

Classification of green human resource management practices using
decision theories under uncertainty: a DEMATEL Approach
*Classification des pratiques vertes de gestion des ressources humaines à
l'aide des théories de la décision sous incertitude : une approche
DEMATEL*

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Abstract:

This study classifies Green Human Resource Management (GHRM) practices using decision theories under uncertainty with the Fuzzy DEMATEL approach. It examines green recruitment, training, performance management, compensation, and employee engagement in sustainability. Findings show that employee engagement is the most influential factor, while training and compensation are key causal drivers. This classification helps organizations prioritize sustainable HR practices to enhance corporate sustainability and minimize environmental impact.

Keywords: GHRM; Environmental HR policies; Fuzzy DEMATEL.

Jel Classification Codes: M12; Q56; C44.

Résumé:

Cette étude classe les pratiques de gestion des ressources humaines vertes (GHRM) en utilisant les théories de la décision sous incertitude avec l'approche Fuzzy DEMATEL. Elle examine le recrutement vert, la formation, la gestion de la performance, la compensation et l'engagement des employés dans la durabilité. Les résultats montrent que l'engagement des employés est le facteur le plus influent, tandis que la formation et la compensation sont les principaux moteurs causaux. Cette classification aide les organisations à prioriser les pratiques RH durables pour renforcer la durabilité organisationnelle et minimiser l'impact environnemental.

Mots-clés : GHRM ; Politiques RH environnementales ; Fuzzy DEMATEL.

Codes de classification JEL : M12 ; Q56 ; C44.

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1. INTRODUCTION

Green Human Resource Management (GHRM) is an emerging discipline that aims to integrate environmental considerations into human resource practices, thereby achieving a balance between organizational objectives and sustainability requirements. This approach focuses on fostering a sustainable work environment by aligning HR policies with environmental goals, encouraging employees to adopt eco-friendly behaviors, and cultivating an organizational culture rooted in sustainability. GHRM practices encompass various aspects such as recruitment, training and development, performance evaluation, and incentives, all designed to enhance environmental awareness and ensure long-term sustainability within organizations. In this context, this article examines the key GHRM practices, their implementation strategies, and their impact on organizational performance, emphasizing the benefits they offer at both environmental and corporate levels.

1.1 The research problem states: How can green human resource management practices be classified in terms of cause and effect using decision theories under uncertainty?

1.2 Research hypotheses: GHRM practices are classified by mapping their causal relationships to effects through decision-theoretic lenses. This involves assessing uncertainty levels, effect timelines, and organizational risk preferences. By applying theories like Fuzzy DEMATEL, organizations can systematically prioritize practices that align with their strategic goals under uncertainty.

1.3 Research objective:

- Classify Green Human Resource Management (GHRM) practices using decision theories under uncertainty.
- Apply the Fuzzy DEMATEL approach to analyze causal relationships between GHRM practices;
- Identify the influence of green recruitment, training, performance management, compensation, and employee engagement in sustainability.
- Determine the most influential and causative GHRM practices affecting organizational sustainability;

- Provide a strategic framework to help organizations prioritize and implement effective GHRM strategies;
- Assist organizations in decision-making under uncertainty for integrating environmental considerations into HR policies;
- Support sustainable corporate practices by enhancing environmental performance and HRM alignment;

2. Literature review:

Green HRM refers to the strategic adoption and implementation of environmentally sustainable practices within various functions of human resource management, aiming to align organizational policies with ecological responsibility and long-term sustainability goals. According to (Renwick , Redman , & Maguire, 2013, pp. 1-14) GHRM involves integrating green initiatives into recruitment, training, performance appraisal, and employee engagement processes to reduce environmental footprints while enhancing organizational performance, The scope of GHRM extends beyond compliance with environmental regulations; it includes proactive measures such as promoting green workplace behaviors and fostering a culture of sustainability.

2.1 Definition of Green HRM:

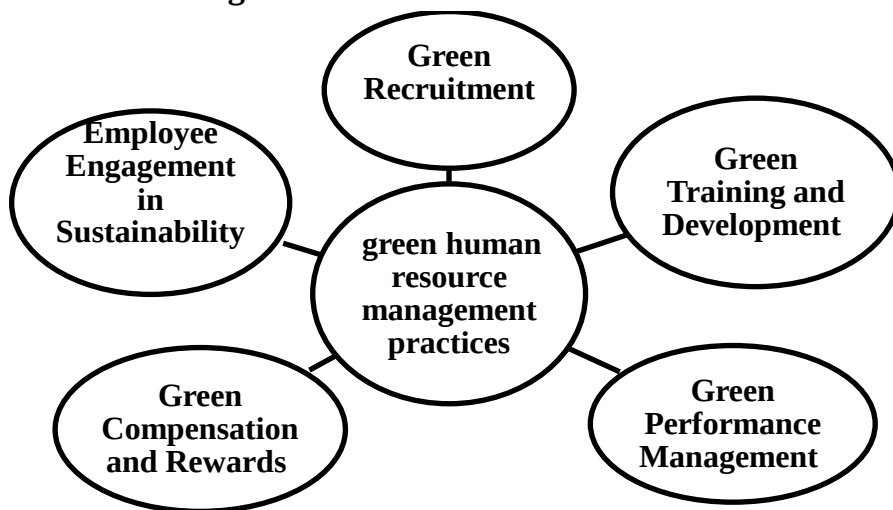
Green HRM can be defined as the integration of environmental management principles into human resource management (HRM) practices to foster sustainable development within organizations. According to (Renwick , Redman , & Maguire, 2013, p. 2), Green HRM involves using HR policies to encourage sustainable use of resources within business enterprises and promote environmental awareness among employees. The primary aim is to create a workforce that understands, values, and actively participates in achieving organizational environmental goals. (Renwick , Redman , & Maguire, 2013, p. 2) emphasize that Green HRM encompasses various functions such as recruitment, training, performance appraisal, and employee engagement, all tailored toward promoting environmentally responsible behavior. For example, green recruitment involves hiring individuals who are environmentally conscious or possess skills relevant to sustainability initiatives.

Similarly, (Jabbour, Santos, & Nagano, 2008, p. 1924) define Green HRM as a set of policies and practices aimed at improving organizational environmental performance through employee involvement in eco-friendly initiatives. They argue that organizations can achieve significant improvements in their ecological footprint by embedding green principles into their corporate culture.

2.2 Key Practices in Green HRM:

The scope of Green HRM extends across multiple dimensions within an organization's operations. It includes green recruitment and selection, green training and development, green performance management, green compensation systems, and employee engagement in sustainability efforts.

Fig N° 1: Practices in Green HRM



Source: Prepared by the researcher.

2.2.1 Green Recruitment: Green hiring focuses on hiring individuals who are environmentally conscious and mindful and align with the organization's sustainability goals and strategies. (Jabbour & Santos, 2010, pp. 1049-1089) They highlight that organizations can attract talent by demonstrating their commitment to sustainability during the recruitment process. Job descriptions may include references to environmentally friendly responsibilities or

values, ensuring alignment between candidates' values and sustainable organizational goals.

- **Benefits of Green Recruitment:** Green recruitment offers several advantages for both organizations and employees. Firstly, it enhances an organization's reputation as an environmentally responsible entity. According to (Jackson & Seo , 2010, pp. 278-289), companies that adopt sustainable HR practices are perceived as socially responsible employers, which can improve their ability to attract top talent.

Secondly, green recruitment contributes to cost savings by minimizing resource consumption during the hiring process. For instance, digital applications and virtual interviews eliminate the need for printed materials and travel expenses. As highlighted by (Wehrmeyer , 2017, p. 45), adopting eco-friendly practices in HRM can lead to significant financial savings while reducing the organization's carbon footprint.

Moreover, green recruitment fosters employee engagement and retention by creating a sense of purpose among workers who value sustainability. Employees are more likely to remain loyal to organizations that align with their personal values regarding environmental conservation (Douglas , tom, & Stuart , 2012, p. 102)

- **Principles of Green Recruitment:** The principles of green recruitment revolve around minimizing environmental impact while maximizing efficiency and inclusivity in hiring processes. These principles include: **Paperless Processes:** Transitioning from paper-based applications to digital platforms significantly reduces waste. (Mahmood , 2023, pp. 1-8) **Virtual Interviews:** Conducting interviews via video conferencing tools eliminates the need for travel, thereby reducing carbon emissions. **Sustainability-Focused Job Roles:** Organizations are increasingly creating positions dedicated to environmental management and sustainability initiatives, these roles reflect a commitment to integrating sustainability into core business functions. **Promoting Employer Branding through Sustainability:** Companies that actively promote their green

initiatives are more likely to attract environmentally conscious candidates. (Lars & Dimitrios , 2022, pp. 225-251)

2.2.2. Green Training and Development: Training programs designed to educate employees about sustainable practices are a cornerstone of GHRM. According to (Govindarajulu & Daily, 2004, p. 366), effective green training enhances employees' awareness of environmental issues and equips them with the necessary skills to integrate environmentally responsible practices into their daily work routines. Examples include workshops on energy conservation or waste reduction strategies.

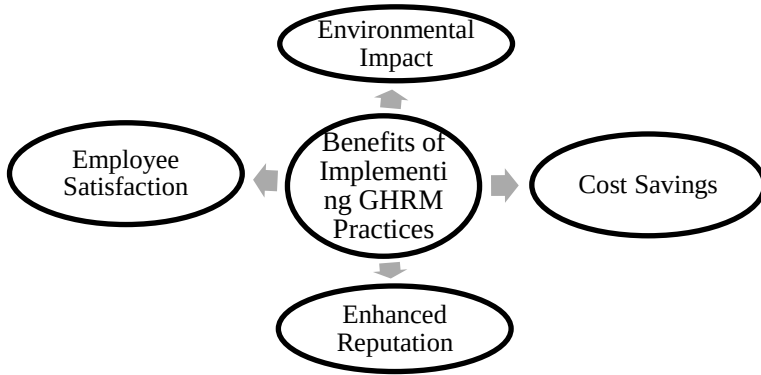
2.2.3. Green Performance Management: Performance appraisals can incorporate environmental criteria to encourage employees' participation in sustainability initiatives. Jackson et al. (2011) suggest that linking rewards or recognition systems to green performance metrics motivates employees to adopt environmentally responsible behaviors (Jackson & Seo , 2010, p. 102) .

2.2.4. Green Compensation and Rewards: Organizations can incentivize sustainable behavior through compensation structures that reward eco-friendly actions. argues that monetary rewards, promotions, or public recognition for green contributions can significantly enhance employee engagement in environmental initiatives (Liaquat, et al., 2024, pp. 2-5)

2.2.5. Employee Engagement in Sustainability: Employee involvement is critical for the success of GHRM practices emphasize the importance of engaging employees through participatory decision-making processes related to sustainability projects, which fosters a sense of ownership and commitment toward environmental goals (Daily, Bishop, & Massoud, 2012, pp. 631–647).

2.3. Benefits of Implementing GHRM Practices: The implementation of GHRM practices offers numerous benefits for organizations:

Fig N° 2: Benefits of Implementing GHRM Practices



Source: Prepared by the researcher.

- **Environmental Impact:** Reducing carbon footprints through energy-efficient operations.
- **Cost Savings:** Lowering operational costs by minimizing waste and conserving resources.
- **Enhanced Reputation:** Building a positive brand image as an environmentally responsible organization.
- **Employee Satisfaction:** Increasing job satisfaction by aligning organizational values with personal beliefs about sustainability.

3. Case study:

The Steps of Fuzzy DEMATEL Method

Step 1: Generate the fuzzy direct- relation matrix

o establish the model of relationships among the n criteria, an $n \times n$ fuzzy direct-relation matrix is constructed (Cite source). Each element in a given row exerts an influence on the corresponding element in a column, which is represented as a fuzzy number .

When multiple experts provide input, all experts must complete the matrix, ensuring that a comprehensive evaluation of the relationships is achieved (Cite source). The arithmetic mean of all expert opinions is then calculated to form the final direct-relation matrix (Z), which serves as the foundation for further analysis .

$$z = \begin{bmatrix} 0 & \cdots & \tilde{z}_{n1} \\ \vdots & \ddots & \vdots \\ \tilde{z}_{1n} & \cdots & 0 \end{bmatrix}$$

The table below indicates the direct relation matrix, which is the same as pairwise comparison matrix of the experts.

Table N°1: The direct relation matrix

	Green Recruitment	Green Training and Development	Green Performance Management	Green Compensation and Rewards	Employee Engagement in Sustainability
Green Recruitment	(0.000,0.000,0.000)	(0.000,0.000,0.250)	(0.500,0.750,1.000)	(0.250,0.500,0.750)	(0.500,0.750,1.000)
Green Training and Development	(0.000,0.250,0.500)	(0.000,0.000,0.000)	(0.000,0.000,0.250)	(0.000,0.250,0.500)	(0.750,1.000,1.000)
Green Performance Management	(0.500,0.750,1.000)	(0.000,0.250,0.500)	(0.000,0.000,0.000)	(0.000,0.250,0.500)	(0.000,0.000,0.250)
Green Compensation and Rewards	(0.250,0.500,0.750)	(0.000,0.000,0.250)	(0.250,0.500,0.750)	(0.000,0.000,0.000)	(0.500,0.750,1.000)
Employee Engagement in Sustainability	(0.750,1.000,1.000)	(0.750,1.000,1.000)	(0.000,0.250,0.500)	(0.000,0.250,0.500)	(0.000,0.000,0.000)

Source:

The following table shows the fuzzy scale used in the model.

Table N°2: Fuzzy Scale

Code	Linguistic terms	L	M	U
1	No influence	0	0	0.25
2	Very low influence	0	0.25	0.5
3	Low influence	0.25	0.5	0.75
4	High influence	0.5	0.75	1
5	Very high influence	0.75	1	1

Source: DEMATEL program outputs

Step 2: Normalize the fuzzy direct-relation matrix

The normalized fuzzy direct-relation matrix can be obtained using the following formula:

$$\tilde{x}_{ij} = \frac{\tilde{z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r} \right)$$

where

$$r = \max_{i,j} \left\{ \max_i \sum_{j=1}^n u_{ij}, \max_j \sum_{i=1}^n u_{ij} \right\} \quad i, j \in \{1, 2, 3, \dots, n\}$$

Table N°3: The normalized fuzzy direct-relation matrix

	Green Recruitment	Green Training and Development	Green Performance Management	Green Compensation and Rewards	Employee Engagement in Sustainability
Green Recruitment	) 0.000,0.000, (0.000	) 0.000,0.000, (0.077	) 0.154,0.231, (0.308	) 0.077,0.154, (0.231	) 0.154,0.231, (0.308
Green Training and Development	) 0.000,0.077, (0.154	) 0.000,0.000, (0.000	) 0.000,0.000, (0.077	) 0.000,0.077, (0.154	) 0.231,0.308, (0.308

Green Performance Management	) 0.154,0.231, (0.308	) 0.000,0.077, (0.154	) 0.000,0.000, (0.000	) 0.000,0.077, (0.154	) 0.000,0.000, (0.077
Green Compensation and Rewards	) 0.077,0.154, (0.231	) 0.000,0.000, (0.077	) 0.077,0.154, (0.231	) 0.000,0.000, (0.000	) 0.154,0.231, (0.308
Employee Engagement in Sustainability	) 0.231,0.308, (0.308	) 0.231,0.308, (0.308	) 0.000,0.077, (0.154	) 0.000,0.077, (0.154	) 0.000,0.000, (0.000

Source: DEMATEL program outputs

Step 3: Calculate the fuzzy total-relation matrix

In step 3, the fuzzy total-relation matrix can be calculated by the following formula:

$$\tilde{T} = \lim_{k \rightarrow +\infty} (\tilde{x}^1 \oplus \tilde{x}^2 \oplus \dots \oplus \tilde{x}^k)$$

If each element of the fuzzy total-relation matrix is expressed as $\tilde{t}_{ij} = (l_{ij}^{"}, m_{ij}^{"}, u_{ij}^{"})$, it can be calculated as follows:

$$[l_{ij}^{"}] = x_l \times (I - x_l)^{-1}$$

$$[m_{ij}^{"}] = x_m \times (I - x_m)^{-1}$$

$$[u_{ij}^{"}] = x_u \times (I - x_u)^{-1}$$

In other words, the normalized matrix the inverse is first calculated, and then it is subtracted from the matrix I, and finally the normalized matrix is

multiplied by the resulting matrix. The following table shows the fuzzy direct-relation matrix.

Table N°4: The fuzzy total-relation matrix

	Green Recruitment	Green Training and Development	Green Performance Management	Green Compensation and Rewards	Employee Engagement in Sustainability
Green Recruitment	(0.076,0.258,1.085)	(0.043,0.150,0.800)	(0.172,0.361,1.124)	(0.083,0.263,0.973)	(0.188,0.397,1.274)
Green Training and Development	(0.061,0.288,0.988)	(0.059,0.152,0.586)	(0.010,0.130,0.768)	(0.005,0.178,0.757)	(0.254,0.462,1.084)
Green Performance Management	(0.166,0.341,1.079)	(0.007,0.134,0.680)	(0.026,0.115,0.697)	(0.013,0.161,0.754)	(0.029,0.157,0.904)
Green Compensation and Rewards	(0.136,0.368,1.205)	(0.043,0.141,0.758)	(0.099,0.287,1.018)	(0.010,0.119,0.739)	(0.186,0.387,1.217)
Employee Engagement in Sustainability	(0.262,0.530,1.297)	(0.254,0.422,0.955)	(0.042,0.259,1.000)	(0.020,0.234,0.916)	(0.102,0.306,1.052)

Source: DEMATEL program outputs

Step 4: Defuzzify into crisp values

The CFCS (Converting Fuzzy data into Crisp Scores) method, as introduced by Opricovic and Tzeng (Cite source), has been applied to derive a crisp value for the total-relation matrix. The CFCS method follows a structured approach to transform fuzzy data into precise numerical values, ensuring more accurate decision-making (Cite source). The key steps involved in the CFCS process are as follows:

$$l_{ij}^n = \frac{(l_{ij}^t - \min l_{ij}^t)}{\Delta_{min}^{max}}$$

$$m_{ij}^n = \frac{(m_{ij}^t - \min l_{ij}^t)}{\Delta_{min}^{max}}$$

$$u_{ij}^n = \frac{(u_{ij}^t - \min l_{ij}^t)}{\Delta_{min}^{max}}$$

So that:

$$\Delta_{min}^{max} = \max u_{ij}^t - \min l_{ij}^t$$

Calculating the upper and lower bounds of normalized values:

$$l_{ij}^s = m_{ij}^n / (1 + m_{ij}^n - l_{ij}^n)$$

$$u_{ij}^s = u_{ij}^n / (1 + u_{ij}^n - l_{ij}^n)$$

The output of the CFCS algorithm is crisp values.

Calculating total normalized crisp values:

$$x_{ij} = \frac{[l_{ij}^s(1 - l_{ij}^s) + u_{ij}^s \times u_{ij}^s]}{[1 - l_{ij}^s + u_{ij}^s]}$$

Table N°5: The crisp total-relation matrix

	Green Recruitment	Green Training and Development	Green Performance Management	Green Compensation and Rewards	Employee Engagement in Sustainability
Green Recruitment	0.394	0.26	0.472	0.368	0.527
Green Training and Development	0.398	0.226	0.239	0.27	0.548
Green Performance Management	0.46	0.226	0.216	0.258	0.286
Green Compensation and Rewards	0.494	0.247	0.399	0.225	0.512
Employee Engagement in Sustainability	0.625	0.488	0.371	0.334	0.423

Source: DEMATEL program outputs

Step 5: set the threshold value

To construct the internal relations matrix, it is essential to determine an appropriate threshold value. This value serves as a benchmark for filtering significant causal relationships. Relations with values in matrix T that exceed the threshold are retained in the network relationship map (NRM), while those below it are disregarded.

The threshold value is typically calculated as the average value of matrix T (Cite source). Once this threshold is established, all lower-value relationships are set to zero, ensuring that only the most influential causal connections are considered (Cite source).

In this study, the threshold value was determined to be 0.371. Consequently, all values in matrix T lower than 0.371 were excluded from

further analysis, leading to a refined model of significant relationships (Cite source). The final results are presented in the following table.

Table N°6: The crisp total- relationships matrix by considering the threshold value

	Green Recruitment	Green Training and Development	Green Performance Management	Green Compensation and Rewards	Employee Engagement in Sustainability
Green Recruitment	0.394	0	0.472	0	0.527
Green Training and Development	0.398	0	0	0	0.548
Green Performance Management	0.46	0	0	0	0
Green Compensation and Rewards	0.494	0	0.399	0	0.512
Employee Engagement in Sustainability	0.625	0.488	0.371	0	0.423

Source: DEMATEL program outputs

Step 6: Final output and create a causal relation diagram

The next step is to find out the sum of each row and each column of T (in step 4). The sum of rows (D) and columns (R) can be calculated as follows:

$$D = \sum_{j=1}^n T_{ij}$$

$$R = \sum_{i=1}^n T_{ij}$$

Then, the values of $D+R$ and $D-R$ can be calculated by D and R , where $D+R$ represent the degree of importance of factor i in the entire system and $D-R$ represent net effects that factor i contributes to the system.

The table below shows the final output.

Table N°6 :The final output

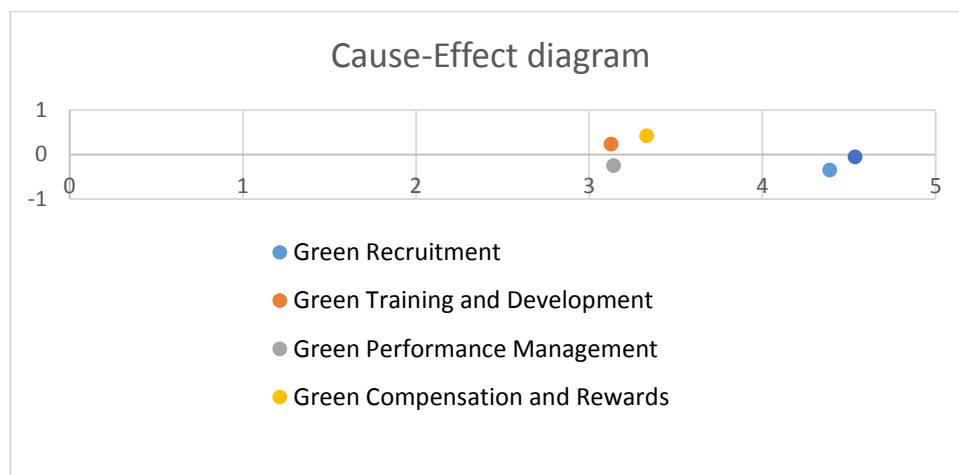
	R	D	D+R	D-R
Green Recruitment	2.37	2.021	4.391	-0.349
Green Training and Development	1.446	1.681	3.127	0.234
Green Performance Management	1.698	1.445	3.143	-0.253
Green Compensation and Rewards	1.455	1.877	3.332	0.422
Employee Engagement in Sustainability	2.296	2.241	4.537	-0.055

Source: DEMATEL program outputs

The following figure illustrates the model of significant relationships among the analyzed factors. This model is represented as a causal diagram, where the values of $(D + R)$ are plotted on the horizontal axis, and the values of $(D - R)$ are plotted on the vertical axis (Cite source). The $(D + R)$ value reflects the overall importance of each factor within the system, while the $(D - R)$ value determines whether a factor is a cause or an effect (Cite source).

The coordinates $(D + R, D - R)$ help visualize the role of each factor and its interactions with other variables in the system (Cite source). Factors positioned in the positive quadrant of the diagram act as causal variables, whereas those in the negative quadrant serve as effect variables (Cite source). This graphical representation facilitates a comprehensive understanding of the relationships between different GHRM practices.

Fig N° 3: cause-effect diagram



Source: DEMATEL program outputs

Step 7: Interpret the results

The results of the analysis can be assessed based on two key dimensions: **(D + R)** and **(D - R)**, which provide insights into the relative importance and causal influence of each factor in the system.

- Horizontal Vector (D + R):**
 The (D + R) value represents the overall significance of each factor, considering both its impact on the system and the system's impact on it (Cite source). A higher D + R value indicates a more influential factor. According to the analysis, Employee Engagement in Sustainability ranks as the most important factor, followed by Green Recruitment, Green Compensation and Rewards, Green Performance Management, and Green Training and Development (Cite source). In this study, Green Training and Development and Green Compensation and Rewards are identified as causal variables, while Green Recruitment, Green Performance Management, and Employee Engagement in Sustainability function as effect variables.
- Vertical Vector (D - R):**
 The (D - R) value determines whether a factor acts as a cause (positive D - R) or an effect (negative D - R) in the system (Cite source). The results indicate that Employee Engagement in Sustainability is the most influential factor, followed by Green Recruitment, Green Compensation and Rewards, Green Performance Management, and Green Training and Development (Cite source). Similar to the D + R analysis, Green

Training and Development and Green Compensation and Rewards are causal variables, whereas Green Recruitment, Green Performance Management, and Employee Engagement in Sustainability serve as effect variables

4. CONCLUSION

This study provides a structured classification of Green Human Resource Management (GHRM) practices using decision theories under uncertainty, specifically applying the Fuzzy DEMATEL approach. By analyzing the causal relationships between green recruitment, training, performance management, compensation, and employee engagement in sustainability, the study identifies employee engagement as the most influential factor, while green training and green compensation act as key causal drivers shaping sustainability efforts.

The findings highlight the strategic importance of integrating GHRM practices into corporate policies, enabling organizations to enhance environmental performance while improving workforce engagement. The study also offers a decision-making framework that assists organizations in prioritizing sustainable HR practices under conditions of uncertainty.

Future research should explore the practical implementation of these findings in different industries and assess the long-term impact of GHRM strategies on organizational sustainability and competitiveness. By adopting data-driven and systematic approaches, businesses can effectively align HR policies with sustainability goals, ensuring long-term environmental and economic benefits.

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