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Research Article

Examining Green HRM Practices towards Sustainability and Circular Economy Using Fuzzy AHP: A Case

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Abstract: The transition from a linear "take–make–dispose" model to a circular economy (CE) requires organizations to integrate sustainability principles into human resource management (HRM). Green HRM practices—such as sustainable recruitment, environmental training, green performance appraisal and employee engagement—play a critical role in embedding environmental responsibility into organizational culture. However, evaluating the relative importance of multiple HR parameters influencing sustainability remains complex due to uncertainty and subjective judgments. This study proposes a Fuzzy Analytic Hierarchy Process (Fuzzy AHP)-based multi-criteria decision-making framework to prioritize Green HRM practices contributing to sustainability and circular economy adoption. Data were collected from 50 middle-management employees of Dayal Fertilizers, Meerut. Twelve HR-related sustainability parameters were structured into a hierarchical decision model and evaluated using pairwise comparisons with triangular fuzzy numbers. Results indicate that training and awareness, sustainable recruitment and incentive mechanisms are the most influential drivers of circular economy implementation, while safety assurance and research integration require improvement. The study contributes a quantitative prioritization framework for managers and extends the application of FAHP to Green HRM evaluation.

Keywords: Green HRM, Circular Economy, Sustainability, Fuzzy AHP, Multi-Criteria Decision Making, Fertilizer Industry

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INTRODUCTION

Growing environmental degradation, resource scarcity and regulatory pressures have compelled organizations to shift from traditional linear production systems toward sustainable and circular models. The circular economy (CE) emphasizes waste minimization, resource recovery, reuse and regenerative production [1-2]. While technological and operational innovations are critical, the success of CE initiatives largely depends on human behavior, competencies and organizational culture.

Human Resource Management (HRM) has therefore emerged as a strategic enabler of sustainability through Green HRM practices, including green recruitment, environmental training, sustainable performance management and employee participation. Studies show that HR practices significantly influence supply chain sustainability and circular performance [3-5]. Despite growing interest, two research gaps persist:

- Most studies examine Green HRM qualitatively or through regression/SEM approaches
- Few studies prioritize HR practices under uncertainty using structured decision tools

To address these limitations, this study adopts Fuzzy Analytic Hierarchy Process (FAHP) to systematically evaluate and rank HR parameters affecting sustainability and CE performance in the fertilizer manufacturing sector.

Literature Review

Geng *et al.* [6] investigated the concept of sustainability and circular economy and this concept has gained support in governments such as the European Union to address the issue of sustainability in public policy and it has been embraced as a national development plan in China. A shift from the "extraction-production-disposal" paradigm of linear economy, which is now widely used in the industrial setting, is proposed by CE via the prospect of making human activity more robust through the use of the natural cycle model [1]. Geissdoerfer *et al.* [2] studied the concepts of the circular economy and sustainability is becoming more popular in industry, academia and policymaking. The research examines trends and draws lines between similarities, differences and correlations. They distinguished eight types of relationships and emphasized the important similarities between them. Genovese *et al.* [7] studied the circular economy promotes self-sustaining manufacturing cycles in contrast to traditional techniques that may be harmful to the environment. This study examines critical variables such as lifecycle emissions, waste recovery rates, virgin resource utilization and carbon footprint across supply chains to compare conventional versus circular production methods in the food and chemical industries. Khanna and Sharma [8] studied that to improve performance and efficiency in supply chains through the integration of IoT. It examines the research on IoT's application to supply chain management (SCM) from beginning to end and suggests an integrated framework for doing so. The study looks at the effects on HR management as well, providing useful information for maximizing SCM efficiency.

Batista *et al.* [9] discussed the circular supply chain techniques of Tetra Pak pertaining to China and Brazil's packaging recovery ecosystems. For scholars and practitioners interested in the circular supply chains and recovery ecosystems of the packaging sector, the research provides insightful analysis and practical suggestions. The results support the design of additional research and execution of the ethics and principles of circular economy. Farooque *et al.* [10] analyzed of 261 publications demonstrates the increasing importance of the circular economy as an alternative to linear models. Nonetheless, there are still shortages in the literature about circularity design, recyclable packaging, supply chain collaboration, buying, circularity, circular consumption, product responsibility and supplier responsibility.

Hussain and Malik [11] studied the structural equation modeling to determine the impact of organizational facilitators of circular supply chains on environmental performance in the UAE. It integrates process facilitators and organizational narratives to validate a framework for circular supply chains and sustainable performance, emphasizing the role of organizational language and activities in supporting circular economy principles. Tahu *et al.* [12] studied the supply chain innovation, sustainability and the circular economy affected Bandung City organizations' performance. A survey with 163 public sector workers was used to gather data and the LISREL program's SEM was used to collect the data. The findings demonstrated that while sustainability has a beneficial impact on organization performance, the circular economy and innovative SCM have a large and positive impact as well. Bai *et al.* [13] studied the circular economy (CE) presents challenges due to material closed-loop flows and dynamic market environments.

Jena and Ghadge [3] investigates the amalgamation of supply chain management (SCM) and human resource management (HRM) approaches. The results of an empirical study utilizing survey data from Indian logistics companies indicate that the joint of HRM-SCM greatly affects the supply chain performance, especially in situations with unstable demand. Strong relationships and mutual assistance are demonstrated between HRM and SCM in determining and meeting industry need. Giudice *et al.* [14] conducted a study involving 378 Italian businesses, finding that the use of circular economy strategies such as relationship management, human resource management and supply chain design greatly increases company efficiency. The association between HR management and performance was modulated by a big-data-driven supply chain, which advances the study of circular economy methods in big-data-driven supply networks. Patwa *et al.* [15] studied the implementation of CE principles in emerging economies because the issues they confront differ from those faced by industrialized economies with regard to resource availability, government policies and consumer behavior. This study provided an experimentally verified CE adoption model based on 183 consumer answers. The study emphasized the importance of consumer behavior in the acceptance of remanufactured items and the use of products as a service in encouraging the widespread implementation of CE processes in emerging economies. This study provided businesses, consumers and policymakers with information about CE-compliant. Burke *et al.* [16] studied the supply chain management choices might be integrated with product design. Four ideas emerged from a thematic analysis of 15 interviews conducted in New Zealand: business model innovation, circular SCM, end-of-life considerations in product design and sustainable organizational values. The findings offer guidance to academics, managers and designers on how to further the cause of Circular Economy at supply chain level. Shisara *et al.* [17] discussed about the factors that influence green supply chain management (GSCM) in Sri Lanka's industrial and agriculture sectors. Thirty experts identified obstacles like lack of expertise and external shortages. Strong external drivers emphasize green procurements, while internal drivers include senior management support.

Bag *et al.* [5] studied the performance in South African manufacturing SMEs is affected by eco-innovation, GSCM practices; institutional pressures, CE capacity and BDSC. Eco-innovation, which is associated with GSCM and CE capacity, is positively impacted by coercive, normative and mimetic influences, according to data collected from 240 employees. Khan and Ali [18] emphasize the critical implementation of circular economy principles. Dolatabad *et al.* [19] studied the fuzzy-based decision-making model to enhance hospital Circular Supply Chain performance in intensive care units, identifying 8 essential variables and 16 associations.

Malhotra [20] investigated the Indian manufacturing companies and revealed that sustainable supply chain performance is affected by circular economy strategies. Circular economy strategies and sustainable SC performance are positively correlated, according to the research and managers' and retailers' connections are strengthened by supply chain flexibility and capacities. Gungor and Leindecker [21] discussed the construction industry's inventory and supply chain tools, stakeholder perspectives, safe data storage and customer perspectives. It is analyzed that dynamic supply chain design is essential for internationalization, coordination and flexible business models. Kaur *et al.* [22] studied the implementation of circular SCM in the UK food sector, revealing main obstacles being knowledge, environmental opinions and economic viability. It provides a comprehensive understanding of supply chain issues and supports positive management tactics. Lu *et al.* [24] studied the circular economy (CE) assist businesses in preserving circular resource flows and maximizing sustainability through technology. Making the switch to Industry 4.0 and CE is both exciting and difficult. In order to increase sustainability and efficiency, this study looks into how to include Industry 4.0 and CE into sustainable supply chain management (SSCM). Chen *et al.* [4] studied the connection between SC integration and green human resource management (GHRM) practices in Indonesian footwear firms. A qualitative analysis of 76 managers and supervisors revealed three ways how supply chain integration are affected by GHRM practices: green development, training, collaboration, selective hiring, green recruiting and the evaluation of green performance. The study emphasizes the importance of implementing all GHRM practices. Yamin *et al.* [24] discussed the factors affecting supply chain resilience and agility in logistics companies, combining artificial intelligence and strategic HRM. Supply chain agility is highly influenced by leadership, organizational culture, employee skills, human capital development, competitive intensity and artificial intelligence, according to data from 221 Saudi Arabian industrial workers.

From a methodological perspective, fuzzy-based multi-criteria techniques are increasingly adopted for sustainability evaluation due to ambiguity in human judgments [19]. However, the application of Fuzzy AHP to evaluate Green HRM priorities remains limited that motivates for this study.

Research Objectives

The study aims to:

- Identify key HR parameters influencing sustainability and circular economy adoption
- Develop a hierarchical Green HRM evaluation model
- Apply Fuzzy AHP to prioritize HR practices
- Provide managerial recommendations for improving sustainable HR strategies

MATERIALS AND METHODS

A case study approach was adopted at Dayal Fertilizers Pvt. Ltd., Meerut, an established manufacturing firm with increasing sustainability initiatives. Fifty middle-management employees with experience in HR and operations participated wherein responses were recorded through questionnaire using Linguistic Scale. Expert judgments were used for pairwise comparisons. Fuzzy AHP was selected because it is suitable for HR sustainability assessments which involve subjective perceptions and uncertainty.

Table1: Dimensions and Criteria of HRM practices

S. No	Dimension	Criteria	Code
1	Strategic Commitment	✓ Sustainability Prioritization ✓ ESG Alignment	C1 C2
2	Green HR Implementation	✓ HR Planning & Job Design ✓ Sectoral environmental evaluation	C3 C4
3	Knowledge and Capability	✓ Research Integration ✓ Recruitment of sustainability-skilled personnel ✓ Training Initiatives	C5 C6 C7
4	Engagement and Incentives	✓ Staff Engagement ✓ Incentive schemes	C8 C9
5	Safety and Compliance	✓ Worker Safety Assurance	C10

Fuzzy AHP Framework and Calculation Procedure

Chang's extent analysis method [25] is used in prioritizing Green HRM criteria in this study. The steps are presented below:

- **Step 1:** Define goal and criteria hierarchy
- **Step 2:** Construct pairwise comparison matrix using linguistic scales
- **Step 3:** Convert linguistic judgments into triangular fuzzy numbers
- **Step 4:** Compute fuzzy synthetic extent values for each criterion
- **Step 5:** Defuzzify weights using centroid method: Wi = (l+m+u)/3
- **Step 6:** Normalize weights and ranking
- **Step 7:** Perform consistency ratio test

Hierarchy Structure

The goal is to prioritize Green HRM practices for Sustainability and Circular Economy. Table 1 depicts various dimensions and criteria of HRM practices for achieving the goal:

RESULTS

Each respondent provides a 10x10 fuzzy pairwise matrix; Table 2 shows the aggregation for each comparison Ci vs Cj as:

$$\tilde{a}_{ij} = \left(\frac{1}{50}\sum l_k, \frac{1}{50}\sum m_k, \frac{1}{50}\sum u_k\right)$$

After carrying out of all other steps of Extent Analysis and normalization of weights, here is the Table 3 which shows the normalize weights and ranking of the criterion.

The Consistency Ratio is calculated as:

- $\lambda max = 10.92$
- Consistency Index (CI) = 0.102
- Random Index (RI) = 1.49

Table2: Aggregated Fuzzy Pairwise Matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	(1,1,1)	(1,2,3)	(2,3,4)	(1,2,3)	(2,3,4)	(2,3,4)	(3,4,5)	(2,3,4)	(3,4,5)	(2,3,4)
C2	(1/3,1/2,1)	(1,1,1)	(2,3,4)	(3,4,5)	(3,4,5)	(4,5,6)	(3,4,5)	(4,5,6)	(3,4,5)	(3,4,5)
C3	(1/4,1/3,1/2)	(1/4,1/3,1/2)	(1,1,1)	(2,3,4)	(3,4,5)	(3,4,5)	(2,3,4)	(3,4,5)	(2,3,4)	(2,3,4)
C4	(1/3,1/2,1)	(1/5,1/4,1/3)	(1/4,1/3,1/2)	(1,1,1)	(1,2,3)	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(1,2,3)
C5	(1/4,1/3,1/2)	(1/5,1/4,1/3)	(1/5,1/4,1/3)	(1/3,1/2,1)	(1,1,1)	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(1,2,3)
C6	(1/4,1/3,1/2)	(1/6,1/5,1/4)	(1/5,1/4,1/3)	(1/3,1/2,1)	(1/3,1/2,1)	(1,1,1)	(1,2,3)	(1,2,3)	(1,2,3)	(1,2,3)
C7	(1/5,1/4,1/3)	(1/5,1/4,1/3)	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1,1,1)	(1,2,3)	(1,2,3)	(1,2,3)
C8	(1/4,1/3,1/2)	(1/6,1/5,1/4)	(1/5,1/4,1/3)	(1/4,1/3,1/2)	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1,1,1)	(1,2,3)	(1,2,3)
C9	(1/5,1/4,1/3)	(1/5,1/4,1/3)	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1,1,1)	(1,2,3)
C10	(1/4,1/3,1/2)	(1/5,1/4,1/3)	(1/4,1/3,1/2)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1/3,1/2,1)	(1,1,1)

Table3: Normalize weights and Ranking

Rank	Criterion	Weight	Priority Weight
1	Training initiatives	0.135	Highest
2	Sustainable recruitment	0.129	High
3	Incentive schemes	0.124	High
4	Staff engagement	0.116	Moderate
5	HR planning & Job design	0.113	Moderate

- Consistency Ratio (CR) = CI / RI = 0.068
- Since, CR < 0.10, the comparisons are considered consistent

DISCUSSION

This paper has explored the priorities of Green Human Resource Management (Green HRM) practices to promote sustainability and circular economy goals based on the Fuzzy Analytic Hierarchy Process (FAHP). The results suggest that sustainable recruitment and green incentive systems, capability-enhancing practices and behavior-oriented practices, especially training programs, are more persuasive than compliance-based or structural processes. The findings support the ever-increasing understanding that sustainability transformation is essentially human-based and not necessarily technological [26-27]. The training initiatives became the prioritized factor, highlighting the importance of the centrality of green competencies in facilitating the practices of the circular economy. The observation is consistent with the Resource-Based View (RBV), according to which firm-specific human capital may be of a competitive sustained advantage [28]. Green training increases employees' environmental awareness, eco-innovation potential and lifecycle thinking which are key elements to operationalizing circular strategies of waste reduction, remanufacturing and product life extension [2]. The higher level of training enhances the Ability Motivation Opportunity (AMO) framework [29]. Green training in this case enables employees to have capacity to drive towards sustainability. In the absence of proper environmental knowledge and skill advancement, circular initiatives can continue to be just rhetoric and not reality. The second one was sustainable recruitment, which emphasizes the necessity to find those who share the values of pro-environmentalism and competencies oriented toward sustainability. The findings are in line with previous studies proposing that the green hiring policies based on environmental culture and ecological long-term dedication [30]. Environmental policies in the recruitment contribute to value compatibility between the employees and the organizational sustainability missions and enhance the internal legitimacy and green employer branding. Recruitment is of specific significance in the context of the circular economy, as the shift towards regenerative models implies new skills, such as sustainable supply chain management, lifecycle assessment and environmental analytics [31]. Hence, talent acquisition acts as a systemic sustainability change enabler. Green incentive schemes were the third ranking, which means that the motivational mechanisms play a role in maintaining the environmental responsible behavior. This observation is consistent with the expectancy theory and literature on performance management [26]. Sustainability measures tied to incentives encourage accountability and indicate commitment of the organization to the environment. In AMO sense, incentive schemes constitute the motivation element that is required to transform green competencies into tangible results. The appraisal systems should incorporate the environmental key performance indicators (KPI) to increase the likelihood of employees taking part in the energy conservation, waste minimization and process optimization exercise, which are the main principles of the systems of circular economy. Institutional enablers are moderately rated elements that comprise staff engagement, green HR planning and job design, ESG alignment and sustainability prioritization. These dimensions form the structure and governance system in which behavioural practices are conducted, despite their relatively lower weights. In one example, it is found that green job design institutionalizes environmental accountability by entrenching sustainability duties on official role descriptions [32]. ESG alignment stimulates transparency and confidence of the investors, increasing external legitimacy. These processes are indicative of the stakeholder theory, which is a part of core organizational governance that integrates environmental and social concerns within their governance framework [33]. Lower-ranked variables including research integration and sector evaluation suggest that although benchmarking and innovation can help sustainability, they can have indirect, but not direct impact. Nevertheless, in a dynamic regulatory context, sustained sectoral evaluation and cooperation with educational organizations may support the ability to adapt and create a long-term circular innovation [34]. Although it is the least significant, worker safety is necessary to ensure that environmental change does not undermine the well-being of the occupants. Sustainable development is intrinsically linked to the environmental, economic and social elements and therefore safety compliance is a cornerstone to the comprehensive sustainability performance.

CONCLUSION

FAHP offers a powerful quantitative model that assesses Green HRM practices in an uncertain situation. The strategy helps in strategic HR decision making towards circular economy objectives. The main drivers are capability development, value-based recruitment and incentive alignment and the support using governance and structural mechanisms. These results support the view that implementation of the circular economy is an inherently socio-organizational change process based on human capital and behavioral change.

Theoretical Contributions

The results add to the Green HRM literature by empirically proving that capability-building practices alongside motivational HR practices have a stronger impact on the development of the circular economy than the structural compliance forces. It supports the thesis that human capital development mediates sustainability performance [34]. Moreover, the incorporation of FAHP into the sustainability studies offers a fine-tuned prioritization system that is able to deal with linguistic ambiguity and subjectivity among managers. This methodological contribution advances the rigor of decision-making in the HR strategy design on sustainability.

Managerial Implications

The implications of the results to practitioners are that organizations aiming to undergo a circular transformation should:

- Focus on green training and development capabilities
- Incorporate sustainability requirements on recruitment and selection. Incorporate environmental KPIs in performance appraisal and incentive systems
- Redesign roles to show the circularity of jobs and lifecycle accountability
- Make HR strategy consistent with ESG reporting schemes to ensure governance consistency

The human ability focus suggests that introduction of technology is not enough unless the same is accompanied by an equivalent investment in developing green workforce.

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