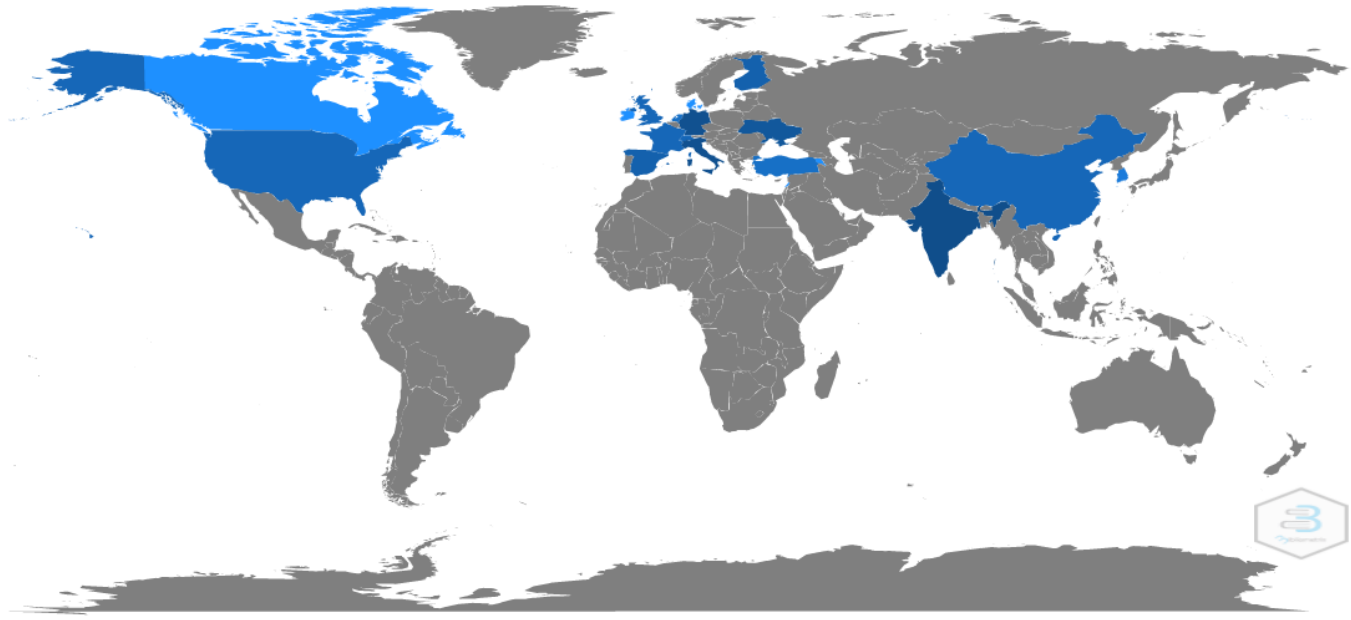

Figure 7: Country Scientific Production

Co-word Analysis

The researchers' self-assessment of how ideas and research are categorized and connected in this context is aided by keywords. This identifies which of these concepts have not received adequate analysis. The keywords deployed by the researchers imply the subject of articles and may indicate the trend of research in the area (Strozzi et al., 2017). According to Small (1973), Co-word analysis is akin to co-citation or co-occurrence analysis. It has been regarded as a practical mapping of the links between concepts, ideas, and issues. Co-word analysis has been used to highlight research developments in several domains. In co-word analysis, it is thought that keywords retrieved from articles indicate a particular research direction or research issue. If two keywords co-occur in the same article, the two study subjects they symbolise are connected. Higher co-word frequency indicates a better association between keyword pairs, indicating that two keywords are associated with a specific research topic (Cambrosio et al., 1993). Co-word analysis can discover patterns and trends in a particular research domain.

Thus, using multivariate statistics and social network analysis, co-word analysis was performed to identify big data and HRM's intellectual structure and development trends. Figure 8 and 9 indicates the co-occurrence map of the VOS Viewer. It shows the most frequently used keywords in the articles and their relationship. This enables the identification of the most compelling themes researchers have addressed. Moreover, the strength of the links connecting the nodes reflects the strength of the relationship among the keywords indicated in the sample (Simao et al., 2021).

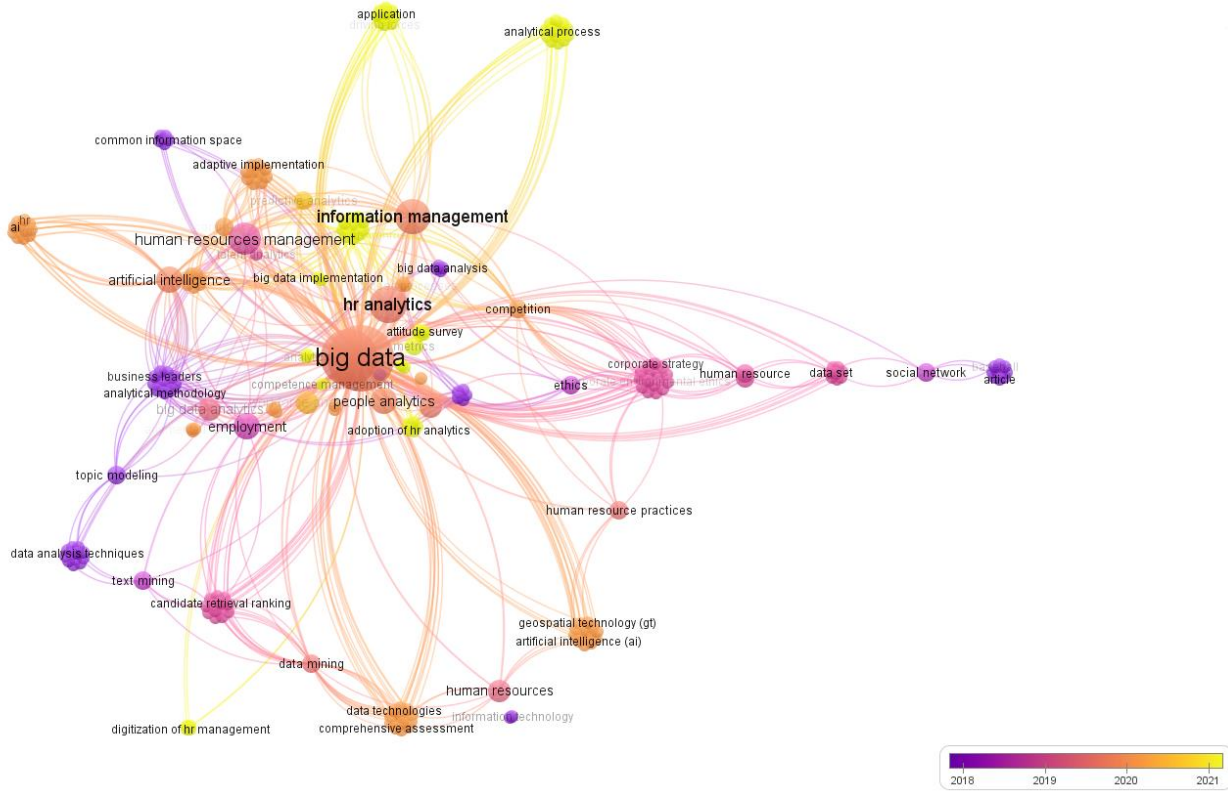

Figure 8: Co-occurrence of Keywords

The size of the nodes is proportional to the number of occurrences of a specified keyword in the big data and HRM literature. A bigger circle in the network indicates that the authors chose the term more often. The width of the lines illustrating co-occurrences of keywords in publications corresponds to the frequency of these co-occurrences (the larger the width, the greater the number). The colors show which word clusters each word belongs to. In this article, several influential keywords were identified using VOSviewer. The keywords are "information management", "HR analytics", "artificial intelligence", "adaptive implementation", "digitization of HR management", "data mining", "big data analytics", and "common information space". As directed by the analysis results (figure 8), the words pigeonholed by the highest total link strength were: "big data", "HR analytics", "information management", "HRM", and "artificial intelligence".

Figure 9 depicts the maturity or growth of each cluster, differentiating the time period from 2006 to 2022 during which they were researched. Therefore, the blue and green clusters are mostly related to the era 2016–2018, while the light green and yellow clusters include terms primarily associated with 2020–2022 and other more recent phrases. This analysis enables the comprehension of the significance of keywords depending on their emergence period since the pioneering keywords are more significant and serve as a reference for the more recent ones. As seen (figure 9), many central nodes represent the primary keywords or topics that influence this area (e.g., big data, information management, big data analytics, HR analytics). However, according to the findings, it should be noted that certain subjects are still in their infancy and garner more significant attention, although their node is not huge; this also symbolizes the niche region (Figure 9). The development of the research on the topic has led to an increase in the number of contributions in relation to big data in HRM. Accordingly, there is an evolution in terminology can be observed by the lines of research such as those that are linked, among others, "information technology", "big data analysis", "HR analytics", "artificial intelligence", "ambidexterity", "talent management", "change management".

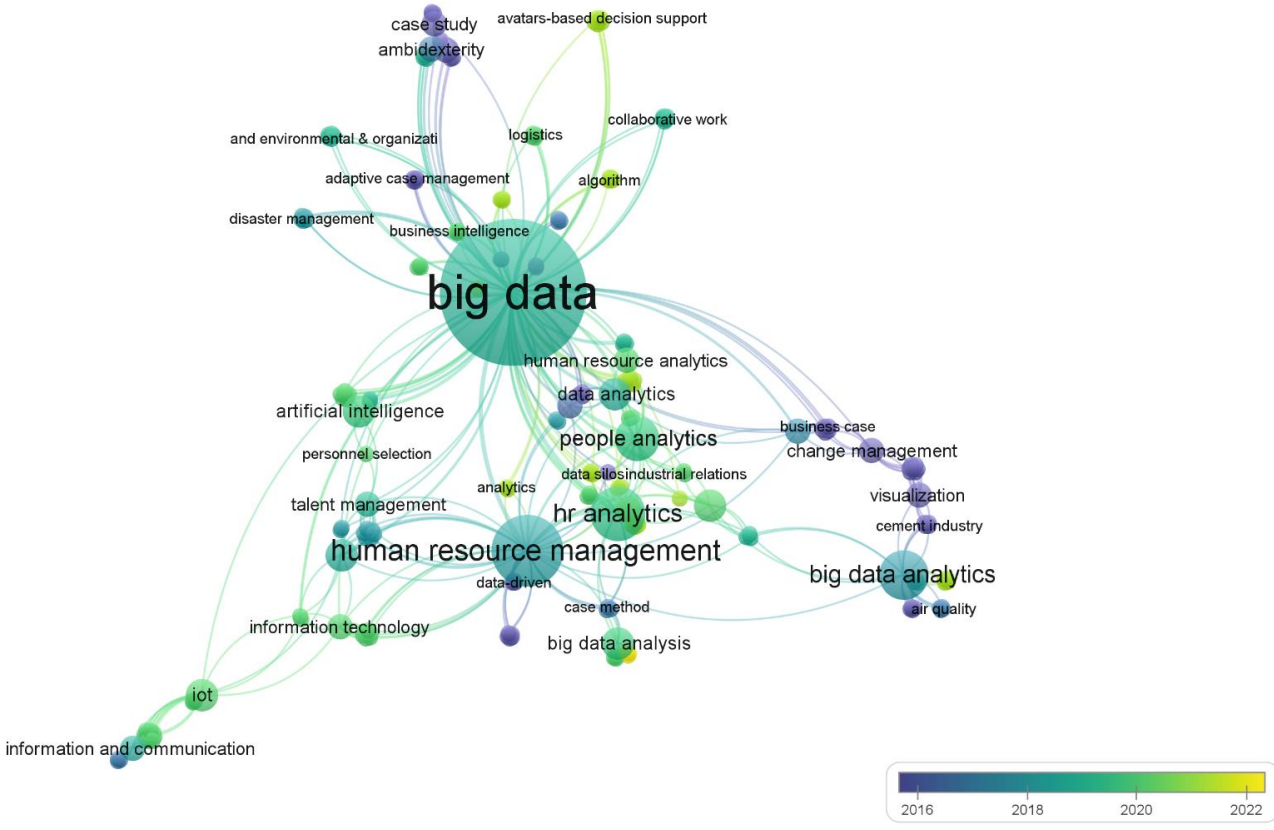

Figure 9: Evolution of Keywords Network

Table 5: Most Frequent Keywords

Words	Occurrences	Words	Occurrences
Human Resource Management	448	Data Analytics	45
Big Data	369	Internet Of Things	42
Information Management	230	Personnel Training	41
Artificial Intelligence	55	Data Handling	40
Decision Making	55	Digital Storage	38
Data Mining	52	Data Technologies	35
Resource Allocation	50	Information Use	28
Natural Resources Management	49	Machine Learning	24
Advanced Analytics	45	Knowledge Management	23

The Scopus database has found that the system generated several most compelling keywords in the big data and HRM domain. Table 5 shows several keywords and the number of occurrences in their specific domain. Accordingly, the keywords such as HRM have occurred (448) times. Similarly, big data (369), information management (230), artificial intelligence (55), decision making (55), data mining (52), Internet of things (42), personnel training (41), data handling (40), digital storage (38), data technologies (35) have frequently used influential keywords in the domain of big data and HRM (see table 5).

Using Biblioshiny analysis, the most influential journals are identified. Table 6 depicts the ten most prolific and prominent journals in big data and HRM. Table 6 displays the journals with five or more publications and those with over 40 citations. According to table 6, the Journal of Business Research (3 articles), Technological Forecasting and Social Change (3 articles), Human Resource Management Review (2 articles), International Journal of Information Management (2 articles), Journal of Cleaner Production (2 articles) have the highest number of publications in the field of big data and HRM. In conclusion, the findings indicate that research on big data and HRM has been progressively published in more journals.

Table 6: Dominant Journals

Sources	Articles
Journal Of Business Research	5
Technological Forecasting and Social Change	5
Human Resource Management Review	5
International Journal of Information Management	5
Journal Of Cleaner Production	5
Baltic Journal of Management	3
Business Horizons	3
Chinese Management Studies	2
Critical Perspectives on International Business	1
Development And Learning in Organizations	1

Source: Scopus Database

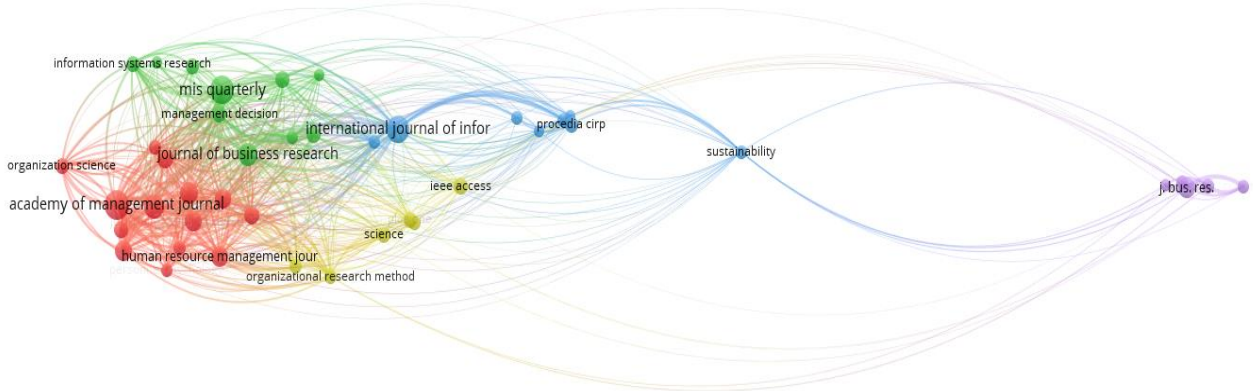

Figure 10: Co-citation Network of Sources

The Co-citation network of sources results shows the most prominent journals regarding co-citations. The node of the network reflects the journal, and the node's size indicates the journal's influence. These journals are vital sources of research and identify a possible target journal for future article publications on the subject. The lines connecting the nodes indicate the degree to which articles are co-cited. When two authors or two sources appear in the reference list of a single publication, this is referred to as co-citation (Tunger and Eulerich, 2018). According to Small (1973), Co-citation is more dynamic and, hence, better reflects developments in knowledge. Figure 11 shows the *red cluster* – academy of management journal, organisation science, human resource management journal, journal of business research, international journal of human resource management, and journal of organisational effectiveness. *Green cluster*- information system research, journal of management decision, human resource management review, international journal of production economics, journal of global information management. *Blue cluster*- sustainability, international journal of information, international journal of enterprise information systems, journal of management information and decision sciences, journal of business research.

Analysis of the Influential Articles

Bibliographic coupling analysis was performed to study the network of co-cited references using VOSviewer. It shows the most compelling research articles with the highest number of citations. The large nodes indicate the most cited articles in big data and HRM. The lines indicate publications that cite one another. The strength of a relationship is determined by the number of co-cited references in the two articles (see figure 12). Thus, bibliographic coupling enables the establishment of publications that are thematically most comparable. Additionally, it permits the identification of the structural elements of a publication devoted to a comparable subject.

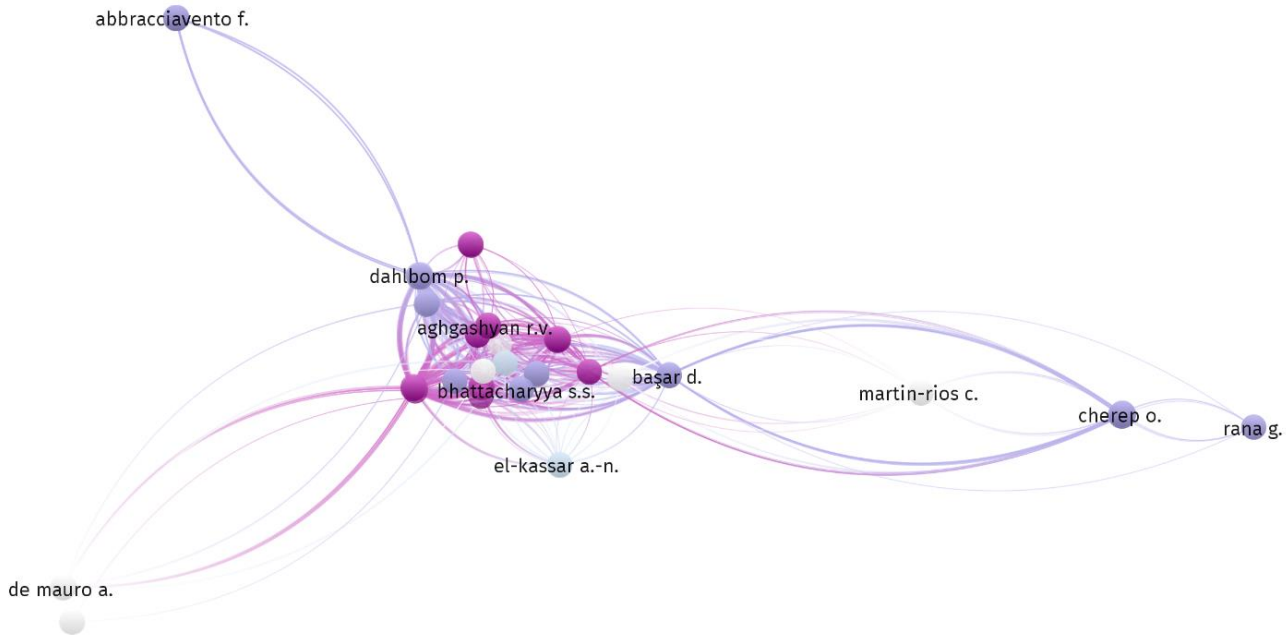

Figure 11: Bibliographic coupling network of documents

The most cited article was found that are summered.

The first, most cited article was by El-Kassar and Singh (2019). This article explores the impact of green innovation and organisational performance and the impact of big data, and the moderating role of management commitment and HR practices. Further, this study proposes and validates a holistic model that represents and investigates the linkages between green innovation, its drivers, and variables that impact the firm's performance and competitive advantage in overcoming technical hurdles. Notably, while there is a large amount of study in this field, more research needs to be undertaken on corporate environmental ethics, stakeholders' views of green goods, and demand for green products as catalysts of green innovation. In addition, the significance of large-scale data, management commitment, and human resource practices in overcoming technical obstacles, achieving a competitive edge, and enhancing economic and environmental performance has still to be explored. The second article was by Oswald et al. (2020). This article offers a standpoint and framework for big data relevant to industrial-organisational psychology and HRM. Eventually, they are sure that industrial-organisational psychology (IOP) and HRM academics and practitioners contribute to the content, technologies, algorithms, and communities that address big data, AI, and machine learning challenges and applications in companies related to their expertise will increase their value.

The third article by Dahlbom et al. (2020). This article focuses on how the HR function utilises human resource analytics (HRA), including big data (BD), and discusses constraints that inhibit HRA and data usage. In addition, the authors explore the ramifications of the HRA-induced alteration of the human resource (HR) function's role. The findings show that the implementation of advanced HRA is hindered by technological and human constraints, including very basic HR procedures, old information systems, and low data quality. This, along with a lack of skills in analytics and business understanding, the inability to go beyond reporting, misperceptions regarding BD, and a traditional compliance-focused HR culture, creates further problems for the HR function's data analytics capacity and business partner role.

Senior executives anticipate no substantial gains in HRA, although HR experts recognised potential usefulness in BD, albeit with widespread scepticism. The findings indicate a need for improved collaboration between data analysts and HR professionals to supply and comprehend HR-related data for business decisions. The fourth article by Garcia- Garcia-Arroyo and Osca (2021) with 25 citations. Big Data has evolved into a dramatic resource for businesses. Publications on Big data have increased dramatically, yet scientific research is sparse. Thus, this study provides a comprehensive systematic review of big data and HRM. The current study seeks to systematise the academic contributions to date and explain the originality of BD, its implications and difficulties for HRM practice, and the HR practice systems that have made the most

significant contributions. Five significant clusters of HR practice systems have been identified, with the greatest concentration of papers in the clusters of "information, learning, and knowledge and strategy, efficiency, and performance, indicating a trend in the studies that the nature and characteristics of BD can explain." Fifth article by Verma et al. (2020). They claim that big data (BD) has recently been seen as a necessary investment for businesses to maintain competitiveness. SMEs' human resource (HR) departments have been sluggish in implementing this innovation. Based on the organisational learning theory (OLT), this research proposes that BD might enhance HR operations, particularly for small and medium-sized enterprises (SMEs), thus giving them a competitive advantage. Sixth article by Zhang et al. (2021). The dearth of big data-based methodologies hampers HRM research and practices. Although academics have recognised the significance of adopting a big data strategy for HRM research, it is unclear how to connect the two. Based on this systematic review, they put forth a generic theoretical framework defined as "Inductive (Prediction paradigm: Data mining/Theory building) vs Deductive (Explanation paradigm: Theory testing)."

Huselid and Minbaeva (2019) argue that the emergence of Big Data may have considerable and beneficial effects on the area of HRM, given that executives and analysts maintain a focus on data for decision-making and workforce plan implementation. In fact, a focus on the workforce (as opposed to the HR function) is crucial to the efficient use of Big Data in enterprises. This represents the trend of both academics and practitioners to transfer their attention from the activities of the HR function (an activity with relatively little value contributed) to assessing the output of the workforce (an activity with considerably more potential).

Big data absorb growing attention in the business and management literature (Holwerda, 2021). While this curiosity has extended into the field of HRM, strong proof of its favourable performance effects is insufficient. Lucidly, the literature shows that the sample-driven small data strategy continues to rule the contemporary HRM studies, notwithstanding the advent of a big data approach that has not been adequately integrated into the existing HRM study paradigm (Zhang et al., 2021; Garcia-Arroyo and Osca, 2021). During the paradigm transition from small to big data research, HRM research confronts significant concerns and obstacles (Zhang et al., 2021), such as methodological (Tonidandel et al., 2018); technological-related problems (Angrave et al., 2016). Regarding the methodological issue, how to get HR big data in the workplace and utilise it to investigate academic HRM topics (Zhang et al., 2021). The paradigm shift from big data comprises more competitive data resources and instantaneous strategic decision-making using the technology to handle a substantial amount of data (Tonidandel et al., 2018). Successful firms employ networking sites, analytics, and even cognitive technologies to attract talent in novel ways.

When the whole firm digitises its data, HRM installs digitised workplaces and workforces (Angrave et al., 2016). HRM researchers are inexperienced with data science analytic technologies; consequently, they must acquire new computing experience to handle big data analytical platforms (Douthitt and Mondore, 2014). Holwerda (2021) found three central vacuums in big data and HRM literature (i.e., "HR possesses big data but doesn't know how to use it," "HR does not possess big data," "Big data generates value in HR, but nobody is talking,". Therefore, adopting a big data strategy has become more critical in addressing these challenges in the present era. More specifically, Zhang et al. (2021) claim that the significant research voids in big data HRM research provide future research opportunities that require special attention and should be directed toward further investigations. According to RBV and the theory of decision-making (Intezari & Gressel, 2017), vast amounts of data could enable HR professionals to make more informed and efficient strategic decisions concerning personnel, which might be a competitive advantage. However, despite the potential advantages of big data in making strategic choices about people management, its application may be difficult for businesses (Angrave et al., 2016) because technological development, skills, and expertise might be a barrier to adoption. Before they can effectively utilise big data as a strategic tool to influence business choices, HR professionals who use big data need advanced training and comprehension, as well as organisational support (Smith Jr, 2018).

Research Frontiers

Seven compelling research clusters were found in the big data and HRM domain (figure 12). Cluster (1) adoption of HR analytics: Cluster (2) decision support systems: Cluster (3) dynamic capabilities: Cluster (4) digital innovation: Cluster (5) organisational ambidexterity: Cluster (6) internet of things: Cluster (7) cloud computing. Further, the *adoption of HR analytics* includes several key terms, such as human enterprise resource, enterprise resource management, management innovation, performance appraisal, performance management, quality control, ubiquitous computing, and teaching management. *Decision support systems* include such key terms as big data applications, cyber-physical systems, data communication systems, embedded systems, and enterprise resource advanced analytics. *Dynamic capabilities* include organisational learning, organisational performance, people analytics, talent management, workforce analytics planning, and management capabilities. *Digital innovation* encompasses real-time systems, digital transformation, data-driven decisions, and artificial intelligence technologies. *Organizational ambidexterity* contains risk management, safety engineering, team management, HRM systems, and research and development (R&D). The *Internet of things* provides data communication systems, ecosystems, and embedded systems. *Cloud computing* includes 5g mobile communication systems, advanced traffic management systems, automation, blockchain, and business intelligence.

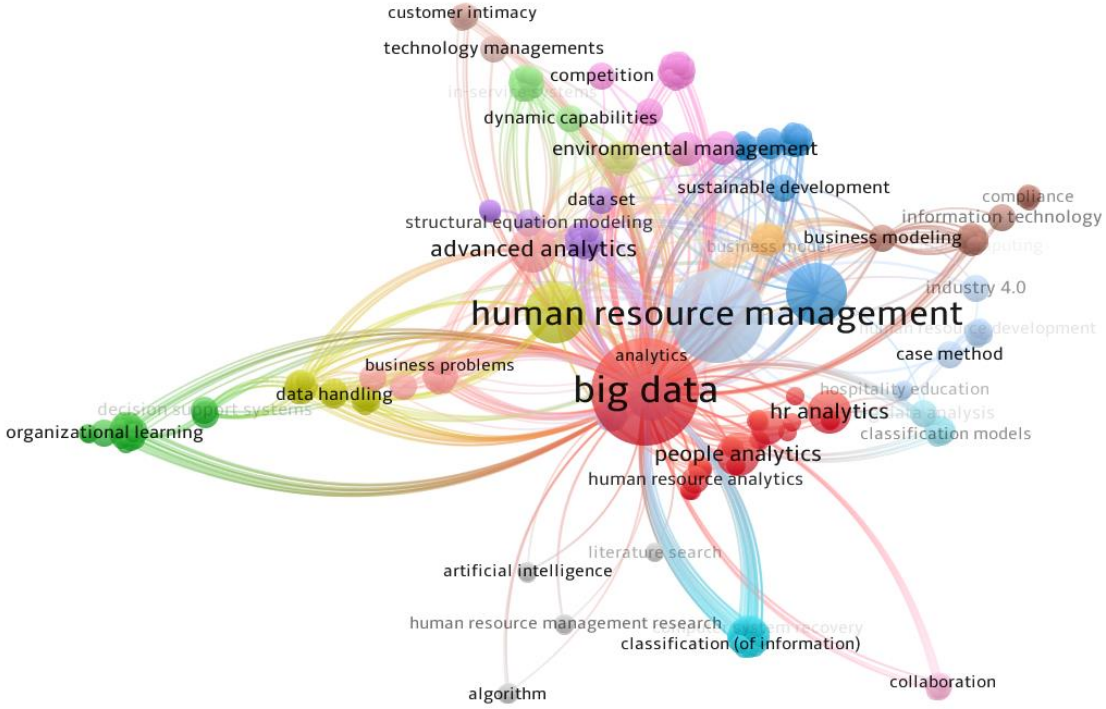

Figure 12: Clusters in Big Data and HRM

Discussion

In recent years, Big Data has evolved as a new paradigm giving plentiful data and the potential to enhance and allow research and decision-support applications with unparalleled value for digital earth applications such as commerce, sciences, and engineering. Big Data creates issues for digital earth storing, transporting, processing, mining and serving the data. To researchers' knowledge and understanding, the present study represents a unique addition to the existing body of literature on artificial intelligence and human resource management. Applying a notion will not result in genuine output until its performance is thoroughly evaluated. Technology is synonymous with change, and change is never stable. It is essential to investigate, comprehend, and debate the current state of artificial intelligence and its potential future applications concerning human resource management. This research examined the literature on the link between big data and HRM using bibliometric techniques. The findings give insight into the conceptual structure, history, and future development of big data-related research on HRM. The number of scholarly papers on the subject is increasing rapidly. Seven compelling research clusters were found in the big data and HRM domain. Cluster (1) *adoption of HR analytics:* Cluster (2) *decision support systems*: Cluster (3) *dynamic capabilities*: Cluster (4) *digital innovation*: Cluster (5) *organisational ambidexterity*: Cluster (6) *internet of things*: Cluster (7) *cloud computing.*

Hitherto, firms' espousal of HR Analytics is "relatively very low". Big data is acknowledged as a crucial type of evidence for enhancing decision-making. It gives executives, HR professionals, and line managers the information required for workforce assistance and HR Analytics. One of the most important points is that HR analytics is linked to or can lead to better performance. It helps business and HR leaders make smart decisions about how to adopt and use HR analytics. It also helps HR researchers place their papers more clearly in current debates and encourages them to find new ways to do research based on some of the questions asked. One of the most popular tendencies among businesses that want to become more nimble is the use of decision support systems. The vast majority of businesses today have implemented decision-support systems that enable agile data, information, and analytics through service delivery. The term "dynamic capabilities" describes an organisation's capacity to set and iteratively re-configure processes to optimise results. Organisations seeking to reap the benefits of big data should use the insights provided by dynamic capabilities to recommend methods of reorganising resources to make big data efforts repeatable and sustainable. Organisations integrate talents, data, technology, and knowledge to develop goods and services that generate money or to improve operational efficiency. Ultimately, dynamic capabilities create innovative thinking inside businesses. Therefore, integrating big data with dynamic capabilities is vital for organisational

practitioners to move towards organisational performance. The study of digital innovation places digital technology at the center of the innovation management process. Digital data, computational algorithms, and evolutionary ontology are just some of the new theoretical lenses and research methodologies researchers have proposed to better understand digital innovation. Big data is an intriguing example of digital innovation since it disrupts and transforms the whole information value chain (data, information, knowledge, choices, and actions) and even academic research. The invention of big data includes not only digital technology and tools but also knowledge, skills, ideas, organisations, and other social and institutional settings.

According to research on organisational ambidexterity, strategic flexibility may emerge from an organisation's capacity to notice significant changes in its external environment, enabling it to either employ resources in response to these changes or pause and reverse existing resource commitment. The literature argues that organisational ambidexterity is difficult to establish because exploratory and exploitative operations have competing objectives, compete for the same resources, and need distinct skills. Companies with ambidexterity may use both discovery-based and application-based forms of innovation. This study's integration of the Internet of things is a fascinating contribution. Artificial intelligence is no exception to the rule that any endeavour is only worthwhile if it contributes to economic growth. This study hopes to introduce the notion of circular economy in conjunction with the Internet of Things. The circular economy is well suited to handle the uniqueness of technological sustainability, which is the talk of the town. Lastly, cloud computing offers basic assistance for addressing the issues posed by shared computing resources, such as processing, storage, networking, and analytical software; the deployment of these resources has enabled remarkable advances in Big Data.

Theoretical Contribution

Theoretically, this article addresses artificial intelligence, including who has contributed to the field, what has been researched, the advantages and disadvantages of previous work, and other topics along these lines. One other thing that sets this study apart from others is the way it identifies different clusters and themes. The cluster analysis results highlight the most important topics for current and future academics in the fields of HRM and AI. Emerged clusters include Cluster1: adoption of HR analytics; Cluster2: decision support systems; Cluster 3: dynamic capabilities; Cluster4: digital innovation; Cluster5: organisational ambidexterity; Cluster6: internet of things; Cluster 7: cloud computing.

Implications for Managers

The study's findings provide managers and policymakers with valuable insights into the role of artificial intelligence in their HRM field. First, rising technology involvements in any form (artificial intelligence, Internet of

things) are reducing the manual abilities of the population, therefore influencing the creation of jobs for manual labour. Second, managers must evaluate the issues presented in this article, such as what has transpired and what might be explored to avoid technological maladies and boost beneficial circumstances leading to sustainable growth. A thorough examination is necessary to determine if artificial intelligence makes a genuine contribution to organisations and whether this idea impedes the growth and development of intellectual capital. As its future scope, policymakers must evaluate each cluster for examination.

Conclusions and Implications

Social science empirical research is experiencing a paradigm transition from the small ancient data era to the emerging big data era. HRM research will be guided by a careful re-examination and expansion of prior research techniques and insights as this trend continues. Adopting big data has become vital in HRM research (Zhang et al., 2021). This study aims to integrate big data techniques into HRM research by thoroughly assessing existing big data HRM studies and recommending new research avenues. Based on a quantitative review that employs bibliometric analysis to visualise and map the evolution of big data HRM research, this article discusses the significance and qualities of big data research and how big data technologies can be adapted to HRM research. In addition, the study gives a taxonomy that facilitates a broader understanding of big data and its role in boosting HRM performance. Integrating various concepts within the big Data literature provides greater insights into producing value via the strategy and execution of Big Data. A considerable deal of interest in Big Data stems from HRM-related operations, where big data increasingly influences firms' performance. This encourages more studies applying a quantitative method and expanding this analysis to developing nations, which have been little explored.

Nonetheless, this study is constrained in several ways. This study, for instance, is restricted to the insights of a bibliometric study, which normally focuses on the breadth rather than the depth of knowledge on the topic. Therefore, future reviews using alternate approaches (e.g., critical and framework-based reviews) that go deeply into each key subject to reveal more nuanced insights are recommended (Paul et al., 2021). In addition, given that the current study is confined to findings from an exploratory review design, future studies seeking confirmatory research may choose to conduct a meta-analysis (Palmatier et al., 2006). This review is confined to insights gleaned from academic literature obtained from Scopus. Future studies that integrate practice insights from alternative sources, such as government white papers and industry reports, are thus recommended (Lim et al., 2022). In this study, articles published only in English were garnered. This could be a notable limitation. Future studies may be expanded to include publications produced in the languages of various emerging and developing nations.

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