

From Environmental Destruction To Sustainability: A Systematic Review Of Green Human Resource Development In Manufacturing Companies

Sholeh Hafidz^{1*}, Muhammad Harfiansyah Makarim²

^{1,2}Universitas Negeri Yogyakarta, Indonesia

*Correspondence Email: sholeh_hafidz@uny.ac.id

Abstract— Environmental degradation caused by manufacturing activities has become a major global concern, driving the need for sustainable transformation within the industrial sector. This study aims to systematically review the role of Green Human Resource Development (GHRD) in facilitating the transition from environmental destruction to sustainability in manufacturing companies. Using the Systematic Literature Review (SLR) method guided by the PRISMA framework, this research analyzed 1,670 Scopus-indexed articles published between 2020 and 2025, of which 15 met the inclusion criteria. The findings reveal that GHRD acts as a strategic mechanism that connects environmental management policies with employee behavior and organizational performance. Through green recruitment, training, and performance appraisal, GHRD develops employees' environmental competencies, strengthens green leadership, and fosters sustainability-oriented organizational cultures. The synthesis of previous studies demonstrates that GHRD enhances sustainable performance by promoting innovation, energy efficiency, waste reduction, and green technological adoption. Furthermore, the transformation from environmental degradation to sustainability is primarily driven by human capacity building and eco-conscious organizational culture rather than by technology alone. This review concludes that integrating GHRD into manufacturing management systems is essential to achieving a balanced alignment between economic growth, social responsibility, and environmental preservation, positioning human resources as the key catalyst for sustainable industrial transformation.

Keywords: *environmental destruction; green human resource development; sustainability; manufacturing companies; systematic literature review.*

INTRODUCTION

Environmental degradation has emerged as an increasingly critical global concern that can no longer be overlooked. Ogiemwonyi et al., (2023) emphasize that the manufacturing industry remains one of the primary contributors to environmental destruction. Industrial waste and emissions are major sources of ecological degradation and threats to human well-being. In Malaysia, for instance, carbon emissions from manufacturing account for approximately 20% of the nation's total 53 million tons of emissions, making it the second-largest contributor to global CO₂ output after the energy and transport sectors. Similarly, in Indonesia, the majority of pollutants originate from manufacturing activities and fossil-fuel-based energy sectors, including power generation, metal processing, cement production, and industrial transportation. Recent national environmental statistics indicate that Indonesia's industrial sector accounts for nearly 30% of total greenhouse gas emissions, with major manufacturing regions such as West Java, Banten, and East Java consistently recording some of the highest Air Pollution Standard Index (ISPU) levels in the country (KLHK, 2023). In Cilegon, home to Indonesia's steel and petrochemical industries, SO₂ and NO_x concentrations have been reported to exceed national permissible thresholds during peak production periods (Rahmawati & Arifin, 2021). The environmental repercussions of manufacturing activities can no longer be ignored, as they lead to severe ecological damage and long-term sustainability challenges (X. Li et al., 2025).

Environmental degradation in the manufacturing sector arises from an intricate interplay of technological, economic, and governance factors. Manufacturing industries contribute substantially to environmental deterioration through greenhouse gas emissions and air pollutants

such as CO₂, SO_x, NO_x, CH₄, and fine particulates (PM₁₀ and PM_{2.5}), resulting from fossil fuel combustion and energy-intensive production processes. These emissions exacerbate global climate change, degrade air quality, and pose significant risks to both human health and ecological systems. Xing et al. (2025) report that in China's heavy industries, environmental violations increased by more than 1,200% over the past decade due to weak regulatory enforcement. Similarly, (M. Li et al., 2024) highlight numerous instances of corporate social irresponsibility within the manufacturing sector. Comparable trends occur in Indonesia, where the government's PROPER environmental compliance program reported that more than 500 manufacturing firms received "Red" or "Black" ratings in 2023, indicating serious non-compliance with environmental regulations (KLHK, 2023). Textile factories in Rancaekek, West Java, have repeatedly discharged untreated chemical effluents, including dyes, heavy metals, and detergents, into the Citarum River, contributing to one of the world's most polluted watersheds (Suryadi et al., 2020). Likewise, investigations into industrial zones in Sidoarjo, East Java, revealed chronic emissions from cement, fertilizer, and petrochemical plants that regularly exceed national PM_{2.5} and SO₂ standards (Putri & Nugroho, 2022). These cases illustrate systemic regulatory weaknesses and the severe environmental risks that persist within Indonesia's manufacturing sector.

Within this context, Green Human Resource Management (GHRM) has emerged as a pivotal strategic approach for fostering environmentally responsible behavior within manufacturing organizations. GHRM serves as a critical mechanism linking managerial policies with pro-environmental behavior in the workplace, thereby directly contributing to the mitigation of environmental damage associated with industrial operations. By integrating sustainability principles into recruitment, training, and employee development, GHRM cultivates ecological awareness and aligns individual and organizational values toward environmental stewardship. In Indonesia, firms such as PT Semen Indonesia, PT Astra International, and PT Indofood have begun implementing GHRM-aligned practices, including green training programs, employee participation in waste-reduction initiatives, and performance evaluations tied to environmental metrics (Hidayati, 2022). Early evidence suggests that companies adopting these practices experience measurable improvements in resource efficiency and better PROPER ratings over time (Saepudin & Hartono, 2023). Firms that adopt GHRM practices not only seek technical competencies but also prioritize employees who demonstrate a strong commitment to sustainability, thus positioning human resources as a transformative driver for green industrial transformation.

LITERATURE REVIEW

Environmental Destruction

Environmental destruction is the direct consequence of unsustainable production and consumption patterns, particularly within the manufacturing and extractive industries. Its primary causes include pollutant emissions, overexploitation of natural resources, industrial waste, deforestation, and weaknesses in environmental and human resource management (Casson et al., 2020; Lucas et al., 2021). The impacts are systemic, encompassing ecological, health, economic, and social crises. Environmental destruction is defined as a significant decline in environmental quality resulting from human activities that exceed the carrying capacity and regenerative ability of ecosystems. According to the World Bank (1997) and the World Commission on Environment and Development (WCED, 1987), environmental degradation arises as a consequence of economic

growth that disregards ecological limits, leading to the overexploitation of natural resources and pollution across multiple sectors (Chou et al., 2023).

Green Human Resource

Green Human Resource Management (GHRM) is a strategic approach to human resource management that integrates environmental values and sustainability principles into every HR function, including recruitment, training, performance appraisal, compensation, and organizational culture (Ali et al., 2024; Liu et al., 2025). This concept emerged from the recognition that the human role within organizations is pivotal to the success of environmental preservation efforts. Through GHRM, organizations aim to cultivate environmentally responsible work behaviors, minimize the ecological footprint of their operations, and foster collective awareness of ecological responsibility. In practice, GHRM encompasses policies such as green recruitment, which involves selecting employees who demonstrate environmental awareness; green training and development, which instills knowledge and skills that support energy efficiency and waste management; and green performance management, which evaluates employees' contributions to the organization's environmental goals. Additionally, green compensation provides incentives and rewards for employees who innovate in resource efficiency or contribute to carbon emission reduction (Noor et al., 2023; Tran, 2023).

Manufacturing Companies

Manufacturing companies are business entities that focus on transforming raw materials into finished products through the utilization of labor, technology, and organized production systems. In the context of the modern economy, this sector serves as the backbone of economic growth while simultaneously being a major contributor to emissions and the consumption of natural resources (Arthur, 1994; Schneider et al., 2024; Wang & Chen, 2025). Consequently, manufacturing firms are increasingly required to transform from conventional profit-oriented production models into sustainable and environmentally responsible systems. This transformation depends not only on technological innovation but also on the development of human resources through Green Human Resource Development (GHRD), which embeds values of environmental awareness, energy efficiency, and green innovation within the organizational culture (Karakuş, 2023; Yusoff et al., 2023). Through green training, the enhancement of environmental competencies, and the implementation of a sustainability-oriented organizational culture, manufacturing companies can shift from being contributors to environmental degradation to becoming key drivers of industrial sustainability effectively balancing economic performance with ecological and social responsibility.

METHODOLOGY

This research uses the systematic literature review (SLR) method to answer the research questions outlined in the introduction. The SLR technique is well-suited for providing an objective and thorough analysis of the studied issue. This approach clarifies the progression of knowledge in the field by integrating previous and contemporary research while also highlighting existing gaps and potential directions for future studies (Cooper et al., 2019; Schmid et al., 2021). To ensure a rigorous and transparent review process, the study applies the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. PRISMA is an evidence-based guideline that systematically directs researchers through each stage of the SLR process. It includes

a three-phase procedure and a 27-item checklist that support detailed reporting and identification of key gaps in the existing literature. Implementing the PRISMA framework in alignment with the research questions is depicted in the PRISMA diagram.

Eligibility Criteria

This systematic review was carried out following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. To be considered for inclusion in the review, studies were required to meet specific eligibility criteria.

Table 1. Inclusion and exclusion criteria

Inclusion	Exclusion
The studies were required to focus on Green Human Resource Development	The material is not pertinent to the research scope
Employed quantitative, qualitative, or mixed-methods approaches	Insufficient methodological rigour
Were subjected to peer review and published in English between 2020-2025	Non-accessible full-text articles
The methodological description was comprehensive enough to enable replication or further synthesis.	Studies emphasizing only human resource development

Source : Authors

Information Sources

To locate relevant literature, the review utilized the main databases from SCOPUS. In addition, the reference lists of the selected studies were examined to identify any further relevant sources. The final search was completed on October 20, 2025, ensuring comprehensive inclusion of the most up-to-date research.

Search Strategy

The search strategy was designed with the objective of achieving optimal sensitivity and precision. This was achieved through the utilisation of a combination of keywords, Boolean operators, and subject headings. The primary search term was as follows: ((Title-Abs-Key(Environmental Damage) And Pubyear > 2019 And Pubyear < 2026 And (Limit-To (Subjarea, "Busi") Or Limit-To (Subjarea, "Mate")) And (Limit-To (Doctype, "Ar")) And (Limit-T(Language, "English")) And (Limit-To))). Where appropriate, database-specific adaptations were implemented. In order to restrict the results to those articles published in peer-reviewed journals in the English language and within the specified time frame (2020–2025), filters were employed.

RESULT

Selection Process

Based on the PRISMA diagram analysis it illustrates the systematic process of selecting articles for a systematic review. At the identification stage, researchers found 1,670 articles from

various databases and registers. After initial screening, 256 duplicate articles and 879 articles that did not meet the criteria were removed using an automated tool, leaving 535 articles for further selection. The screening stage was then carried out on these articles, and 429 articles were excluded because they were not relevant to the research topic. Thus, only 106 reports proceeded to the eligibility assessment stage. At the eligibility stage, researchers assessed the methodological quality of each article. As a result, 54 reports were excluded for inadequate methodological rigor, and 37 were excluded for not fitting the study's scope. Finally, only 15 studies met all the criteria and were included in the final review.

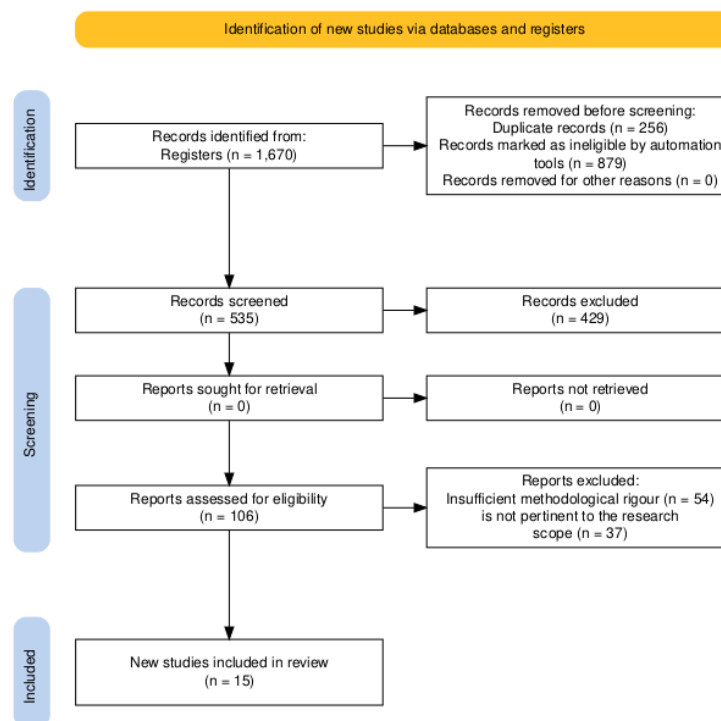


Figure 1. PRISMA Flow Diagram

Publication Trends

Publication trends on the topic of Environmental Destruction show a fluctuating pattern from 2020 to 2025. In 2020, there were around 17 articles discussing the issue of environmental destruction, then a slight decrease in 2021 to 14 articles. An increase was seen again in 2022 with 19 articles, indicating a growing interest among researchers in the theme of environmental destruction. However, the trend declined again in 2023 with only 13 publications. The peak of research activity occurred in 2024 with 28 documents, indicating a surge in global interest and urgency regarding the issue of environmental destruction and increased awareness of environmental sustainability. The significant decline in 2025 to 15 articles is likely due to the current year's data not being fully indexed in Scopus. Overall, this trend indicates that academic attention to the topic of Environmental Destruction is growing stronger, particularly in the 2024 period, in line with increasing scientific awareness and international policies related to climate change and environmental sustainability.

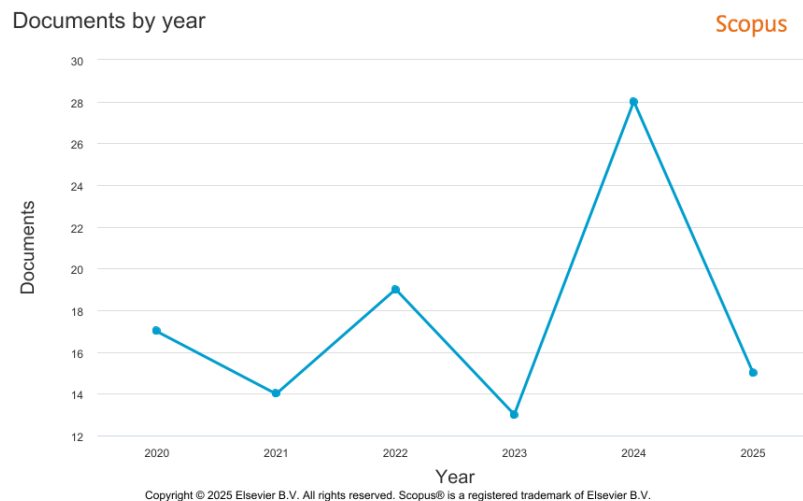


Figure 2. Trend analysis by year

Based on the diagram, the field of Materials Science occupies the largest proportion with 24.5%, indicating that research related to environmental damage is largely focused on the development of environmentally friendly materials, recycling technology, and sustainable material innovation. The field of Engineering ranks second with 16.6%, signifying a high level of attention to the design of more efficient and environmentally oriented industrial systems. Furthermore, the fields of Chemistry (7.9%), Business, Management, and Accounting (7.6%), and Physics and Astronomy (7.3%) also make significant contributions, demonstrating the interconnection between chemical innovation, sustainable business management, and physical modeling of environmental phenomena. The disciplines of Chemical Engineering (6.9%), Energy (5.4%), Environmental Science (5.4%), and Biochemistry, Genetics, and Molecular Biology (5.1%) play an important role in researching the impact of pollution, energy efficiency, and biological degradation due to industrial activities. Meanwhile, Computer Science (3.3%) shows the application of digital technologies such as machine learning and environmental modeling in monitoring environmental damage. Overall, this distribution confirms that the issue of Environmental Destruction is multidisciplinary, with the dominant involvement of applied science and engineering, as well as the growing integration of technology, business, and environmental science to support global sustainability solutions.

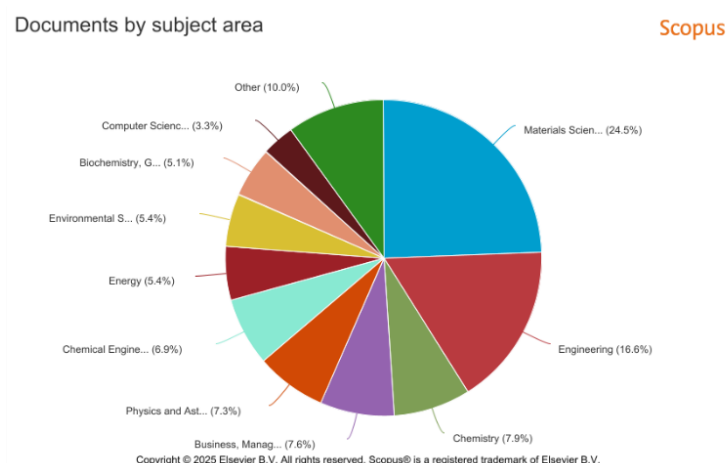


Figure 3. Trend analysis by subject area

Keyword Analysis

VOSviewer displays a co-occurrence map of publications on the topic of Environmental Destruction. The size and proximity of each node represent the frequency of occurrence and the interconnection between research topics in the Scopus database. The most dominant keywords are “environmental damage” and “environmental impact,” which are at the center of a large red cluster. This shows that the main focus of the research is on the environmental impact of industrial activities, material corrosion, and water and air pollution. Words such as corrosion, pollution, and seawater indicate that there is a lot of research related to material degradation and marine environmental contamination. The second large cluster, colored green and blue, highlights keywords such as “human,” “humans,” “animal,” “toxicity,” “oxidative stress,” and “pathology.” This cluster describes research focusing on the biological and health impacts of environmental damage, such as the effects of pollution and heavy metal exposure on animal and human tissues. There is also a close relationship with methodological terms such as scanning electron microscopy and controlled study, which indicates the dominance of experimental approaches in environmental impact analysis. In addition, several new keywords, such as 3D printing, graphite, and mechanical properties appear in the purple cluster, indicating the emerging research on material technology and sustainable engineering for environmental damage mitigation. Overall, this map shows that research on Environmental Destruction is multidisciplinary, combining the fields of environment, health, biology, and materials engineering. The main focus is still on identifying the impacts and mechanisms of environmental damage, but the latest trends are moving towards technological innovation and environmentally friendly materials as solutions to global ecological degradation.

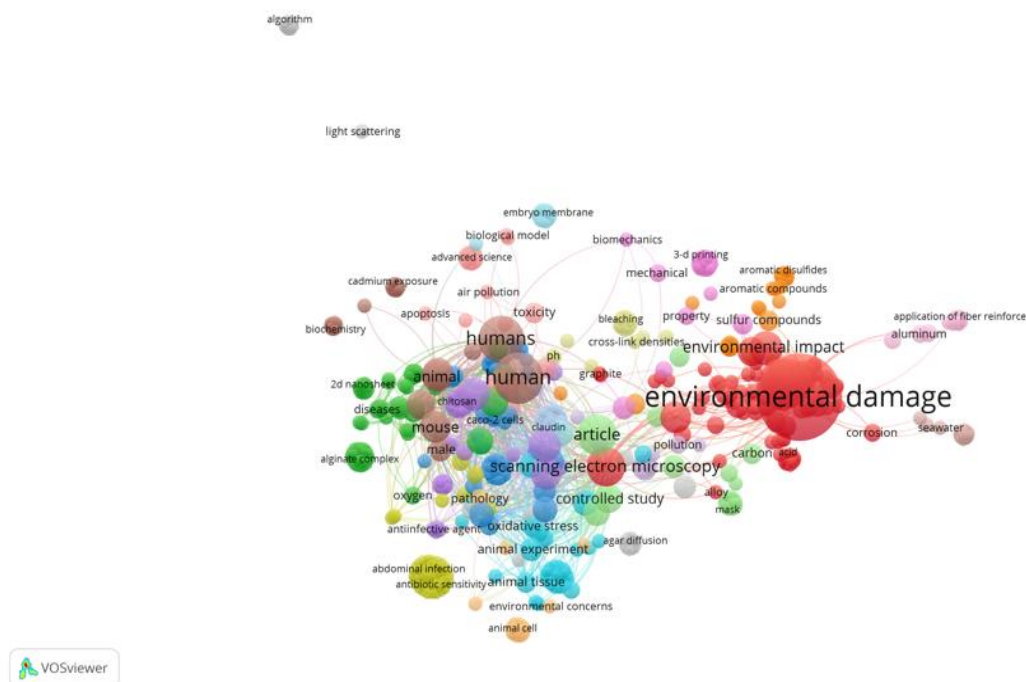


Figure 4. Keyword analysis

Review of Article

Table 1. Review of the Article

Author	Year	Title	Abstract
Tahir, Abdul Haseeb; Umer, Muhammad; Nauman, Shazia; Abbass, Kashif; Song, Huaming	2024	Sustainable development goals and green human resource management: A comprehensive review of environmental performance	This study explores the application of Green Human Resource Management (GHRM) in a large state-owned steel company. Findings from 236 employees analyzed using PLS-SEM show that GHRM enhances environmental performance by promoting proactive green behavior. The research highlights both its theoretical contribution to Sustainable HRM and its practical value for improving sustainability in high-emission industries.
Kumar, Ashish; Sethi, Soumya Ranjan; Sahoo, Chandan Kumar	2025	Greening the workforce: Unveiling the role of proactive employee behaviour in enhancing environmental performance	This study investigates how Green Human Resource Management (GHRM) enhances environmental performance in a state-owned steel company. Based on data from 236 employees analyzed using PLS-SEM, the results show that GHRM fosters proactive green behavior, leading to better environmental outcomes. The study contributes to Sustainable HRM theory and offers practical guidance for high-emission industries to improve sustainability through employee engagement.
Anshima,; Bhardwaj, Bhawana; Sharma, Dipanker	2026	Green Human Resource Management- A Sustainable Approach for People Management	This article discusses the concept and importance of Green Human Resource Management (GHRM) as a response to environmental degradation caused by human activity. It emphasizes that while humans have contributed to ecological damage, their participation is also essential in solving environmental problems. Previous studies show that GHRM practices significantly enhance employees' environmental behavior and promote sustainability, making HR interventions a vital component of environmental management and sustainable development.
Khan, Umair; Wang, Shouwen; Qin, Zhaohui; Salik, Madiha; Ghani, Sumbal	2025	Governance and green finance for sustainable mineral resources: Technological innovation and infrastructure pathways in emerging economies	This study examines how green finance promotes the sustainable management of mineral resources (SMR) in 100 emerging economies from 2010–2019. Using the System GMM approach, it finds that green finance significantly enhances SMR, especially in regions with strong technological innovation and infrastructure. The results highlight that innovation and infrastructure partially mediate this relationship, offering key insights and policy implications for

			advancing sustainability in resource-dependent economies.
Tenaw, Dagmawe	2025	Green and traditional productivity growth with natural capital: The role of resource depletion, environmental damages, and sectoral composition	This study measures traditional and green productivity growth by incorporating natural capital and adjusting output for capital depreciation, resource depletion, and environmental damage. Using translog-stochastic production frontier models across 100 countries (1999–2018), the findings show that only 46% followed a sustainable path, with environmental and capital losses reducing actual GDP by about 18%. The study concludes that ignoring ecological costs leads to productivity overestimation, emphasizing the need for green technologies and policies to enhance sustainable productivity growth.
Ahmad, Shoeb; Javed, Uzma; Sharma, Chetan; Siddiqui, Mohd Shuaib	2025	Green Human Resource Management: Analyzing sustainable practices and organizational impact through a Word2Vec approach	This study conducts a bibliometric and NLP-based analysis of 3,233 Scopus-indexed articles (1996–2024) to identify trends and key themes in Green Human Resource Management (GHRM) research. Using an advanced Word2Vec model, it maps the semantic relationships among GHRM-related keywords, revealing the growing link between sustainability, employee development, and technological innovation. The findings emphasize the integration of GHRM into corporate culture, the use of AI-driven monitoring systems, and the need for region-specific policies to advance global sustainability through human-centered management practices.
Fu, Weiqiong; Ali, Tahir; Hussain, Yasir; Asif, Muhammad	2025	Advancing environmental sustainability through enhanced enterprise resource planning and green supply chain integration: Evidence from the manufacturing sector	This study examines how enhanced Enterprise Resource Planning (ERP) improves firm performance through Green Supply Chain Management (GSCM), supplier integration, and internal integration in an ISO-certified manufacturing company. Using data from 273 valid responses analyzed with PLS-SEM, all hypotheses were supported, showing that ERP positively influences GSCM and integration processes, which in turn improve procurement, production, and overall performance. The study uniquely models GSCM, internal, and supplier integration as mediators and procurement and production planning as moderators, offering practical insights for managers to strengthen sustainable supply chain performance.
Montalvo-Falcón, Johnny Vicente; Sánchez-García, Eduardo; Marco-	2023	Green human resource management and economic, social, and environmental performance: Evidence	This study evaluates the impact of Green Human Resource Management (GHRM) on the economic, social, and environmental performance of 196 Spanish wineries using PLS-SEM analysis. The findings reveal a

Lajara, Bartolomé; Martínez-Falcó, Javier		from the Spanish wine industry	significant positive relationship between GHRM practices and all three performance dimensions, regardless of winery age, size, or Protected Designation of Origin (PDO) status. This research provides novel insights into how GHRM enhances sustainability in the wine industry, offering valuable implications for both scholars and practitioners.
Masud, Abdullah Al; Islam, Mohammad Fakhrul; Ahmed, Selim; Lipy, Nusrat Sharmin; Emon, Md.; Rahman, Md. Kazi Hafizur; Mim, Anika Tasnim	2025	Enhancing sustainable performance through green human resource management: Green competencies building and green passion playing as a joint moderation	This study examines how green competencies building (GCB) and green passion (GP) influence the relationship between Green Human Resource Management (GHRM) and sustainable performance (SP) in Bangladeshi manufacturing firms. Using SEM analysis on 410 survey responses, the results indicate that both GCB and GP individually and jointly strengthen the positive link between GHRM and SP. The study provides novel insights into how employees' environmental skills and enthusiasm amplify the effectiveness of GHRM in achieving sustainability outcomes.
Gao, Wenfang; Zeng, Xianju; Yang, Hailun; Chen, Fangfang; Pan, Anyu; Yang, Feiming; Wang, Yuting; Li, Huajie; Ren, Zhijun; Zhang, Guangming; Sun, Zhi	2025	Green manufacturing evaluation of light-emitting diodes lamps production: Resource and environmental assessment	This study investigates the moderating roles of green competencies building (GCB) and green passion (GP) in the relationship between Green Human Resource Management (GHRM) and sustainable performance (SP) within Bangladeshi manufacturing firms. Based on 410 survey responses analyzed using Structural Equation Modeling (SEM), the results show that both GCB and GP, individually and jointly, amplify the positive influence of GHRM on SP. The findings highlight the importance of fostering employees' environmental expertise and motivation to strengthen GHRM's contribution to organizational sustainability.
Ogiemwonyi, Osarodion; Alam, Mohammad Nurul; Alotaibi, Hammad S.	2023	Pathways toward environmental performance: Link between green human resource management, green innovation, and green behavior at work in manufacturing companies	The research also shows that GHRM operations are making increased efforts towards EnvP, specifically in terms of promoting green innovation and encouraging green behavior in the workplace. Likewise, these actions have a direct impact on a company's EnvP. This study demonstrates the vital role of GHRM activities in the manufacturing industry. It conclusively proves that these activities can effectively promote green behavior in the workplace, thus significantly enhancing the social and EnvP of companies. This invaluable information is indispensable for both researchers and managers in their drive towards sustainable development.
Schneider, Daniel; Thome, Philippe;	2024	Identification and assessment of transitory	The results provide insights into the effectiveness of the methodology in

Woerle, Markus; Reinhart, Gunther		environmental sustainability risks in manufacturing: industrial applicability and economic viability	improving sustainability practices while ensuring economic feasibility. This study contributes to the field of sustainable manufacturing by showcasing the practical implementation of a robust methodology for sustainability risk assessment.
Wang, Jinren; Chen, Yizhi	2025	Does carbon risk promote green innovation in manufacturing companies?	Mechanism analysis reveals that this occurs through stronger social network connections and greater willingness to invest in green research and development. However, current carbon prices in China's Carbon Emissions Trading Exchange weaken this effect, while favorable institutional environments enhance it. These dynamics are especially evident in regions with strict environmental regulation and firms with high disclosure transparency. Overall, the findings highlight carbon risk as both a regulatory pressure and a driving force in the green transformation of manufacturing.
Xia, Qiu; Zhou, Zhibin	2024	Research on the impact of manufacturing servitization on environmental pollution: spatial econometric analysis of sulfur dioxide based on 284 prefecture-level cities	The results show that manufacturing servitization can reduce SO ₂ emissions. Producer servitization and consumptive services can both significantly reduce industrial SO ₂ emissions. Transportation and warehousing servitization, information servitization, leasing, and commercial servitization, technology research and development servitization significantly reduce SO ₂ emissions; technology research and development servitization, in particular, have the largest influence coefficient, while the reduction effect of servitization in the wholesale and retail and finance sectors is not significant. The study also found that servitization reduced the SO ₂ emissions through technological innovation and industrial structure upgrading.
Liu, Yuan; Wen, Zuomin	2024	Green manufacturing process supply chain management based on thermal efficiency improvement and environmental impact assessment technology	This study employs case analysis and quantitative evaluation to examine green supply chain management (GSCM) practices in manufacturing enterprises, focusing on the role of thermal management indicators. The findings reveal that improving thermal efficiency reduces energy consumption, production costs, and greenhouse gas emissions throughout a product's life cycle. The study concludes that optimizing heat management technologies and production processes is essential for achieving green manufacturing, enhancing environmental performance, and strengthening firms' sustainability and competitiveness.

Based on the comprehensive analysis of studies contained in ekstrak_ris.xlsx, it can be concluded that Green Human Resource Development (GHRD) occupies a strategic position as a

driving force for sustainable transformation in the manufacturing sector.) Tahir et al., (2024) demonstrate that green human resource development directly contributes to the achievement of the Sustainable Development Goals (SDGs) by enhancing employees' environmental awareness and competencies. In the manufacturing context, this implies that firms must design training and learning systems that go beyond technical skills, fostering an environmental mindset that enables workers to integrate energy efficiency, waste reduction, and the use of eco-friendly materials into production processes.

Kumar et al. (2025) reinforce this perspective by asserting that the success of GHRD strongly depends on green leadership and organizational support. In the complex environment of manufacturing industries, green leadership acts as a critical catalyst for nurturing a pro-environmental organizational culture. Environmentally oriented leaders guide, exemplify, and cultivate a work climate that encourages active employee participation in green initiatives such as lean manufacturing, energy efficiency, and sustainable innovation. Managerial support through rewards, continuous training, and green performance evaluation systems further strengthens employees' commitment to corporate sustainability goals. Furthermore, Anshima et al. (2025) emphasize that Green Human Resource Management (GHRM) and GHRD are not merely administrative approaches but strategic instruments for building corporate competitive advantage. Practices such as green recruitment, green training, and green performance appraisal have been shown to enhance operational efficiency, reinforce employee loyalty, and build a socially and ecologically responsible corporate image. Within the manufacturing context, GHRD serves as a key mechanism for preparing a workforce capable of operating clean technologies, applying the 3R principles (reduce, reuse, recycle), and supporting low-carbon production processes.

In synthesis, all studies indicate that GHRD is central to the success of manufacturing firms in achieving sustainable transformation. Through the development of green competencies, visionary leadership, and an innovation-driven environmental culture, GHRD functions as a bridge between sustainability strategy and its practical implementation on the production floor. Manufacturing firms that effectively integrate GHRD into their human resource policies and practices are more likely to achieve a balance among economic, social, and ecological performance, thereby strengthening their competitiveness in the emerging green industry era.

Based on the overall findings presented in the analysis of studies, the transformation from environmental destruction to sustainability unfolds through a gradual process centered on Green Human Resource Development (GHRD). In its early stages, the manufacturing sector was often associated with production activities that generated pollution, high carbon emissions, and excessive exploitation of natural resources, factors that contributed significantly to environmental degradation and long-term ecological threats. However, recent studies indicate a paradigm shift within the industry, wherein the human factor has become the key driver in transforming destructive production patterns into sustainable systems.

Gao et al., (2025) emphasize that the transition toward sustainability cannot rely solely on policies or green technologies but must begin with the transformation of employees' awareness and competencies. Through GHRD, companies can instill sustainability values, cultivate green work behaviors, and integrate eco-efficiency principles into every operational dimension of manufacturing. Green training and continuous learning enhance employees' sensitivity to the environmental impacts of production and empower them to devise innovative solutions to reduce industrial emissions and waste (Ahmadi-Gh & Bello Pintado, 2022; Fu et al., 2025). Further highlight that green leadership and organizational support are the primary drivers of this transition. Environmentally visionary leaders not only reform production policies but also reshape the

organizational mindset. The transformation from environmental degradation to sustainability begins with the creation of a work culture that values energy efficiency, waste management, and responsible resource utilization. GHRD functions as a vehicle to transmit green leadership values to all employees through structured training, performance evaluation, and environmental reward systems. Demonstrate that Green HRM practices, including green recruitment, green training, and green performance appraisal, enable organizations to cultivate a human resource ecosystem oriented toward sustainable innovation (Haldorai et al., 2025; Masud et al., 2025; Ogiemwonyi et al., 2023b). Through GHRD implementation, manufacturing companies can convert activities that once contributed to environmental degradation into sustainable production processes. For instance, by promoting green technology training and adopting lean manufacturing principles, employees are able to produce low-carbon, energy-efficient products that align with sustainability objectives.

Overall, the transformation from environmental destruction to sustainability is driven by fundamental changes in human capacity and organizational culture. GHRD acts as a catalyst linking ecological responsibility with business effectiveness. When manufacturing firms succeed in embedding sustainability values within their human resource management systems, formerly destructive production practices can evolve into green innovation, resource-efficient operations, and a balanced pursuit of economic profitability and environmental preservation. Thus, GHRD serves as a strategic foundation that transforms the manufacturing sector from a major contributor to environmental degradation into a leading force for global sustainability.

CONCLUSION

This study concludes that the transformation from environmental destruction to sustainability in the manufacturing sector is fundamentally driven by the strategic implementation of Green Human Resource Development (GHRD). The findings from fifteen reviewed studies reveal that GHRD plays a central role in shaping employees' environmental awareness, competencies, and behaviors, which are essential for achieving sustainable industrial operations. Through systematic practices such as green recruitment, green training, green performance appraisal, and green compensation, manufacturing companies are able to embed ecological values into organizational culture and align human resource strategies with environmental objectives. The review highlights that technological innovation alone is insufficient to ensure sustainability unless it is supported by environmentally literate and committed human resources. Moreover, green leadership and organizational support systems emerge as key enablers that strengthen the link between GHRD and sustainable performance. Leaders with environmental vision foster a culture of responsibility and innovation, motivating employees to engage in energy efficiency, waste reduction, and low-carbon production. In conclusion, the transition from destructive industrial practices to sustainable manufacturing requires a human-centered transformation, where GHRD serves as a catalyst bridging sustainability strategy and operational reality. By institutionalizing GHRD principles, manufacturing companies can simultaneously enhance environmental performance, social responsibility, and economic competitiveness, thereby positioning human resources as the primary driver of global sustainability.

LIMITATION AND IMPLEMENTATIONS

Limitations

Although this study provides a comprehensive understanding of the role of Green Human Resource Development (GHRD) in promoting sustainability within manufacturing companies,

several limitations should be acknowledged. First, the scope of the systematic review is limited to studies published between 2020 and 2025, potentially excluding earlier foundational works that might have contributed valuable theoretical perspectives. Second, the review focuses exclusively on Scopus-indexed articles, which, while ensuring quality and credibility, may omit relevant studies from non-indexed journals or gray literature. Third, the heterogeneity of research methods and contexts across the selected studies, ranging from quantitative to qualitative approaches and from developed to emerging economies, may constrain the generalizability of findings. Lastly, the study relies on secondary data and existing literature, so it cannot empirically validate causal relationships between GHRD practices and environmental performance outcomes.

Implications

Despite these limitations, the findings offer significant theoretical and practical implications. Theoretically, this research enriches the understanding of GHRD as a transformative framework that bridges human resource development and environmental sustainability, emphasizing the human dimension in achieving green industrial transformation. It also extends the discourse of sustainable HRM by positioning GHRD as a strategic tool for organizational learning, innovation, and ecological adaptation. Practically, the results highlight that manufacturing firms must invest in continuous green training programs, leadership development, and environmental performance management systems to cultivate a sustainability-oriented workforce. To operationalize GHRD, companies can adopt structured implementation models such as the Green Competency Framework, which maps required environmental skills, behaviors, and leadership capabilities across job roles (Jabbour & de Sousa Jabbour, 2016). Firms can also follow a staged green training model consisting of (1) awareness-building sessions on environmental risks, (2) skill-based technical training on waste reduction, energy efficiency, and pollution control, and (3) performance-based reinforcement using green KPIs and incentives (Renwick et al., 2013). These structured approaches enable firms to integrate GHRD more systematically into daily operations.

Additionally, companies should incorporate environmental performance measurement strategies such as Key Environmental Indicators (KEIs), carbon accounting tools, and lifecycle assessment (LCA) systems to monitor progress (Goyal et al., 2020). Approaches like the Balanced Scorecard with an environmental dimension or PROPER-based internal audit checklists can help firms align HRD initiatives with measurable ecological outcomes. Developing green performance appraisal systems that evaluate employees on eco-efficiency efforts, compliance, and participation in green initiatives can further strengthen accountability (Pham et al., 2020). Policymakers and industry leaders are encouraged to integrate GHRD principles into industrial sustainability policies, linking workforce development with national green growth agendas. Future research should incorporate longitudinal and empirical analyses to measure the long-term impact of GHRD initiatives and explore how cultural, institutional, and technological factors mediate their effectiveness across different manufacturing contexts.

REFERENCES

- Ahmadi-Gh, Z., & Bello Pintado, A. (2022). Why Is Manufacturing Not More Sustainable? The Effects Of Different Sustainability Practices On Sustainability Outcomes And Competitive Advantage. *Journal Of Cleaner Production*, 337. <https://doi.org/10.1016/J.Jclepro.2022.130392>

- Ali, S. R., Al Masud, A., Hossain, Md. A., Islam, K. M. Z., & Shafiul Alam, S. M. (2024). Weaving A Greener Future: The Impact Of Green Human Resources Management And Green Supply Chain Management On Sustainable Performance In Bangladesh's Textile Industry. *Cleaner Logistics And Supply Chain*, 10, 100143. <https://doi.org/10.1016/J.Clscn.2024.100143>
- Anshima, Sharma, D., & Bhardwaj, B. (2025). Green Human Resource Management Practices And Sustainable Development In India: A Systematic Literature Review And Future Research Agenda. *Social Sciences & Humanities Open*, 11, 101420. <https://doi.org/10.1016/J.Ssaho.2025.101420>
- Arthur, J. B. (1994). Effects Of Human Resource Systems On Manufacturing Performance And Turnover. *Academy Of Management Journal*, 37(3), 670-687.
- Casson, A., Giovenzana, V., Tugnolo, A., Fiorindo, I., Beghi, R., & Guidetti, R. (2020). Environmental Impact Of A New Concept Of Food Service: A Case Study For The Re-Use Of Naval Shipping Containers. *Journal Of Cleaner Production*, 274. <https://doi.org/10.1016/J.Jclepro.2020.122912>
- Chou, S.-H., Lu, H.-W., Liu, T.-C., Chen, Y.-T., Fu, Y.-L., Shieh, Y.-H., Lai, Y.-C., & Chen, S.-Y. (2023). An Environmental-Inert And Highly Self-Healable Elastomer Obtained Via Double-Terminal Aromatic Disulfide Design And Zwitterionic Crosslinked Network For Use As A Triboelectric Nanogenerator. *Advanced Science*, 10(2). <https://doi.org/10.1002/Adv.202202815>
- Cooper, H. M. ., Hedges, L. V. ., & Valentine, J. C. . (2019). *Handbook Of Research Synthesis And Meta-Analysis*. Russell Sage Foundation.
- Fu, W., Ali, T., Hussain, Y., & Asif, M. (2025). Advancing Environmental Sustainability Through Enhanced Enterprise Resource Planning And Green Supply Chain Integration: Evidence From The Manufacturing Sector. *Journal Of Environmental Management*, 391, 126329. <https://doi.org/10.1016/J.Jenvman.2025.126329>
- Gao, W., Zeng, X., Yang, H., Chen, F., Pan, A., Yang, F., Wang, Y., Li, H., Ren, Z., Zhang, G., & Sun, Z. (2025). Green Manufacturing Evaluation Of Light-Emitting Diodes Lamps Production: Resource And Environmental Assessment. *Renewable And Sustainable Energy Reviews*, 211, 115317. <https://doi.org/10.1016/J.Rser.2024.115317>
- Goyal, S., Rahman, Z., & Kazmi, A. A. (2020). Environmental Performance Measurement In Manufacturing Companies: A Systematic Review. *Journal Of Cleaner Production*, 258, 120730.
- Haldorai, K., Kim, W. G., Phetvaroon, K., & Gazzoli, G. (2025). Green Synergy: Integrating Green Human Resource Management And Green Supply Chain Management For Sustainable Performance In The Thai Hospitality Industry. *International Journal Of Hospitality Management*, 128, 104196. <https://doi.org/10.1016/J.Ijhm.2025.104196>
- Hidayati, N. (2022). Adoption Of Green Hrm Practices In Indonesian Manufacturing Firms: Evidence And Implications. *Jurnal Manajemen Dan Bisnis Indonesia*, 8(2), 98–115.
- Jabbour, C. J. C., & De Sousa Jabbour, A. B. L. (2016). Green Human Resource Management And Green Supply Chain Management: Linking Two Emerging Agendas. *Journal Of Cleaner Production*, 112, 1824–1833.
- Karakuş, G. (2023). A Research On Reasons Leading To Environmentally Responsible Manufacturing Practices And Their Effects. *International Journal Of Social Ecology And Sustainable Development*, 14(1). <https://doi.org/10.4018/Ijsesd.329199>

- Klhhk. (2023). *Laporan Inventarisasi Gas Rumah Kaca Nasional Dan Evaluasi Proper 2023*. Kementerian Lingkungan Hidup Dan Kehutanan Republik Indonesia.
- Kumar, A., Sethi, S. R., & Sahoo, C. K. (2025). Greening The Workforce: Unveiling The Role Of Proactive Employee Behaviour In Enhancing Environmental Performance. *Strategic Business Research*, 1(1), 100005. <https://doi.org/10.1016/J.Sbr.2025.100005>
- Li, M., Martínez-Del-Río, J., Li, P., & Guthrie, J. P. (2024). Exploring The Antecedents Of Green Human Resource Management: A Path Dependence Perspective. *Journal Of Business Research*, 181, 114743. <https://doi.org/10.1016/J.Jbusres.2024.114743>
- Li, X., Tse, Y. K., & Bu, X. (2025). Examining Corporate Social Irresponsibility In Manufacturing: An Eye-Tracking Study Of Social Media News. *International Journal Of Production Economics*, 281. <https://doi.org/10.1016/J.Ijpe.2025.109539>
- Liu, Z., Li, Y., Guo, Y., Zhang, M., & Ramsey, T. (2025). Does Green Human Resource Management Foster Green Advocacy? A Perspective Of Conservation Of Resources Theory. *Journal Of Organizational Change Management*, 38(2), 414–435. <https://doi.org/10.1108/Jocm-03-2024-0160>
- Lucas, S., Soler, L.-G., Irz, X., Gascuel, D., Aubin, J., & Cloâtre, T. (2021). The Environmental Impact Of The Consumption Of Fishery And Aquaculture Products In France. *Journal Of Cleaner Production*, 299. <https://doi.org/10.1016/J.Jclepro.2021.126718>
- Masud, A. Al, Islam, M. F., Ahmed, S., Lipy, N. S., Emon, Md., Rahman, Md. K. H., & Mim, A. T. (2025). Enhancing Sustainable Performance Through Green Human Resource Management: Green Competencies Building And Green Passion Playing As A Joint Moderation. *Acta Psychologica*, 260, 105701. <https://doi.org/10.1016/J.Actpsy.2025.105701>
- Noor, J., Tunnufus, Z., Handrian, V. Y., & Yumhi, Y. (2023). Green Human Resources Management Practices, Leadership Style And Employee Engagement: Green Banking Context. *Heliyon*, 9(12), E22473. <https://doi.org/10.1016/J.Heliyon.2023.E22473>
- Ogiemwonyi, O., Alam, M. N., & Alotaibi, H. S. (2023a). Pathways Toward Environmental Performance: Link Between Green Human Resource Management, Green Innovation, And Green Behavior At Work In Manufacturing Companies. *Journal Of Cleaner Production*, 425, 138949. <https://doi.org/10.1016/J.Jclepro.2023.138949>
- Ogiemwonyi, O., Alam, M. N., & Alotaibi, H. S. (2023b). Pathways Toward Environmental Performance: Link Between Green Human Resource Management, Green Innovation, And Green Behavior At Work In Manufacturing Companies. *Journal Of Cleaner Production*, 425. <https://doi.org/10.1016/J.Jclepro.2023.138949>
- Pham, N. T., Tučková, Z., & Jabbour, C. J. C. (2020). Greening The Workforce: Evaluating Environmental Performance In Hr Systems. *Business Strategy And The Environment*, 29(1), 1–17.
- Putri, A. F., & Nugroho, S. P. (2022). Emission Level Assessment In Industrial Zones Of Sidoarjo, East Java: Implications For Environmental Policy. *Jurnal Teknologi Lingkungan*, 23(1), 55–68
- Rahmawati, D., & Arifin, M. (2021). Industrial Air Pollution And Its Health Impacts In Cilegon City, Indonesia. *Journal Of Environmental Science And Sustainable Development*, 4(2), 145–160.

- Renwick, D. W. S., Redman, T., & Maguire, S. (2013). Green Human Resource Management: A Review And Research Agenda. *International Journal Of Management Reviews*, 15(1), 1–14.
- Saepudin, D., & Hartono, D. (2023). Proper-Based Environmental Performance Improvements Through Green Hr Policies In Indonesian Companies. *Economic And Environmental Studies*, 23(1), 57–72.
- Schmid, C. H. ., Stijnen, Theo., & White, I. R. . (2021). *Handbook Of Meta-Analysis*. Crc Press, Taylor And Francis.
- Schneider, D., Thome, P., Woerle, M., & Reinhart, G. (2024). Identification And Assessment Of Transitory Environmental Sustainability Risks In Manufacturing: Industrial Applicability And Economic Viability. *Procedia Cirp*, 130, 988–994. <https://doi.org/10.1016/j.procir.2024.10.196>
- Suryadi, A., Nuraeni, L., & Pratama, R. (2020). Water Pollution In The Citarum River Caused By Textile Industrial Waste: An Environmental And Socioeconomic Analysis. *Indonesian Journal Of Environmental Management*, 12(3), 211–225.
- Tahir, A. H., Umer, M., Nauman, S., Abbass, K., & Song, H. (2024). Sustainable Development Goals And Green Human Resource Management: A Comprehensive Review Of Environmental Performance. *Journal Of Environmental Management*, 370, 122495. <https://doi.org/10.1016/j.jenvman.2024.122495>
- Tran, N. K. H. (2023). An Empirical Investigation On The Impact Of Green Human Resources Management And Green Leadership On Green Work Engagement. *Heliyon*, 9(11), E21018. <https://doi.org/10.1016/j.heliyon.2023.E21018>
- Wang, J., & Chen, Y. (2025). Does Carbon Risk Promote Green Innovation In Manufacturing Companies? *International Review Of Financial Analysis*, 108, 104684. <https://doi.org/10.1016/j.irfa.2025.104684>
- Xing, K., Yang, F., Liu, P., Wang, J., & Wu, J. (2025). Environmental Violations And Financial Distress Risk: Evidence From Chinese Listed Heavily Polluting Companies. *Pacific Basin Finance Journal*, 89. <https://doi.org/10.1016/j.pacfin.2024.102583>
- Yusoff, N. M., Ahmad, A. N., & Md Dahlal, N. (2023). The Degree Of Whistleblowing Intention And Its Determinants Among Halal Food Manufacturing Employees. *Journal Of Fatwa Management And Research*, 28(2), 14–38. <https://doi.org/10.33102/jfatwa.Vol.28no2.517>