

## RESEARCH ARTICLE

## Prioritising green HRM practices: A pre-test application of Fuzzy TOPSIS

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**Abstract** - Green Human Resource Management (Green HRM) has been acknowledged as a strategic approach to encouraging green sustainability within organisations. However, there is a lack of structured practices for ranking the most impactful Green HRM practices, especially among Malaysian manufacturing industries. This study addresses the research gap by evaluating the relative importance of Green HRM practices using the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). It aims to identify whether Fuzzy TOPSIS can serve as a prominent decision-making tool for determining the most effective Green HRM practices in organisations. A pre-test was conducted with two decision-makers comprising Human Resource (HR) managers from the manufacturing industries. The questionnaire was developed based on prior studies and the variables encompassed four Green HRM practices: green recruitment, green training, green rewards, and green employee involvement. Fuzzy logic was incorporated to handle the uncertainty in expert judgment. The findings revealed that green rewards ranked first, followed by green employee involvement, green recruitment, and green training. This suggests that reward-based and involvement strategies are the most influential factors in driving sustainable HR outcomes within organisations. This study contributes to the limited research on decision-making tools in Green HRM and provides a practical foundation for future large-scale evaluations by using Fuzzy TOPSIS.

### Article History

Received : 10 June 2025  
 Revised : 18 August 2025  
 Accepted : 31 October 2025  
 Published : 30 June 2026

### Keywords

*Green HRM*  
*Green recruitment*  
*Green training*  
*Green rewards*  
*Green employee involvement*  
*Fuzzy TOPSIS*

### 1. Introduction

In recent years, growing awareness of environmental sustainability has influenced corporate strategies, especially in the Human Resources (HR) field. This shift has led to the emergence of Green Human Resource Management (Green HRM), which incorporates green policies and practices into core HR functions. The purpose of Green HRM is to produce a workplace that cares about the environment and promotes long-term sustainability performance. In the context of Malaysia's manufacturing industries, the application of Green HRM practices is gaining importance due to increasing regulatory pressures and global sustainability trends (Ichdan & Maryani, 2024). The manufacturing industries in Malaysia not only contribute to the economy but also play a key role to pollution. This industry is a key contributor to economic development and a major source of environmental degradation due to high rates of wasteful consumption. It is also responsible for global energy use, accounting for approximately 30% of global consumption (International Energy Agency, 2019). In Malaysia, the manufacturing industry continues to face pressure from stakeholders, regulatory board members, and international trade standards to enhance its Green HRM practices (Zaid et al., 2020). This emphasises the need for manufacturers to apply sustainable practices (Zaid et al., 2020). Therefore, Green HRM plays a major role in advancing sustainable operations by integrating environmental values into human resource management. While there is growing interest in sustainability, research on Green HRM in manufacturing industries remains predominantly conceptual and lacks empirical evidence to inform managerial decision-making. The absence of quantitative assessments limits the ability to analyse and prioritise practices with the greatest potential to improve sustainability performance, thus constraining strategic resource allocation. To address this research gap, this study presents a pre-test of structured instruments to quantitatively evaluate and rank Green HRM practices by using Fuzzy TOPSIS, a multi-criteria decision-making approach that facilitates structured, objective, and data-driven prioritisation (Piya et al., 2022).

This study aims to address the following research objectives and subsequent research questions. The primary objectives are to evaluate the reliability of the developed instrument for evaluating Green HRM practices in the Malaysian manufacturing industry, examine which Green HRM practices are perceived as the most significant by HR managers based on a preliminary Fuzzy TOPSIS method application, and examine how the incorporation of Fuzzy TOPSIS with HR managers' input can address the vagueness and subjectivity involved in sustainability-related decision-making. To achieve these aims, the study addresses corresponding inquiries regarding how reliable and valid the developed instrument is for evaluating Green HRM practices in the Malaysian manufacturing industry, which Green HRM practices are perceived as most significant by HR managers through the preliminary application of Fuzzy TOPSIS, and how Fuzzy TOPSIS, combined with expert input, can address the vagueness and subjectivity inherent in sustainability-related decision-making. The structure of this paper is as follows: Section 2 reviews the relevant literature and identifies research gaps. Section 3 outlines the methodology employed in this study. Section 4 explains the data analysis and results, along with a comprehensive discussion of the key findings and their research implications. Lastly, Section 5 addresses the study's limitations and offers recommendations for future research.

## 1.1 Literature Review

### 1.1.1 Green HRM

While numerous studies have examined Green HRM practices and MCDM tools, it is also essential to consider Green HRM from multiple research perspectives. Green HRM is a derived term developed from green management policies and practices that organisations implement for environmental management (EM) (Patel, 2018). It can be defined as the integration of environmental management with HR practices to improve sustainability goals within the company (Arulrajah, 2016). Green HRM practices such as green recruitment, green training, employee involvement, and performance management have been incorporated in the HR initiatives (Renwick et al., 2013). Research has shown that Green HRM practices can reduce the costs and environmental damage caused by industry (Agag & Colmekcioglu, 2020; Asadi et al., 2020; Al-Aomar, 2017). It shows that the application of Green HRM practices plays a pivotal role in the workplace, as stakeholders have forced organisations to improve their business operations in light of environmental impact (Ahmed et al., 2021). In fact, Green HRM practices help organisations meet their sustainability purpose and reduce pollution and their environmental footprint (Zaid et al., 2018). Stone et al. (2024) also emphasised that the most important strategic role of HRM is in achieving organisational goals.

### 1.1.2 Green HRM practices

According to O'Donohue (2015), the most essential element in Green HRM practices is green recruitment and selection, as it helps recognise green employees who display green tendencies and develop a green working environment. Green recruitment can assist organisations in attaining environmental goals (Gupta et al., 2022). This demonstrates that green recruitment and selection can give advantages to both employers and employees. Moreover, training can enhance employees' knowledge, skills, and awareness relevant to environmental activities (Aykan, 2017). Several studies also highlighted that green training must be delivered to align with educational programs for all employees, and that it must not be limited to environmental organisational departments (Calia et al., 2009). Jamal et al. (2021) found a positive relationship between green rewards and corporate sustainability. To improve and achieve sustainability goals, organisations can reward employees for their commitment to displaying green behaviours and sustainable practices (Alhaddi, 2015). Masri and Jaaron (2017) also noted that corporate sustainability can benefit from reward systems if these systems reduce limitations and encourage green behaviour. Several studies also emphasised that Green Employee Involvement can be a crucial factor in improving organisational performance, such as reducing waste and pollution (Alhaddi, 2015; Delmas & Burbano, 2011; Colwell & Joshi, 2011).

Therefore, organisations must encourage their employees to become involved by initiating green and eco-friendly ideas as part of implementing green practices (Ahmad, 2015; Alhaddi, 2015). Zibarras and Coan (2015) further noted that the HR department can focus on creating a participative work environment for strategic-level managers. This will lead to a working culture where employees feel confident in negotiating or disagreeing with top management's decisions and they can also offer diverse ideas to improve any organisational issues (Zibarras & Coan, 2015). This shows that Green Rewards, Green Training and Development, Green Recruitment, and Green Employee Involvement are key practices frequently highlighted in the literature. In the Malaysian manufacturing context, Yong et al. (2019) also observed that implementing Green HRM practices as an integrated system is more effective at driving environmental performance. Similar findings have been reported in other developing economies, such as Vietnam and Indonesia, where Green HRM has been associated with improved sustainable competitiveness (Pham et al., 2020; Longoni et al., 2018).

### 1.1.3 Multi-criteria decision-making tools

The Multi-criteria decision-making (MCDM) tool is a reliable decision-making method which has been regarded as a revolution in this field. To implement frameworks that aid in structuring decision-making problems and generating preferences over alternatives, several empirical studies have employed MCDM methods to examine potential mathematical modelling since the 1950s. According to Rane et al. (2023), MCDM tools can help prioritise criteria, assign weights to each criterion, and evaluate alternatives based on their performance against these criteria. This method allows researchers to decide on the most suitable Green HRM practices for their specific decision-making context. Rane et al. (2023) further noted that Analytic Hierarchy Process (AHP), Fuzzy Analytic Hierarchy Process (FAHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Fuzzy TOPSIS, Elimination and Choice Expressing Reality (ELECTRE), and VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) are some of the MCDM methods available for sustainable development decision-making.

Each of these methods offers a unique approach to decision-making, allowing decision-makers to select the most suitable method for their particular decision-making context. This study applied Fuzzy TOPSIS as this tool is particularly effective for evaluating Green HRM practices, which involve subjective and multi-dimensional criteria. Fuzzy TOPSIS maintains relatively low rank-reversal rates under uncertainty, thereby producing more stable and consistent rankings than other tools like Fuzzy AHP, which tends to exhibit greater instability (Nazim et al., 2022). In fact, Fuzzy TOPSIS shows an effective balance between computational simplicity and flexibility in modelling both quantitative and qualitative criteria using fuzzy sets (Chen, 2000; Shih et al., 2007). This demonstrates that Fuzzy TOPSIS is more practical and efficient for real-world sustainability evaluations, where criteria such as environmental awareness and employee engagement are essentially ambiguous and subjective (Govindan et al., 2013; Jabbour & Jabbour, 2016).

## 2. Methods and Materials

This study employed a quantitative research design using the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy TOPSIS), which is widely recognised for handling uncertainty and subjective evaluations in decision-making. The primary objective of this pre-test study was to evaluate the applicability of Fuzzy TOPSIS for identifying key Green HRM practices in Malaysia's manufacturing sector.

### 2.1 Questionnaire Development and Data Collection

The questionnaire was developed based on prior research related to Green HRM practices. All items were adapted from existing studies to ensure content validity and relevance to the research context. It consisted of structured items designed to assess four core dimensions of Green HRM: green recruitment, green training, green rewards, and green employee involvement. Each practice was evaluated using linguistic terms, which were later converted into triangular fuzzy numbers (TFNs) to capture the vagueness and uncertainty in expert judgments.

#### Green Recruitment

1. My organisation has included the company's green and social needs in the job description and specification (Shah, 2019).
2. My organisation has incorporated environmental considerations into the job description (Shah, 2019).
3. In my organisation, job candidates are evaluated on green aspects during job interviews (Shah, 2019).
4. My organisation considers candidates' environmental concern, motivation, and interest as selection criteria (Saeed et al., 2019).
5. The organisation prefers to recruit employees who are familiar with the environment (Siyambalapitiya et al., 2018).

#### Green Training

1. In my organisation, environmental training is offered to all employees (including outsourced ones) across all hierarchical levels (Jabbour, 2015; Saeed et al., 2019).
2. In my organisation, employees are overall satisfied with the environmental training offered (Jabbour, 2015).
3. In my organisation, the topics covered in environmental training sessions are suitable and current for the organisational activities (Jabbour, 2015).
4. My organisation assesses who needs training in environmental management (Shah, 2019).
5. My organisation delivers environmental management training to improve employee awareness, skills, and know-how (Shah, 2019).
6. In general, staff are satisfied with the organisation's green training (Nejati et al., 2017).

#### Green Rewards

1. My organisation offers non-monetary or monetary rewards based on environmental achievements (e.g., sabbaticals, leave, gifts, bonuses, cash, premiums, promotions) (Masri & Jaaron, 2017; Saeed et al., 2019).
2. In my organisation, environmental performance is recognised publicly (Masri & Jaaron, 2017; Saeed et al., 2019).
3. My organisation provides incentives to encourage environmentally friendly activities and behaviours (e.g., car sharing) (Saeed et al., 2019).
4. Contribution to environmental management is assessed (Khan et al., 2021).
5. Individual performance assessment results are recorded (Khan et al., 2021).

#### Green Employee Involvement

1. My organisation uses various formal and informal communication methods to develop green values (Shah, 2019).
2. In my organisation, the top managers use teamwork to successfully manage and produce awareness of the environmental issues (Masri & Jaaron, 2017).
3. My organisation recognises employees as key stakeholders in environmental management (Saeed et al., 2019).
4. My organisation emphasises a culture of environmental protection, stressing the values of green safety and presenting green practices (Rephrased from Shah, 2019).
5. My organisation has a procedure of helplines and green whistle-blowing (Shah, 2019).

The survey was distributed to HR managers representing different manufacturing companies in Malaysia. In the pre-test phase, responses were successfully obtained from two HR managers since the responses from other experts were pending. These experts provided domain-specific insights to assess the suitability of the Fuzzy TOPSIS method for identifying and ranking the most significant Green HRM practices. This also ensures methodological appropriateness before proceeding to the main study.

### 2.2 Respondents and Demographic Profile

The respondents for this study were HR managers employed at ISO 14001-certified manufacturing companies across Malaysia. This group was selected because they possess direct knowledge of their organisation’s human resource management policies and practices, particularly those related to environmental sustainability. Their expertise and decision-making responsibilities make them well-suited to provide informed assessments of Green HRM practices.

### 2.3 Fuzzy TOPSIS Procedure

First proposed by Hwang and Yoon in 1981, Fuzzy TOPSIS is a widely used Multi-Criteria Decision Making (MCDM) method that manages uncertainty and prejudice in evaluation processes. According to Yong et al. (2020), the method allows researchers to rank practices based on expert judgement, providing a clearer sense of the most important ones. Fuzzy set theory, via MCDM, can quantitatively handle uncertainties and vagueness in decision-making (Alrashedi, 2024). As a result, fuzzy MCDM has increasingly become a core theme in research for optimising HRMP (Alrashedi, 2024). Fuzzy TOPSIS was chosen for this research because it is simpler and more realistic (Piya et al., 2022). The wide application is prompted by its clear methodology and easily programmable computation procedure (Shamsuzzoha, 2021). This justifies the application of Fuzzy TOPSIS during the pre-test phase of this study to identify prominent Green HRM practices.

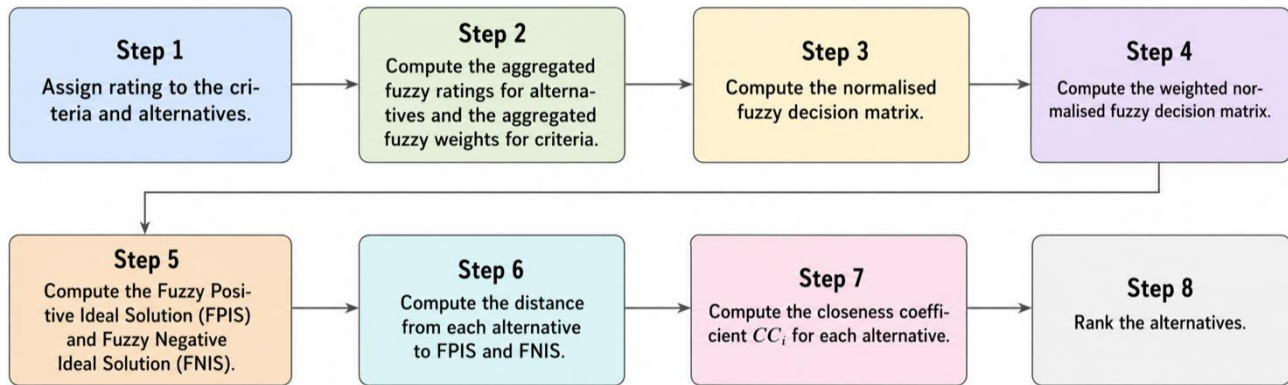


Figure 1. Fuzzy TOPSIS procedure

As shown in Figure 1, the Fuzzy TOPSIS procedure began by rating the alternatives and criteria, where each decision maker assigned fuzzy values to the alternatives relative to each criterion and provided fuzzy weights for the criteria. These fuzzy ratings and weights were then aggregated to form an overall average. Next, the decision matrix was normalised using different formulas for benefit and cost criteria to ensure all values were on a comparable scale. After normalisation, the scores were weighted by multiplying them by their corresponding fuzzy weights. The method then identified the Fuzzy Positive Ideal Solution (FPIS) and the Fuzzy Negative Ideal Solution (FNIS) to represent the best and worst values, respectively. The distance of each alternative from FPIS and FNIS was calculated using Chen’s distance formula. Subsequently, a closeness coefficient (CC<sub>i</sub>) was computed for each alternative, with higher values indicating greater closeness to the ideal solution. Finally, alternatives were ranked by their closeness coefficients, with the highest-ranked option considered the most preferred choice.

Chen (2000) extended TOPSIS with triangular FNs and introduced a vertex method to calculate the distance between two triangular FNs. If  $\tilde{x} = (a1, b1, c1)$ ,  $\tilde{y} = (a2, b2, c2)$  are two triangular FNs, then:

$$d(\tilde{x}, \tilde{y}) := \sqrt{\frac{1}{3} [(a1 - a2)^2 + (b1 - b2)^2 + (c1 - c2)^2]} \tag{1}$$

The procedures of Fuzzy TOPSIS are as follows:

Step 1. Assignment rating according to the criteria and alternatives.

The fuzzy rating of the kth decision maker about alternative A<sub>i</sub> concerning criterion C<sub>j</sub> is denoted  $\tilde{x}_{kij} = (a_{kij}, b_{kij}, c_{kij})$ , and the weight of criterion C<sub>j</sub> is denoted  $\tilde{w}_{kj} = (w_{kj1}, w_{kj2}, w_{kj3})$ .

Step 2. Compute the aggregated fuzzy ratings for alternatives and the aggregated fuzzy weights for criteria.

The aggregated fuzzy rating  $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$  of the ith alternative with respect jth criterion is obtained as follows:

$$a_{ij} = \min_k \{a_{ij}^k\}, b_{ij} = \frac{1}{K} \sum_{k=1}^K b_{ij}^k, c_{ij} = \max_k \{c_{ij}^k\} \tag{2}$$

The aggregated fuzzy weight  $\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$  for the criterion C<sub>j</sub> is calculated using these formulas:

$$w_{j1} = \min_k \{w_{j1}^k\}, w_{j2} = \frac{1}{K} \sum_{k=1}^K w_{j2}^k, w_{j3} = \max_k \{w_{j3}^k\} \tag{3}$$

Step 3. Compute the normalised fuzzy decision matrix.

The normalised fuzzy decision matrix is  $\tilde{R} = [\tilde{r}_{ij}]$ , where:

$$\tilde{r}_{ij} = \left( \frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*} \right) \text{ and } c_j^* = \max_i \{c_{ij}\} \text{ (benefit criteria)} \tag{4}$$

Or

$$\tilde{r}_{ij} = \left( \frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}} \right) \text{ and } c_j^- = \min_i \{a_{ij}\} \text{ (cost criteria)} \tag{5}$$

Step 4. Compute the weighted normalised fuzzy decision matrix.

The weighted normalised fuzzy decision matrix is  $V^- = (\tilde{v}_{ij})$ , where  $\tilde{v}_{ij} = \tilde{r}_{ij} \times w_j$ .

Step 5. Compute the Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS).

FPIS and FNIS are calculated as follows:

$$A^* = (\tilde{v}_1^*, \tilde{v}_2^* \dots, \tilde{v}_n^*), \text{ where } \tilde{v}_j^* = \max_i \{v_{ij3}\}; \tag{6}$$

$$A^- = (\tilde{v}_1^-, \tilde{v}_2^- \dots, \tilde{v}_n^-), \text{ where } \tilde{v}_j^- = \min_i \{v_{ij1}\}. \tag{7}$$

Step 6. Compute the distance from each alternative to FPIS and FNIS.

Let

$$d_i^* = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^*), d_i^- = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^-) \tag{8}$$

Be the distance from each alternative  $A_i$  to the FPIS and the FNIS, respectively.

Step 7. Compute the closeness coefficient  $CC_i$  for each alternative.

For each alternative  $A_i$ , we calculated the closeness coefficient  $CC_i$  as follows:

$$CC_i = \frac{d_i^-}{d_i^- + d_i^*} \tag{9}$$

Step 8. Rank the alternatives.

The alternative with the highest closeness coefficient represents the best alternative.

### 2.4 Evaluation Criteria

In this study, three main criteria were identified that serve as dimensions for evaluating Green HRM practices.

1. Contribution to environmental goals
2. Improvement of employees' environmental knowledge
3. Enhancement of employees' environmental awareness

### 2.5 Alternative

This study also included four main alternatives to be assessed, representing the Green HRM practices under consideration:

1. Green Recruitment
2. Green Training
3. Green Rewards
4. Green Employee Involvement

Figure 2 shows the framework for prioritising Green HRM practices. It proposes that a company's commitment to environmental sustainability is driven by a combination of main factors, such as environmental goals, employee knowledge, and employee awareness. These factors influence the implementation of specific Green HRM practices. In this framework, the criteria represent the evaluation dimensions, while the alternatives are the specific Green HRM practices being ranked. The Fuzzy TOPSIS method was applied to determine the relative priority of each alternative based on expert assessments against the stated criteria.

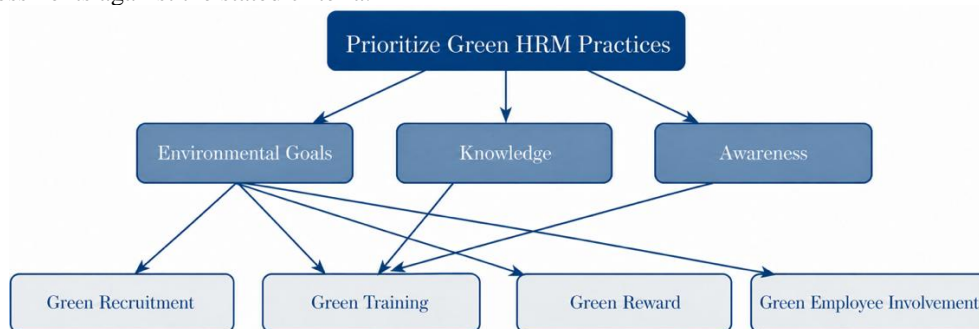


Figure 2. Decision hierarchy of the Fuzzy TOPSIS model for ranking Green HRM practices

**3. Results and Discussion**

**3.1 Fuzzy Ratings of Alternatives and Criteria**

Table 1 provides the foundation for the entire Fuzzy TOPSIS analysis and represents the initial data collection phase. It highlights the linguistic ratings from two separate decision-makers who evaluated four green HRM practices (alternatives) based on the three identified criteria. For example, while both decision-makers (HR experts) rated Green Recruitment Selection (GRS) as "High" across all criteria, there were notable differences in their assessments of Green Training (GT) and Green Reward (GR), emphasising the need for a fuzzy approach to aggregate these varied subjective opinions. The linguistic ratings were then translated into specific fuzzy numbers to prepare the data for the next stages of the model.

Table 1. Initial fuzzy ratings of alternatives and criteria

	Environmental Goals			Knowledge			Awareness												
	Decision Maker-1 (COMPANY 1)									Decision Maker-2 (COMPANY 2)									
GRS	High			High			High			GRS	High			High			High		
GT	High			Average			Average			GT	Very High			Very High			Very High		
GEI	High			High			High			GEI	Very High			Very High			Very High		
GR	High			High			High			GR	High			High			Very High		
GRS	5	7	9	5	7	9	5	7	9	GRS	5	7	9	5	7	9	5	7	9
GT	5	7	9	3	5	7	3	5	7	GT	7	9	9	7	9	9	7	9	9
GEI	5	7	9	5	7	9	5	7	9	GEI	7	9	9	7	9	9	7	9	9
GR	5	7	9	5	7	9	5	7	9	GR	5	7	9	5	7	9	7	9	9

Table 2. Aggregated fuzzy decision matrix

Weights	High			Very High			Average				
	Combined Decision Matrix										
GRS	5	7	9	5			7	9	5	7	9
GT	5	8	9	3			7	8	3	5	7
GEI	5	8	9	5			8	9	5	7	9
GR	5	7	9	5			7	9	5	7	9
	Combined Decision Matrix										
Weights	5	7	9	7			9	9	3	5	7
	Environmental Goals			Knowledge			Awareness				
GRS	5	7	9	5			7	9	5	7	9
GT	5	8	9	3			7	8	3	5	7
GEI	5	8	9	5			8	9	5	7	9
GR	5	7	9	5			7	9	5	7	9

**3.2 Aggregated Fuzzy Decision Matrix**

After the initial fuzzy ratings were collected, the data from both decision-makers were assimilated to generate a comprehensive perspective. Table 2 shows the results of this process in the Aggregated Fuzzy Decision Matrix. It also presents the combined fuzzy ratings for each Green HRM practice (GRS, GT, GEI, and GR) and incorporates the aggregated fuzzy weights for each criterion (Environmental Goals, Knowledge, and Awareness). The weights row at the top of the table indicates the relative importance of each criterion, with Environmental Goals and Knowledge receiving a higher weight than Awareness.

**3.3 Normalisation and Weighted Matrix**

The normalised fuzzy decision matrix was derived to ensure comparability across criteria. Each fuzzy value was then multiplied by its corresponding fuzzy weight to obtain the weighted normalised decision matrix. This process ensures that criteria with higher importance (as viewed by the experts) have a greater influence on the result. In Table 3, the normalised fuzzy decision matrix was calculated to convert all criteria values into a uniform range from 0 to 1, regardless of their original scales. Subsequently, the normalised values were multiplied by the aggregated fuzzy weights for their respective criteria, yielding the Weighted Normalised Fuzzy Decision Matrix. This matrix is important because it accurately represents the alternatives' initial ratings while accounting for the relative importance of each criterion. It ensures that the final ranking is not biased by any single factor.

Table 3. Normalisation and weighted matrix

Normalised fuzzy decision matrix									
Weights	5	7	9	7	9	9	3	5	7
	Environmental Goals			Knowledge			Awareness		
GRS	0.555556	0.777778	1	0.555556	0.777778	1	0.555556	0.777778	1
GT	0.555556	0.888889	1	0.333333	0.777778	0.888889	0.333333	0.555556	0.777778
GEI	0.555556	0.888889	1	0.555556	0.888889	1	0.555556	0.777778	1
GR	0.555556	0.777778	1	0.555556	0.777778	1.285714	0.555556	0.777778	1
Weighted Normalised Fuzzy Decision Matrix									
Weights	5	7	9	7	9	9	3	5	7
	Environmental Goals			Knowledge			Awareness		
GRS	2.777778	5.444444	9	3.888889	7	9	1.666667	3.888889	7
GT	2.777778	6.222222	9	2.333333	7	8	1	2.777778	5.444444
GEI	2.777778	6.222222	9	3.888889	8	9	1.666667	3.888889	7
GR	2.777778	5.444444	9	3.888889	7	11.57143	1.666667	3.888889	7
A*	<b>2.778</b>	<b>6.222</b>	<b>9</b>	<b>3.889</b>	<b>8.000</b>	<b>12</b>	<b>2</b>	<b>4</b>	<b>7</b>
A-	<b>2.778</b>	<b>5.444</b>	<b>9.000</b>	<b>2.333</b>	<b>7.000</b>	<b>8</b>	<b>1.000</b>	<b>2.778</b>	<b>5.444</b>

3.4 Determination of FPIS and FNIS

The Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS) were identified based on the maximum and minimum values for each criterion across all alternatives. These ideal points serve as benchmarks for calculating the proximity of each Green HRM practice to the most and least desired solutions. Table 4 presents these critical calculations and indicates the distance of each Green HRM practice from FPIS, illustrating the best possible outcome. It also demonstrates the distance from FNIS to signify the worst possible outcome. These distances were then used to compute the Closeness Coefficient (CC<sub>i</sub>), a measure of each alternative's proximity to the ideal and negative ideal solutions.

Table 4. Determination of FPIS and FNIS

	Distance from FPIS			di*	Distance from FNIS			di-	CC <sub>i</sub>	Rank
GRS	0.449	1.593	0.000	2.042	0.000	1.068	1.169	2.237	0.522737	3
GT	0.000	2.322	1.169	3.491	0.449	0.000	0.000	0.449	0.113975	4
GEI	0.000	1.485	0.000	1.485	0.449	1.214	1.169	2.832	0.656045	2
GR	0.449	0.577	0.000	1.026	0.000	8.124	1.169	9.293	0.90054	1

3.5 Closeness Coefficient and Ranking

The distance of each alternative from both FPIS and FNIS was computed using the vertex method (Chen, 2000). The closeness coefficient specifies how close an alternative is to the ideal solution. As shown in Table 5, the final ranking identified Green Reward as the most prioritised practice (CC<sub>i</sub> = 0.90054), followed by Green Employee Involvement, Green Recruitment, and Green Training.

Table 5. Summary of results for ranking green HRM practices

Green HRM Practices	Distance to FPIS	Distance to FNIS	Closeness Coefficient (CC <sub>i</sub> )	Rank
Green Recruitment and Selection	3.491	0.449	0.522737	3
Green Training	1.485	2.832	0.113975	4
Green Employee Involvement	1.026	9.293	0.656045	2
Green Rewards	2.042	2.237	0.90054	1

3.6 Discussion

The closeness coefficients result from the Fuzzy TOPSIS analysis indicate that Green Rewards is considered the most significant among the four green HRM practices evaluated against the criteria of alignment with environmental goals and the enhancement of employees' knowledge and awareness. This shows that providing sustainability-related incentives or recognition plays a crucial role in motivating employees to be responsible towards the environment. Green Employee Involvement, which includes engaging staff in environmental initiatives and sustainability decision-making, was ranked second. This underscores the importance of fostering a culture of participation and shared perspectives for environmental outcomes. Green Recruitment was ranked third, emphasising that recruitment practices aligned with environmental values

are acknowledged but may not be as directly impactful as rewards or involvement, particularly since recruitment is the initial stage of HRM. Green Training was ranked fourth, likely due to insufficient immediate visibility into its effects, even though it was an initial practice for developing green capabilities over time.

#### 4. Conclusions

This pre-test study applied the Fuzzy TOPSIS method to prioritise Green HRM practices in the Malaysian manufacturing context. Four Green HRM practices (Green Recruitment, Green Training, Green Rewards, and Green Employee Involvement) were evaluated using expert judgment to assess their relevance in promoting environmental sustainability within HRM. The decision-making framework treated these practices as alternatives, while the evaluation was guided by criteria that captured environmental goals, knowledge, and awareness. The results of this preliminary application revealed that Green Rewards was perceived by the experts as the most critical practice, highlighting the importance of providing environmentally focused incentives to encourage green behaviour among employees, followed by Green Employee Involvement, Green Recruitment, and Green Training. These rankings provide initial insights into the perceived strategic importance of various Green HRM initiatives from a managerial perspective. While fuzzy logic in Fuzzy TOPSIS enabled the representation of linguistic and subjective expert judgments, this pre-test does not validate the method's effectiveness in this specific domain. The small sample size of two experts, although acceptable for preliminary testing, limits the generalisability of the findings. Future studies should involve a larger and more diverse panel of decision-makers, incorporate statistical or comparative validation, and test the stability of rankings across different industry contexts. This pre-test, therefore, serves as a methodological exploration rather than a conclusive empirical study. It demonstrates the potential applicability of Fuzzy TOPSIS for structured decision-making in Green HRM and highlights the need to refine the decision hierarchy, clearly distinguish between criteria and alternatives, and validate results through broader expert engagement and cross-method comparisons.

From a theoretical standpoint, this study contributes to the expanding body of literature by incorporating Fuzzy Multi-Criteria Decision-Making techniques into the context of Green HRM. The use of Fuzzy TOPSIS introduces methodological consistency into the complex evaluation of human resource practices and supports decision-making under uncertainty, thereby advancing sustainability research. From a practical perspective, the findings provide a ranked list of Green HRM practices, enabling HR managers and company representatives to allocate budgets and resources more efficiently and focus on initiatives with the highest perceived impact. The Fuzzy TOPSIS tool presents a coordinated, empirical model that companies can use to evaluate, assess, and enhance Green HR practices aligned with sustainability objectives. Future research is recommended to apply this validated framework to a wider sample to improve generalisability. Furthermore, incorporating qualitative insights may provide a clearer understanding of how Green HRM practices evolve and influence sustainability over time. Future studies can also broaden this work by applying the model across different sectors or by incorporating other decision-making tools such as AHP (Analytic Hierarchy Process), ANP (Analytic Network Process), VIKOR (Vlsekriterijumska Optimizacija I Kompromisno Resenje), LECTRE (Elimination and Choice Expressing Reality), and PROMETHEE (Preference Ranking Organisation Method for Enrichment Evaluations) for comparison.

#### Acknowledgements

The authors wish to thank Universiti Malaysia Pahang Al-Sultan Abdullah for full supports to do the research.

#### Funding

This study was not supported by any grants from funding bodies in the public, private, or non-profit sectors.

#### Declaration of Competing Interests

The authors declare no conflicts of interest

#### CRedit Authorship Contribution Statement

Nur Halimah Zaihan: Conceptualisation; Methodology; Writing – review & editing; Data Analysis; Visualisation; Writing – original draft; Investigation; Resources; Validation; Project administration  
 Suhaidah Hussain: Project administration; Supervision; Writing – review & editing  
 Zetty Ain Kamaruzzaman: Project administration; Supervision; Writing – review & editing  
 Galuh Tresna Murti: Investigation; Writing – review & editing

#### Availability of Data and Materials

The data supporting this study's findings are available on request from the corresponding author

#### Ethics Declarations

This study did not involve human or animal participants, nor did it require ethical approval.

#### Generative Artificial Intelligence Declarations

The authors claim that artificially intelligent-assisted technologies in the form of generative AI were not used to generate content, ideas, or theories. AI is only used to enhance readability and refine the language. This was used with extreme human control and oversight. The authors take full responsibility for reviewing and approving the content.

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