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GREEN HUMAN RESOURCE MANAGEMENT IN THE MANUFACTURING SECTOR: A BIBLIOMETRIC LITERATURE REVIEW

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ABSTRACT

This study aims to examine the structure of Green Human Resource Management (GHRM) within the manufacturing industry research field and identify future research directions in this area as GHRM increasingly gains scholarly attention. This study utilised a comprehensive three-step approach. Initially, Scopus was selected as the primary database for its extensive coverage, followed by applying a targeted search strategy to gather literature on GHRM in the manufacturing sector, yielding 117 relevant articles. The analysis was twofold: a performance analysis to assess the impact and role of research elements within the field and a co-words analysis for mapping scientific relationships and trends in GHRM, using tools like VosViewer and MS Excel for visualisation. This methodology enabled a detailed exploration of the GHRM landscape, focusing on established research and emerging trends. The findings indicate a growing interest in GHRM in manufacturing since 2020, yet the total volume of publications remains relatively modest. The research identified four main clusters of focus: the integration of sustainability in business practices, the effects of environmental management behaviours on organisational performance, the role of sustainability in enhancing competitive advantage and sustainable development, and the formation of conceptual and strategic frameworks for sustainable practices. Notably, emerging research areas from 2021 to 2023 encompass digital challenges related to Big Data and digital transformation, the interplay of organisational learning and knowledge management in green management, and the influence of employee engagement on GHRM. This paper contributes to the field by mapping out the current state and evolution of GHRM within the manufacturing sector, highlighting both established and emerging areas of interest. It provides a comprehensive overview of how sustainability is integrated into business operations and impacts organisational performance and competitive advantage. The study offers some implications for practitioners in the manufacturing industry by identifying key areas of focus for implementing and enhancing GHRM practices. It underscores the importance of digital transformation, organisational learning, and employee engagement in the successful adoption of green management practices.

KEY WORDS

production, manufacturing, green HRM, environmental sustainability, sustainable development, science mapping, bibliometric analysis

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INTRODUCTION

The increasing awareness of climate change and its severe impacts on the planet, such as rising temperatures, extreme weather events, and melting ice caps, has heightened concerns about the need for

environmental sustainability, which balances economic and environmental priorities. Environmental degradation can have direct and indirect impacts on human health. As the global population continues to grow, there is a heightened awareness of the finite nature of many natural resources, including water, fossil fuels, and certain minerals. Furthermore, air

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and water pollution, exposure to harmful chemicals, and the loss of green spaces can contribute to various health issues. In this context, focusing on “green” aspects aims to ensure that natural resources are used efficiently and conserved for future generations (Morelli, 2011).

At the same time, governments and international organisations are implementing stricter environmental regulations to address pressing issues, such as climate change and pollution. This regulatory environment pushes industries to adopt more sustainable practices (Čiarnienė et al., 2020). Consumers increasingly expect businesses to adopt sustainable practices in their supply chains, manufacturing processes, and overall operations. The attitudes of top managers also play a significant role (Piowar-Sulej, Malik et al., 2023).

The concept of managing human resources in a sustainability-oriented way has emerged as modern businesses increasingly recognise the importance of sustainability in their operations, and the effective implementation of any management concept requires employee engagement. Green human resource management (GHRM) aims to develop employees’ environmental knowledge and awareness and to create a sustainability-oriented corporate culture (Piowar-Sulej, Austen et al., 2023; Ren et al., 2018; Abu-Mahfouz et al., 2023; Suharti & Sugiarto, 2020). GHRM practices are usually discussed in terms of green recruitment and selection, green performance appraisal, rewarding, training, and HR flow (Piowar-Sulej, 2021). Many research projects revealed that GHRM practices stimulate employees’ environmental behaviour (in-role, extra-role, innovative behaviour) (e.g., Dumont et al., 2017; Piowar-Sulej, Austen et al., 2023). At this point, it is worth emphasising that the literature also provided evidence about the positive impact of these practices on employee job satisfaction and retention (Wagner, 2011).

The challenge of going green is particularly visible in the manufacturing sector, historically viewed as a significant environmental threat (Panagiotopoulou et al., 2022). Although many companies consider the safeguarding of the natural environment as a primary responsibility (Piowar-Sulej, 2022) and are also more active in developing employee competencies than other businesses (Bidwell & Briscoe, 2010), there is a need to examine green issues, also in the context of HRM.

It has been noted that GHRM as a research topic has attracted more scholars in recent years (Pham et al., 2020). As researchers play a role in advancing sci-

ence by analysing and synthesising existing studies (Templier & Paré, 2015), several recent literature reviews have attempted to understand the antecedents and outcomes of GHRM practices (e.g., Ren et al., 2018; Yong et al., 2019). There is also a review integrating GHRM with green supply management (Jabbour & De Sousa Jabbour, 2016) and ISO standards (Akdeniz, 2023). In turn, Tanova and Bayighomog (2022) synthesised research on GHRM in service industries. Finally, Pham et al. (2020) analysed GHRM literature in terms of business sectors and Industry 4.0. They found that most articles focus on implementing GHRM in the manufacturing industry; however, they identified only 22 such articles in their research sample. Consequently, this research addresses the following research questions:

RQ1. What is the structure of the manufacturing sector’s GHRM research field?

RQ2. What research areas constitute promising gaps to be filled in the future?

The systematic literature review process is designed to highlight the theoretical viewpoints and key attributes found in published papers. Additionally, it seeks to outline emerging issues, identify gaps and limitations in the current body of literature (Snyder, 2019). Therefore, to answer the above RQs, this article employs a systematic review. Bibliometric reviews enable the exploration of bibliographical material from both objective and qualitative perspective to identify, organise, and analyse information in a specific research domain (Zhang et al., 2017).

To the best of the authors’ knowledge, this work is the first literature review on GHRM in the manufacturing sector. It contributes to the existing literature on GHRM through the objective and replicative synthesis of the analysed research field based on publications indexed in Scopus, which is the most widely used database of academic works covering more journals and records than Web of Science (Falagas et al., 2008). Furthermore, in this study the authors applied different types of analyses, which allows for deeper understanding of the research topic.

This study is organised as follows. The second section presents the methodology used. The third section presents the results of the bibliometric analyses related to the publications on GHRM in the manufacturing. In the fourth section, the authors provide the discussion of the results. The last section presents conclusions, limitations of this study as well as future research directions.

1. METHODOLOGY

In the first step, the authors selected the most suitable database. As presented above, Scopus offers about 20 % more coverage than Web of Science, whereas Google Scholar results are inconsistently accurate (Falagas et al., 2008). Furthermore, it allows for the extraction of data in the files, which are accepted by the VosViewer tool. In this study, VosViewer was used to analyse the scientific networks according to guidelines presented by van Eck and Waltman (Van Eck & Waltman, 2013).

In the second step, the authors applied the following search strategy for documents published before 2023: (TITLE-ABS-KEY("green HRM" OR "green human resource management") AND TITLE-ABS-KEY("manufacturing" OR "production")). It resulted in 155 documents (on 1 February 2024). Then the authors included further limitations such as: (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ENGI") OR LIMIT-TO (SUBJAREA , "ENER") OR LIMIT-TO (SUBJAREA , "DECI")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j")) and abstracts of the articles were scanned to decide about the relevancy of a given paper. The result was a base of 124 articles, yet seven of them were excluded after a manual screening of the database.

In the third step, the authors selected the proper analysis techniques. First, knowledge structure was described using performance analysis metrics. The assessment of performance analysis focuses on understanding the role and impact of research elements in their respective fields (Donthu et al., 2021). The analysis, which is descriptive in nature, is the hallmark of bibliometric studies. It presents the per-

formance of different research constituents (e.g., authors, institutions, countries, and journals) and the number of citations (Chen & Xiao, 2016). Then, one of the analyses used for science mapping was conducted. Science mapping examines the relationships between research constituents (Donthu et al., 2021). The co-words analysis, which utilises words present in documents to establish connections and construct the conceptual framework of a particular domain, was used for the synthesis and structuring of existing knowledge within GHRM, helping to delineate potential future research directions. To illustrate the results in tabular and/or graphical form, the authors used MS Excel and VOSViewer. In VOSViewer, the analyses were performed based on full counting.

2. RESULTS

2.1. PUBLICATION PATTERN

Interest in the Green Human Resource Management (GHRM) concerning the manufacturing sector has been evident since 2012. However, the volume of publications remained sparse until 2020. Later, a discernible shift occurred towards a more systematic dissemination of articles, albeit the overall quantity is still relatively low, as depicted in Fig. 1.

2.2. MOST INFLUENTIAL JOURNALS

Most papers were published in five journals with SSCI. The highest numbers of papers were published in Sustainability (14) and Journal of Cleaner Production (12), yet the latter had been publishing papers in GHRM since 2016 and has the higher number of citations (1815), while the former started just in 2020 (number of citations is 202) (Fig. 2, Tab. 1). Articles

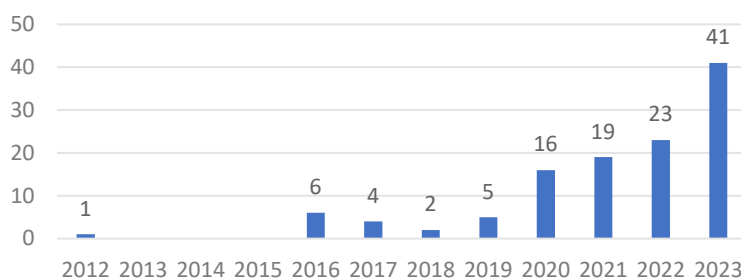


Fig. 1. Temporal distribution of articles

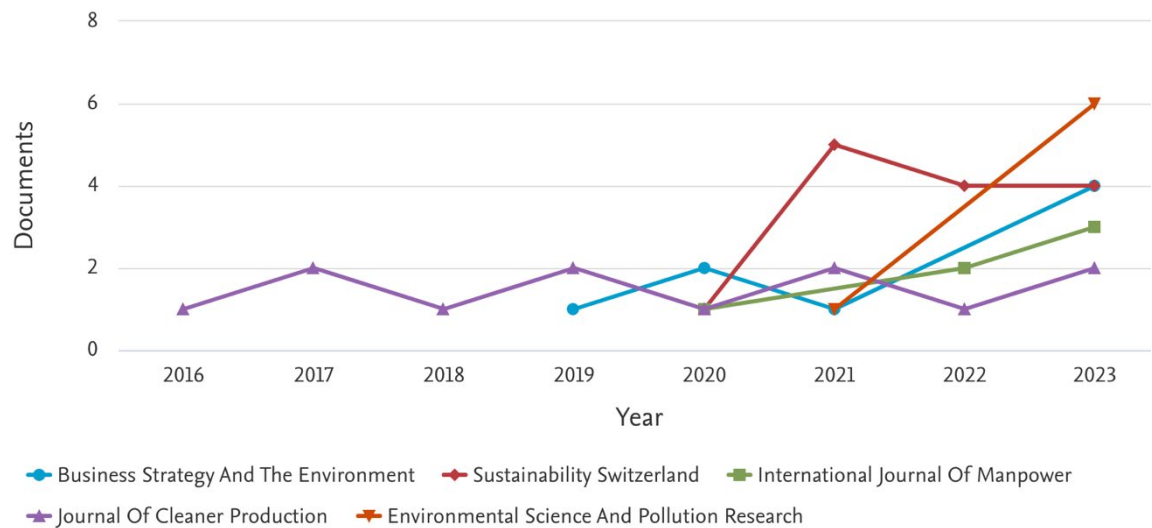


Fig. 2. Number of papers per journal

Tab. 1. Most influential journal

JOURNAL NAME	NO. OF ARTICLES	NO. OF CITATIONS	NO. OF CITATIONS PER ARTICLE
Journal Of Cleaner Production	12	1815	151.3
Business Strategy And The Environment	8	754	94.3
Benchmarking	5	236	47.2
Sustainability (Switzerland)	14	202	14.4
International Journal Of Manpower	6	126	21.0
Environmental Science And Pollution Research	7	99	14.1

Tab. 2. Most contributing countries

COUNTRIES	NO. OF DOCUMENTS	NO. OF CITATIONS	NO. OF CITATIONS PER ARTICLE
China	41	1200	29.3
Pakistan	34	873	25.7
Malaysia	32	1657	51.8
India	15	379	25.3
United Kingdom	13	754	58
France	11	1950	177.3
United States	10	584	58.4
Italy	7	1332	190.3
Brazil	7	766	109.4
Saudi Arabia	6	337	56.2
Indonesia	6	242	40.3
Australia	5	448	89.6

published in *Business Strategy and Environment* were cited 754 times.

The table below presents the most influential journals with numbers of articles, citations and citations per article. The pattern of citations per article almost completely overlaps with the number of citations.

2.3. MOST CONTRIBUTING COUNTRIES

Analysing country statistics, most citations relate to documents affiliated to French, Malaysian, Italian, and Chinese Institutions (Tab. 2). Also, Pakistan, Brazil, and United Kingdom made huge contributions. Regarding the number of documents, most were produced by Chinese, Pakistani, and Malaysian scientists.

2.4. MOST IMPACTFUL AUTHORS

In total, 383 authors contributed to the scientific development of GHRM in the context of production and manufacturing. The number of global citations was used to determine the most influential authors (Hashemi et al., 2022). Nine authors were cited more than 500 times. Based on the number of articles, the most productive author is C.J.C. Jabbour, who wrote eight papers and was cited 1389 times (Tab. 3). M.Y. Yuzliza presented nine papers which were cited 778 times. S.S. Kumar with 768 citations and two papers.

Additionally, numbers of citations per authors were calculated. The table below shows the results of this analysis, presenting authors with the analysed index higher than 300.

2.5. MOST INFLUENTIAL ARTICLES

The number of citations indicates the impact or influence of a document (Svensson, 2010). The top-cited article by Singh et al. (2020) presented research on the interplay of green human resource management on the relationships among green transformational leadership, green innovation, and environmental performance (Tab. 5). The objective of the research conducted by Zaid et al. (2018) was to explore the connections between bundles of green human resource management practices and green supply chain management, encompassing both external and internal practices, and their collective influence on the Triple Bottom Lines of sustainability performance. The next article investigated the link between GHRM practices, factors that contribute to

a green organisational culture, and a company's environmental effectiveness (Roscoe et al., 2019a).

2.6. CO-WORD ANALYSIS

The co-word analysis was applied to document keywords; thus, the unit of analysis was a concept (Zupic & Čater, 2015). Fig. 3 shows the keywords' network designed with the use of VosViewer. The threshold value for total link strength was set at ten, which indicates a stronger relationship between the concepts.

1. Red cluster (four items). This cluster emphasises the integration of sustainability into key business practices, particularly in human resources and supply chain management. It includes terms like "Green HRM", "Green supply chain management" (GSCM), "Sustainability", and "Sustainable operations". This suggests a focus on how businesses can embed environmental considerations into their core operations, developing sustainable human resource policies and environmentally conscious supply chain processes. It highlights the importance of aligning organisational practices with broader sustainability goals, ensuring that internal and external operations contribute to environmental stewardship. Yong, Yuzliza, Jabbour et al. (2020) explored how different organisational factors support Green HRM adoption. The study highlights the internal mechanisms that enhance sustainable practices within firms, reinforcing the need to integrate HRM with environmental management strategies for long-term sustainability. Masri and Jaaron (2017). Yong, Yuzliza, Ramayah et al. (2020). and Roscoe et al. (2019) explored how GHRM practices contribute to broader sustainability goals. Other authors examined how GHRM enhance GSCM strategies (Chiappetta Jabbour et al., 2017; Nejati et al., 2017). Several papers focus on research linking GHRM, GSCM and sustainability performance. Saeed et al. (2022) explored the connection between Green GHRM and environmental performance, with GSCM serving as a mediating factor. Another paper explored the synergistic influence of GHRM and GSCM on various aspects of business performance, including operational, market, financial, social, and environmental outcomes (Acquah et al., 2021). By confirming the positive correlation between green training and the successful adoption of green supply chain practices, Teixeira et al. (2016) highlighted how aligning HR efforts with supply chain operations contributes to broader sustainability goals. Findings from Jermisittiparsert et al. (2019) align with the

Tab. 3. Most impactful authors based on the number of citations

AUTHOR	NO. OF ARTICLES	CITATIONS
Chiappetta Jabbour, Charbel José	8	1389
Yusliza, M.-Y.	9	778
Singh, Sanjay Kumar	2	768
Giudice, Manlio Del	1	764
Chierici, Roberto	1	764
Graziano, Domenico	1	764
Jaaron, Ayham A.M.	3	686
Yong, Jing Yi	6	633
Ramayah, Thurasamy	6	586

Tab. 4. Most impactful authors based on the number of citations per article

AUTHOR	NO OF ARTICLES	NO OF CITATIONS	NO. OF CITATIONS PER ARTICLE
Giudice, Manlio Del	1	764	764.0
Chierici, Roberto	1	764	764.0
Graziano, Domenico	1	764	764.0
Singh, Sanjay Kumar	2	768	384.0
Talib Bon, Abdul	1	384	384.0
Roscoe, Samuel	1	357	357.0
Subramanian, Nachiappan	1	357	357.0
Chong, Tao	1	357	357.0

Tab. 5. Most impactful papers

AUTHORS	ARTICLE TITLE	JOURNAL	NO. OF CITATIONS
(Singh et al., 2020)	Green innovation and environmental performance: The role of green transformational leadership and green human resource management	Technological Forecasting and Social Change	764
(Zaid, Jaaron & Talib Bon, 2018)	The impact of green human resource management and green supply chain management practices on sustainable performance: An empirical study	Journal of Cleaner Production	384
(Roscoe et al., 2019b)	Green human resource management and the enablers of green organisational culture: Enhancing a firm's environmental performance for sustainable development	Business Strategy and the Environment	357
(Masri & Jaaron, 2017)	Assessing green human resources management practices in Palestinian manufacturing context: An empirical study	Journal of Cleaner Production	300
(Rehman et al., 2021).	Analyzing the relationship between green innovation and environmental performance in large manufacturing firms	Technological Forecasting and Social Change	265
(Yong, et al., 2020)	Pathways towards sustainability in manufacturing organizations: Empirical evidence on the role of green human resource management	Business Strategy and the Environment	260
(Yong et al., 2019)	Nexus between green intellectual capital and green human resource management	Journal of Cleaner Production	236
(Teixeira et al., 2016)	Green training and green supply chain management: Evidence from Brazilian firms	Journal of Cleaner Production	232
(Nejati et al., 2017)	Envisioning the invisible: Understanding the synergy between green human resource management and green supply chain management in manufacturing firms in Iran in light of the moderating effect of employees' resistance to change	Journal of Cleaner Production	221

cluster's focus on integrating sustainability into key business practices by demonstrating that Green HRM influence the link between green logistics and environmental outcomes. Several recent studies examine the intersection of digital transformation (DT) with GHRM and GSCM. Trujillo-Gallego et al. (2022) highlight how digital technologies (DTs) and GHRM contribute to improving economic and environmental performance by building environmental capabilities, such as GSCM operational practices. Ma et al. (2023) focused on the synergistic effects between GHRM, GSCM, and digital technologies, highlighting how businesses can align internal operations to meet broader sustainability objectives.

2. Green cluster (three items). This cluster centres on the behavioural and performance aspects of environmental management within organisations. It comprises terms like "Employee green behaviours", "Environmental management", and "Sustainable performance". This indicates an interest in how individual behaviours within an organisation contribute to overall environmental objectives, the strategies employed in managing an organisation's environmental footprint, and the measurement of organisational performance in sustainability terms. It underscores the role of human behaviour in achieving environmental goals and the need for effective management practices that foster sustainable performance. In many studies, these topics were raised. Khan et al. (2021) underscored the importance of individual behaviours and structured environmental management practices in achieving sustainability goals. Malik et al. (2021) further supported the connection between GHRM and sustainable performance through the mediating role of organisational citizenship behaviour towards the environment (OCBE). Also, Aftab et al. (2023) demonstrated the role of pro-environmental behaviour in the impact of GHRM on environmental performance. Some papers focus on ways of enhancing green behaviours. Islam et al. (2020) highlighted the role of ethical leadership and GHRM in promoting green in-role and extra-role behaviours among employees. The research of Zhu et al. (2021) and Waqas, Yahya et al. (2021) support the green cluster by providing evidence of how GHRM practices foster different types of employee green behaviours, reinforcing the role of individual behaviours in achieving organisational environmental goals. The other area of research refers to the meaning of green management for sustainable performance. Huo et al. (2020) claimed that environmental regulation positively regulates the relationship

between commitment to GHRM and offers practical enlightenment for enterprises to carry out environmental management and achieve sustainable development. Khan et al. (2021) discussed the environmental management system (EMS) as a mediator between GHRM and sustainable performance. By embedding environmental management within the organisation's operational framework, the EMS facilitates the translation of GHRMP initiatives into measurable improvements in environmental performance, reinforcing the critical role of structured environmental strategies in achieving sustainable outcomes. On the other hand, environmental management indirectly influences Green HRM adoption by being embedded in the organisational knowledge and innovation systems that drive sustainable practices (Yong et al., 2020). Also, Liu et al. (2021) found support for the influence of green management on the implementation of GHRM.

3. Blue cluster (three items). This cluster explores the strategic and innovative dimensions of sustainability, particularly their role in competitive advantage and sustainable development. It includes "Competitive advantage", "Green innovation", and "Sustainable development". This suggests a strategic approach to sustainability, where environmental initiatives are not just seen as compliance requirements but as opportunities for innovation and market differentiation. It highlights the importance of developing sustainable products, services, and processes that contribute to long-term sustainability goals and provide a competitive edge in the market. In many studies, authors focus on linking green innovation to competitive advantage. Ogiemwonyi et al. (2023) examined how GHRM, green innovation, environmental policy, and green workplace behaviour influence environmental performance. Muisyo et al. (2022) focused on how GHRM and Green Innovation Culture (GIC) contribute to CA. By exploring how green HRM mediates the relationship between leadership and innovation, Singh et al. (2020) underscored how sustainable practices can be leveraged to achieve green performance. Obeng et al. (2023) found the mediating role of green innovation in the relationship between GHRM and organisational competitiveness. Additionally, Shahzad et al. (2023) emphasise green innovation and organisational culture as strategic drivers of sustainable performance. In some research, Big Data Analytics (BDA) has also been considered in this context. Waqas, Honggang et al. (2021) explored the strategic role of Big Data Analytics (BDA) in enhancing green innovation,

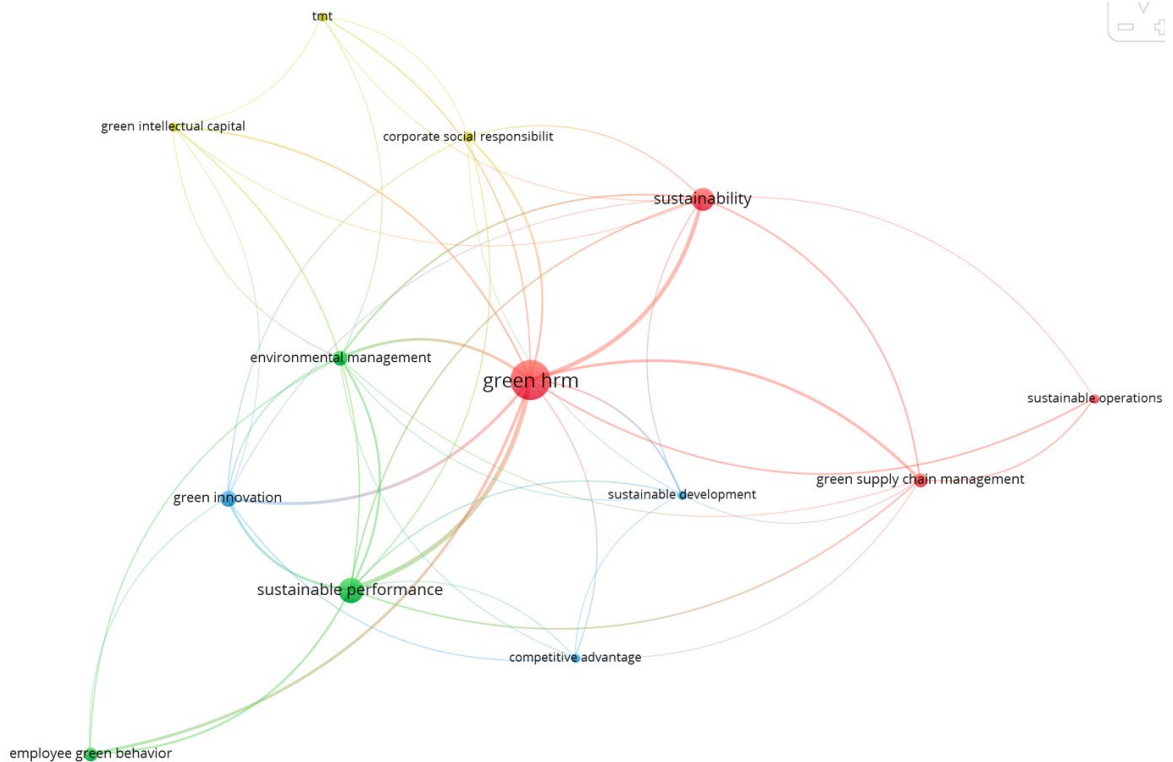


Fig. 3. Keywords' map

competitive advantage, and environmental performance. Green innovation and big data analytics further strengthen the relationship between GHRM and performance by acting as key mediators and moderators (Chau et al., 2024).

4. Yellow cluster (three items). This cluster focuses on the conceptual and strategic frameworks that guide sustainable practices, especially in relation to corporate social responsibility and intellectual capital. It encompasses “CSR”, “Green intellectual capital”, and “TMT”. This cluster implies a focus on the role of corporate governance and leadership in driving sustainability, the importance of incorporating environmental thinking into the organisation's knowledge base, and the strategic role of top management in embedding sustainability into the corporate ethos. It reflects an understanding that sustainable practices are deeply intertwined with corporate strategy, knowledge management, and leadership commitment. Many studies focus on the role of green intellectual capital (GIC). For example, Yong et al. (2023) highlighted the importance of investing in green IC to achieve sustainability through green HRM practices. Ullah et al. (2023) found that GIC enhances a firm's ability to innovate in environmentally friendly ways, which in turn improves the firm's

environmental performance. On the other hand, Yong et al. (2019) emphasised the role of GIC in GHRM. Other papers focus on the activities of the Top Management Team (TMT). A strong positive link between top management commitment and both CSR and GHRM was found (Yusliza et al., 2019). Moreover, TMT's influence is critical in ensuring that external pressures translate into actionable environmental practices within the firm. Thus, TMT is key to embedding sustainability into corporate strategies and decision-making processes (Gedam et al., 2021; Ma et al., 2021) and for ensuring that GHRM policies are effectively implemented (Huo et al., 2020). A third stream of research refers to CSR. First, CSR positively impacts sustainable performance (Zhao et al., 2021) both directly and through the mediation of GHRM and green innovation (Zhou et al., 2023). It also plays a mediating role between green HRM practices and environmental sustainability (ES) (Wen et al., 2022).

2.7. FUTURE AVENUES FOR GHRM RESEARCH

Following Subramanian et al. (2023), to designate avenues for future research, the authors focused on publications from the last three years (2021–2023) and analysed 87 articles. Such an approach allowed

for the identification of current areas of interest and contemporary trends in GRHM research. The analysis revealed three emerging areas of interest.

The first area refers to the digital issues. Big Data Analysis, data-driven culture and digital transformation may support firms suffering from sustainability issues if they are interconnected with GHRM. As Waqas et al. (2021) noted, Big Data Analysis is an underexamined topic. The cited authors examined the role of BDA in boosting green innovation, competitive advantage, and environmental performance. Chau et al. (2023) proposed to focus on big data analytics and data-driven culture as moderators in the relationship between GHRM and performance. Also, Awan et al. (2023) emphasised the need to examine data-driven culture in existing routines and use them to improve sustainable environmental development. Ma et al. (2023) and Trujillo-Gallego et al. (2022) proved that digital transformation and GHRM may enhance green performance.

The second research area includes organisational learning and knowledge management that support green management and performance. First, Subramanian and Suresh (2022) emphasised that the role of organisational learning in the transition to a more circular economy remains unknown. Cited authors investigated the model that explains factors of organisational learning and green human resource management practices, which create a circular economy. Awan et al. (2023) link data-driven culture with organisational learning capability and GHRM in the context of environmental performance. Also, green knowledge processes are discussed (Rashid et al., 2023; Wang et al., 2023).

The last research area covers employee issues labelled as employee engagement. Rashid et al. (2023) and Islam et al. (2020) examined the moderating role of individual green values between GHRM and different results. Apart from focusing on in-role and extra-role behaviours, Liu et al. (2021) and Malik et al. (2021) examined organisational green citizenship behaviours. Tariq et al. (2016). Khatoon et al. (2021). and Yusliza et al. (2017) emphasised the role of green employee empowerment in the implementation of GHRM and performing their tasks.

3. DISCUSSION OF THE RESULTS

The first research question was about the structure of the manufacturing sector's GHRM research field. Based on the analyses, future research should

focus on several key areas. While there's a growing interest post-2020, which is a natural consequence of the trend noticed by Shah et al. (2024). the overall volume of GHRM publications remains relatively low. Future research should aim to expand the body of work in this field, contributing to a more comprehensive understanding of GHRM. Key journals in this field include the Journal of Cleaner Production and Sustainability and Business Strategy and the Environment, with the former having the highest number of citations. These journals are significant contributors to the GHRM literature. However, considering the journals in which the most influential articles were published, Technological Forecasting and Social Change needs also to be mentioned. With significant contributions from countries like France, Malaysia, Italy, China, Pakistan, Brazil, and the UK, there's a clear global interest in GHRM. Yong, Yusliza and Fawehinmi (2019b) noticed that the importance of GHRM research has increased noticeably among scholars since 2016. The most frequent sources of articles were the Journal of Cleaner Production and The International Journal of Human Resource Management. Most of the research was carried out in developing countries, with Brazil being the most productive region. They found only 12 GHRM studies that were conducted in developed countries. According to Pham et al. (2020). the most popular journals are the Journal of Cleaner Production and The International Journal of Human Resource Management. Papers from Brazil and China prevailed in their sample. Future research should continue to foster this international perspective, possibly exploring region-specific challenges and solutions in GHRM implementation.

Co-word analysis of all analysed articles revealed four clusters. For integrating sustainability into business practices, future research should delve deeper into how sustainability can be effectively embedded in various business contexts and the role of HR in this process. Studies may also focus on how environmental management behaviours within organisations affect performance, exploring the dynamics between employee behaviour, GHRM practices, and organisational outcomes. Third, exploring how sustainability contributes to competitive advantage and sustainable development is crucial. Finally, there's a need to develop and refine conceptual and strategic frameworks guiding sustainable practices, especially in relation to corporate social responsibility and intellectual capital. This research partially supports research conducted by Fachada et al. (2022). who

identified (1) the GHRM implementation as a facet of environmental management, (2) consequences for employees (such as “organisational citizenship behaviour”, “employee green behaviour”, “empowerment”), (3) consequences for organisations (e.g. “sustainability”, “environmental performance”). Also, Shah et al. (2024) referred to such clusters as environmental performance and green behaviour.

The second research question was aimed at discovering research areas that constitute promising gaps to be filled in the future. Three emerging areas were identified while analysing articles from 2021 to 2023: (1) digital issues, highlighting the role of Big Data and digital transformation in enhancing firms’ sustainability when integrated with GHRM, (2) organisational learning and knowledge management, focusing on their contribution to green management and performance, particularly in transitioning to a circular economy, and (3) employee engagement, emphasising the impact of individual green attitudes and behaviours and employee green empowerment on GHRM effectiveness and various organisational outcomes. These trends are visible also in the general HRM literature. Relating to GHRM in all industries, Shah et al. (2024) indicated digital issues and the examination of relationships between the organisational level and the employee level of analysis. Moreover, they proposed to focus on sustainability, environmental management, green training, and sustainable performance. In the presented research, only the role of the top management team (TMT) was emphasised, yet as Bahuguna et al. (2023) noticed in their bibliographic review, future research should focus on line managers and HR managers. Jabbour and De Sousa Jabbour (2016) proposed to focus on employee-related outcomes such as job satisfaction and well-being. Many more potential avenues may be examined, e.g., the integration of GHRM practices and Industry 4.0 for a company’s sustainability or exploring the effects of GHRM practices on employees’ green activities outside of the organisation Pham et al. (2019) and the perspective of society (e.g., greenwashing) (Paulet et al., 2021).

CONCLUSIONS

Although researchers have recently been reviewing literature in the field of GHRM, according to the authors’ knowledge, none of the articles focused exclusively on the manufacturing sector. The study enabled the authors to understand current state-of-

art and to highlight future research directions. The bibliometric analysis of GHRM in the manufacturing sector reveals several significant findings. There has been a noticeable increase in scholarly interest in GHRM within the manufacturing sector since 2020. However, the overall volume of publications remains modest, indicating a relatively nascent field that requires further exploration and academic attention. The analysis identified four primary research clusters: integration of sustainability into business practices, the impact of environmental management behaviours on organisational performance, the role of sustainability in competitive advantage and sustainable development and the development of conceptual and strategic frameworks for sustainable practices. Recent studies (2021–2023) highlight emerging areas such as the role of Big Data and digital transformation in sustainability, the interplay between organisational learning, knowledge management, and green performance, and the influence of employee engagement on GHRM practices.

Literature reviews can also serve as overviews of a topic for practitioners and thus have real-world implications (Piwowar-Sulej & Iqbal, 2023). First, environmental considerations should be embedded into core operations through sustainable HR policies and eco-conscious supply chains, ensuring alignment with broader sustainability goals. Second, managers should foster individual green behaviours within the organisation. Moreover, sustainability should be perceived as a strategic opportunity. Finally, incorporating environmental thinking into the organisation’s knowledge base and embedding sustainability into corporate strategy through effective leadership and intellectual capital management are crucial for the successful adoption of sustainable practices.

To point out limitations, a literature search by using keywords does not guarantee an exhaustive outcome, and other techniques like bibliographic coupling or meta-analysis could provide different results. Second, the study analysed only articles available in Scopus. Nevertheless, such a review allows for several benefits. The manufacturing industry has unique environmental impacts and sustainability challenges. A targeted bibliometric analysis of 117 articles revealed specific trends, practices, and research gaps pertinent to GHRM in this sector. Focusing on a specific industry allowed for a more in-depth analysis of the relevant literature, which provides richer and more detailed insights than a general overview might. We hope that providing context-specific evidence and insights can fill impor-

tant gaps in the literature, offering future directions relevant to the field.

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