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RESEARCH ARTICLE

The influence of green human resource management on environmental performance: Exploring the differential effects of green work engagement and moral reflection

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ABSTRACT

This study investigates the impact of the implementation of Green Human Resource Management (GHRM) on the environmental performance of higher education institutions from the perspective of the Ability-Motivation-Opportunity (AMO) theory. A purposive sampling approach was employed to collect 670 questionnaires from the academic and administrative staff of higher education institutions in Thailand. The findings of the research demonstrate that GHRM enhances the environmental performance of higher education institutions. Moreover, GHRM contributes to this enhancement by positively influencing employees' green work engagement, thereby improving the environmental performance of the institutions. Additionally, employees' moral reflection positively moderates the relationship between GHRM and green work engagement. This study aspires to construct a holistic research framework, offering new practical and theoretical insights into GHRM, which, in turn, provides meaningful guidance for the sustainable development of global higher education institutions.

Keywords: green human resource management; green work engagement; moral reflection; environmental performance; higher education institutions

1. Introduction

Sustainable development refers to the process of meeting present needs without compromising the ability of future generations to satisfy their own requirements[1]. The issue of environmental sustainability is currently at the forefront of all discussions aimed at resolving sustainability challenges[2]. Given the increasingly pressing global environmental circumstances, organizations of all types and sizes are encountering intensifying pressure from multiple stakeholders to mitigate the environmental repercussions of their operational activities[3]. In the process of implementing environmental management systems aimed at achieving financial growth, organizations must concurrently align with the imperatives of the green economy, steadily advance toward environmental sustainability, and address the global challenges associated with sustainable development.

Higher education institutions, analogous to large-scale enterprises, are substantial resource consumers and, consequently, exert significant influence on environmental degradation. Furthermore, as institutions that propagate knowledge, they serve as pivotal drivers of societal progress toward sustainability[4], contributing profoundly to social development and assuming a distinctive social responsibility[5]. Accordingly, beyond their focus on the core mandates of teaching and research, environmental efforts pertaining to the operational

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performance of these institutions have attracted growing attention[6]. The principle of environmental sustainability within higher education institutions is premised on the understanding that universities not only impact their immediate surroundings through operational activities but also influence broader societal attitudes toward sustainability. Therefore, the exploration of environmental performance within the higher education context has been advanced by several scholars[6-9], underscoring its pivotal role in promoting institutional sustainability and addressing the inherent challenges and deficiencies in environmental performance[10].

Additionally, research has identified that the absence of sustainability-oriented human resource practices within universities leads to suboptimal environmental performance[10]. Therefore, universities should integrate environmental management into human resource management, formulating eco-friendly policies to enhance environmental performance. GHRM is regarded as a critical strategy for achieving sustainable performance [11-14].

In recent years, there has been considerable research on GHRM, albeit predominantly focused on the corporate sector[7,9,15,16]. However, studies on GHRM within higher education institutions remain relatively scarce[7,8,17-19], indicating a need for further research to enrich and explore this domain, particularly within the context of higher education institutions[8,20]. Hence, this study is dedicated to investigating GHRM within the context of higher education institutions to fill this research gap.

Research pertaining to Human Resource Management (HRM) and Organizational Development has consistently underscored the significance of work engagement as a focal theme within the field of Human Resource Management, garnering substantial scholarly attention[21,22]. Furthermore, work engagement is widely recognized as a direct motivational factor influencing both performance outcomes and employee attitudes[23]. However, the application of work engagement within the context of higher education remains insufficiently explored[24]. Consequently, this study introduces the concept of Green Work Engagement, deriving from the perspective of employee engagement, to examine the relationship between GHRM and environmental performance within higher education institutions.

The implementation of GHRM practices is directed towards the faculty and staff of institutions, who, as self-aware individuals capable of self-regulated cognition, do not necessarily exhibit uniform responses, as individual differences significantly influence their behavior[25]. Among these individual differences, moral reflection plays a crucial role. According to Social Cognitive Theory (SCT)[26], human cognition influences both attitudes and behaviors. In contemporary discourse, with the escalating prominence of environmental protection issues, the latter has increasingly been framed as a moral concern[27]. The extent to which faculty and staff engage in moral reflection on environmental issues directly affects their pro-environmental behaviors [28], thereby impacting their level of engagement in green work. Therefore, this research aims to explore the moderating role of moral reflection in the relationship between GHRM and employees' Green Work Engagement, specifically from the perspective of cognitive differences among university employees.

In summary, this research centers on higher education institutions in Thailand, examining, through the lens of the AMO Theory[29] and SCT[26], how GHRM influences environmental performance in higher education institutions by enhancing employees' green work engagement. Furthermore, this study investigates whether employees' levels of moral reflection serve as a moderating factor between GHRM and green work engagement. The findings of this study will provide significant theoretical support and practical reference for higher education institutions in formulating effective GHRM strategies to enhance overall environmental performance.

2. Literature review and hypothesis development

2.1. SCT and AMO

This study is grounded in SCT and the AMO framework. First, SCT emphasizes the impact of individuals' beliefs on their behavior and cognition, positing that personal attitudes and behaviors are closely intertwined with social cognition[26]. Reynold employed the concept of individual subjective moral choice to examine ecological sustainability, suggesting that SCT provides a theoretical foundation for explaining the extent of individuals' concern with moral and ethical issues[25]. Therefore, moral reflection, understood as the depth of individual contemplation on ethical issues, plays a crucial role when employees within an organization perceive the GHRM practices implemented by their enterprise as aligning with moral standards, aimed at protecting the broader social environment and fostering both organizational and environmental sustainability. In such a context, employees are more likely to consider environmental sustainability in their workplace conduct, adhere to their moral expectations, support the organization's GHRM initiatives, and willingly embrace and assimilate the environmental knowledge imparted by the institution. Consequently, they contribute efforts towards environmental protection and actively participate in environmental initiatives.

Furthermore, research based on the AMO framework has elucidated the relationship between GHRM practices and organizational citizenship behavior among hotel employees[20]. Other studies have utilized the AMO framework to investigate the impact of GHRM on organizational performance, demonstrating that GHRM systems effectively enhance employees' awareness of and skills related to environmental issues, stimulate their motivation to engage in environmental activities, and provide opportunities and support for environmental initiatives. This, in turn, significantly promotes organizational environmental behavior and the attainment of environmental performance, thereby contributing to sustainable development[30,31]. Thus, this study, rooted in the AMO framework, aims to explore the impact of GHRM on environmental performance within higher education institutions from a micro-level perspective.

2.2. GHRM and environmental performance

GHRM represents an integrative approach where HRM aligns with green management elements. Organizations employ HRM as a strategic tool to devise and implement environmentally friendly policies, with a focus on minimizing pollution through the effective management of operational processes[32]. GHRM encompasses various facets of HRM practices[33]. When an organization's environmental objectives are congruent with its HRM objectives, that is, when HRM practices are systematically and deliberately aligned with organizational goals, this constitutes what is referred to as GHRM[34,35].

The core practices of GHRM can be thoroughly articulated using the AMO framework (Ability, Motivation, Opportunity), which constitutes the essential bedrock for the proficient functioning of the GHRM system[9,31,36]. Primarily, fostering green abilities entails attracting and cultivating employees endowed with both environmental awareness and requisite competencies through green recruitment and training initiatives. Green recruitment extends beyond the mere evaluation of professional capabilities to encompass the environmental values of potential employees, ensuring that newly recruited personnel are in harmony with the organization's environmental objectives. Through ongoing green training programs, employees are equipped with cutting-edge environmental knowledge and technologies, thereby not only enhancing their professional skill set but also broadening their understanding and cognizance of environmental management. Furthermore, the stimulation of green motivation is realized through green performance appraisals and environmentally linked compensation incentives. By setting clear environmental performance metrics, organizations assess employees' eco-friendly behaviors and integrate these assessments into the reward and compensation structure. Such a strategy serves to encourage employees' proactive

participation in environmental efforts while fostering a recognition of their contributions to the organization's overall environmental performance, thus heightening their sense of environmental accountability and drive. Lastly, providing green opportunities involves creating an organizational infrastructure that facilitates the execution of environmentally responsible behaviors. By offering opportunities for the acquisition, practice, and development of environmental knowledge, the organization equips employees with the necessary resources to engage in eco-conscious actions in their roles[37]. Additionally, organizations reinforce environmental consciousness by fostering an eco-friendly culture (such as implementing green policies and organizing environmental events), thereby enabling employees to more seamlessly integrate environmental behaviors into their daily work routines. This provision of resources and opportunities ensures that employees, armed with the requisite environmental knowledge and motivation, can consistently make environmentally sound decisions and actions in their everyday work.

Through this integrative and synergistic set of practices, GHRM not only augments employees' individual environmental capacities but also propels their active involvement in advancing the organization's green and sustainable development agenda. Ultimately, GHRM plays a pivotal role in enhancing the organization's overall environmental performance by elevating the environmental behavior of its workforce. Based on the aforementioned rationale, this study proposes the following first research hypothesis (H1):

H1: GHRM positively influences environmental performance.

Through the implementation of green recruitment and selection processes, organizations signal their preference for candidates committed to environmental protection. This approach not only enhances the organization's green image but also attracts and filters high-quality candidates who align with the organizational culture and can contribute value to the organization. Such employees, driven by their commitment to environmental issues, are more likely to consider environmental concerns in their professional and personal lives, thereby promoting environmentally responsible behaviors [38] and improving the organization's environmental performance[14,39,40].

Green training, recognized as a significant investment by organizations, has been empirically validated by numerous scholars to have a positive correlation with organizational environmental performance[3,15,39,41,42]. This form of training imparts environmental knowledge, enhances employees' awareness of environmental issues, and equips them with the skills to address these challenges. It deepens their understanding of the complexities surrounding environmental issues and guides them in making informed decisions and taking proactive environmental actions[43]—such as actively reducing paper and energy consumption—to enhance environmental performance[11]. Therefore, green training is considered a pivotal factor in improving environmental knowledge and skills, which, in turn, are crucial for advancing environmental performance[3,44].

Green performance evaluation focuses on the deployment of environmental initiatives, the allocation of environmental responsibilities, and the communication of environmental policies and issues within the organization[35]. By establishing relevant green evaluation standards aligned with its sustainability objectives, an organization can assess employee behaviors and identify their contributions to the organization's environmental goals. Consequently, the adoption of green standards within an organization is essential for enhancing environmental performance[3,15,39-42]. As a tool for monitoring employees' environmentally responsible behaviors, green performance evaluation not only allows employees to self-assess but also provides feedback on their green attitudes to the management. This feedback mechanism stimulates the development of employees' environmental attitudes, awareness, and behaviors, helping them understand their

role in the organization's environmental management, thereby contributing to the achievement of sustainable performance.

By offering material or non-material rewards to employees who have made significant contributions to environmental management, organizations can attract, retain, and motivate outstanding employees while simultaneously fostering their green knowledge and capabilities to achieve organizational objectives [45]. When employees' performance is linked to promotions, additional benefits, and bonuses, they become motivated. In other words, the reward system benefits the organization by aligning resource benefits with organizational goals[9]. Furthermore, numerous scholars have highlighted the positive and significant relationship between green rewards and environmental performance[3,14,39,41].

Based on the aforementioned inferences, this study formulates the following hypotheses, designated as H1a-H1d:

H1a: Green recruitment and selection exert a positive impact on environmental performance.

H1b: Green training positively influences environmental performance.

H1c: Green performance appraisal has a positive effect on environmental performance.

H1d: Green compensation and rewards positively affect environmental performance.

2.3. GHRM and green work engagement

HRM has been substantiated as one of the antecedents of work engagement[21,46-48]. Scholars, drawing upon the Job Demand-Resource (JD-R) theory, have elucidated the relationship between GHRM and green work engagement[46], positing that the practices of GHRM constitute organizational resources[49], which can function as intrinsic or extrinsic motivators. These resources foster the development of organizational employees and assist them in realizing their career aspirations. Consequently, there exists a positive correlation between GHRM and employees' green work engagement. Another perspective contends that GHRM serves as a signal to employees, indicating the organization's green values and genuine concern for the environment [50,51]. This, in turn, motivates employees to participate more actively in environmentally sustainable work, ultimately enhancing environmental performance. Therefore, GHRM is recognized as one of the tools for cultivating highly engaged employees, as the availability of HRM practices or high-performance work systems can incentivize employees to accomplish work-related objectives[52].

In higher education institutions, through the implementation of GHRM, employees with environmental consciousness are recruited, and relevant green knowledge training is conducted. Furthermore, a fair and transparent green performance appraisal system and green compensation system are established. These green practices convey the institution's commitment to sustainable development and green values to its employees, providing them with the green competencies necessary for participating in environmentally sustainable work. This approach fosters employees' motivation to engage in green work, thereby creating a green and environmentally friendly atmosphere within the institution. As employees perceive these practices, they are more likely to actively participate in green work initiatives. Consequently, this study posits that GHRM has a positive impact on employees' green work engagement. Based on the aforementioned reasoning, the study constructs the second hypothesis below (H2):

H2: GHRM positively influences employees' green work engagement.

Specifically, higher education institutions, in their recruitment and selection processes, emphasize environmental factors by implementing green recruitment and selection standards [3]. By showcasing the institution’s green brand, they attract candidates who are environmentally conscious and possess green skills.

These employees demonstrate a commitment to environmental protection and actively engage in eco-friendly initiatives[38]. The genesis of green work engagement is rooted in effective human resource management practices[53]. During recruitment, human resource specialists leverage the advantages of green human resource management to motivate employees, enhancing their capacity to exhibit constructive green behaviors, thereby fostering the generation of new ideas and the proposal of innovative solutions within the green framework, which in turn elevates green work engagement[46].

Green training, one of the most effective practices within green human resource management, aims to enhance employees' environmental awareness, skills, and knowledge. By aligning with the organization's green development goals, green training bolsters employees' environmental management capabilities, thereby promoting green attitudes and behavioral responses, ultimately increasing green work engagement. This aligns with scholars' perspectives, which posit that green training cultivates environmentally conscious employees capable of identifying and reducing waste while focusing on green tasks[11,32,35].

Effective performance appraisal plays a crucial role in regularly assessing employees' work, providing positive feedback, and inducing shifts in employees' green attitudes. Firstly, regular performance appraisals are considered instrumental in reducing job burnout, which, in effect, can enhance employee engagement[54]. Secondly, through the evaluation of feedback results, organizations can gauge employees' green environmental attitudes; employees who receive positive feedback may exhibit higher levels of engagement and a greater willingness to invest effort in green work, whereas negative feedback may diminish engagement[55]. Moreover, performance appraisal is typically linked to rewards and compensation; hence, through green performance management, employees can be encouraged to heighten their environmental awareness, exert effort in green work, and more actively participate in the organization's green initiatives, thereby better achieving environmental management objectives[56]. Faculty and staff in higher education institutions, through their perception of green performance appraisal practices, voluntarily invest more effort into green work, further enhancing their green work engagement[46,57]. Appropriate rewards incentivize employees to deliver exceptional service, prevent job burnout, and enhance work motivation[47]. As a tool for improving employee performance, rewards positively influence employee behavior, thereby increasing work engagement[58]. When employees receive appropriate rewards, they feel an obligation to the organization, consciously assuming environmental responsibility[32], thereby increasing their commitment to environmental management and actively engaging in green actions in their daily work, which enhances employee work engagement[47].

Hence, based on the aforementioned deductions, this study forms the following hypotheses H2a-H2d:

H2a: Green recruitment and selection positively influence green work engagement.

H2b: Green training positively influences green work engagement.

H2c: Green performance appraisal positively influences green work engagement.

H2d: Green compensation and rewards positively influence green work engagement.

2.4. Green work engagement and environmental performance

The extant literature on HRM theory indicates that employee responses—such as motivation, commitment, and work engagement—exert a significant influence on organizational performance[59]. Consequently, work engagement, as one of the critical dimensions, has been identified as a direct motivational factor influencing both performance outcomes and employee attitudes. It is, therefore, considered a pivotal element in the attainment of organizational performance[24]. However, empirical evidence concerning the potential outcomes of green work engagement remains relatively sparse[46,60,61].

Green work engagement refers to the energy, willingness, and absorption levels that employees dedicate to tasks related to environmental sustainability. It reflects the psychological state of employees regarding their readiness and the extent to which they engage in green-related tasks[57,61]. Employees who exhibit high levels of engagement in green work are oriented towards the organization's environmental sustainability goals. They possess the energy and enthusiasm necessary to successfully accomplish these tasks and, through their environmentally responsible behaviors, contribute to the organization's "go green" initiatives. Consequently, in organizations where environmental management is a strategic objective, employees with elevated levels of green engagement are likely to lead to higher levels of green outcomes[61]. In other words, the realization of an organization's environmental objectives necessitates the active involvement of capable employees in the environmental management system and green tasks, thereby contributing to the organization's environmental performance through their eco-friendly behaviors.

Based on the aforementioned theoretical foundations, it is posited that employees who exhibit vigor, enthusiasm, and dedication towards green work are considered to have a high level of green engagement. Such employees are expected to execute their daily tasks in an environmentally responsible manner and proactively fulfill environmental responsibilities, thereby contributing to the company's environmental performance. Accordingly, this study makes the third research hypothesis as indicated below (H3):

H3: Green work engagement positively influences environmental performance.

2.5. The mediating role of green work engagement

GHRM has been empirically validated to positively impact an organization's environmental performance through its influence on environmental outcomes[34,39]. Nevertheless, the underlying mechanisms linking GHRM with organizational environmental objectives warrant comprehensive investigation[9,62]. The research conducted by Katou et al. has introduced a novel perspective in exploring the relationship between HRM and organizational performance, emphasizing the significance of employee reactions in evaluating the impact of HRM systems on organizational performance (with employee training and rewards being the most influential in enhancing employee work engagement, thereby improving organizational performance)[59]. Consequently, employee reactions have been demonstrated to partially and positively mediate the relationship between HRM practices and organizational performance, indicating that HRM practices influence organizational performance by affecting HR-related outcomes or employee reactions.

GHRM practices enhance employee participation in environmentally friendly behaviors, such as reducing environmental waste, improving the efficiency of cost-elimination processes, and refining products, thereby augmenting environmental performance. In studies focusing on higher education institutions, researchers have proposed a model elucidating how GHRM contributes positively to employees' green outcomes by introducing the mediating variable of green work engagement, which explicates the relationship between GHRM and its consequences. Notably, the authors highlighted that this study is the first of its kind to employ green work engagement as a research variable and intervention mechanism within this research domain[21]. Furthermore, scholars examining hotel employees have confirmed that GHRM fosters employee work engagement[52]. Employees' cognitive evaluations (favorable perceptions) of GHRM lead to higher employee engagement, which in turn guides their behavior, eliciting corresponding behavioral responses (e.g., green recovery performance). This research tested the mediating role of employee engagement (involvement).

Therefore, the researchers put forward that it is the employees' perceptions of GHRM practices that shape their green attitudes and behaviors, enhancing green work engagement, which ultimately leads to

improved organizational environmental performance. Based on this premise, this study makes the fourth research hypothesis (H4):

H4: Green work engagement mediates the relationship between GHRM and environmental performance.

2.6. The moderating role of moral reflection

Moral reflection among employees, as a cognitive process of self-regulation, serves as a potent driver of moral conduct within the workplace and shapes employees' perceptions of their roles in ethics and social responsibility[28,63]. According to social cognitive theory, reflection within a specific domain tends to elicit corresponding behaviors. Consequently, scholars have applied moral reflection to the environmental protection domain[22,28,64]. Environmental protection is inherently a moral issue[27], and GHRM embodies corporate environmental responsibility and ethicality. However, the impact of GHRM is contingent upon employees' perceptions of these HRM practices[59]. Employees with high levels of moral reflection are more likely to perceive the ethicality of their organization, thereby enhancing their awareness of ethics and social responsibility[63]. Such employees are more susceptible to the influence of GHRM and are more likely to actively participate in environmental protection initiatives, thereby improving the organization's environmental performance. Conversely, employees with low levels of moral reflection may lack identification with GHRM, leading to negative psychological responses that diminish their engagement in green work. Thus, this study finalizes the following fifth research hypothesis (H5):

H5: Moral reflection positively moderates the relationship between GHRM and green work engagement.

Conclusively, this study extends the model concerning the relationship between GHRM and environmental performance within higher education institutions. GHRM in higher education institutions influences environmental performance, wherein green work engagement plays a mediating role. Moreover, moral reflection serves as a moderating factor between GHRM and green work engagement. The following represents the research framework model established in the current study:

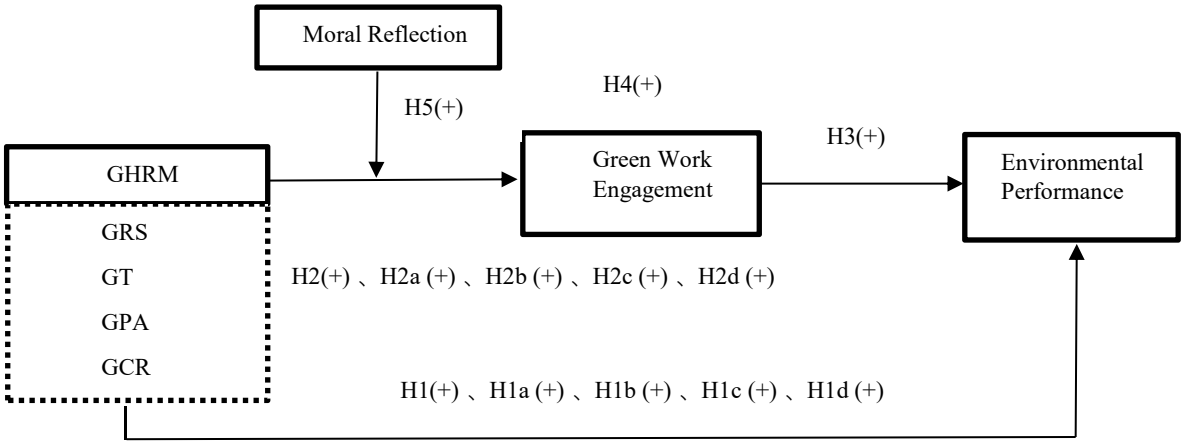

Figure 1. Research model.

Note: *GRS= Green Recruitment & Selection; GT= Green Training; GPA= Green Performance Appraisal; GCR= Green Compensation and Rewards; GHRM=Green Human Resource Management.*

3. Methodology

3.1. Measurements

The measurement scales employed in this study are all well-established instruments, encompassing various dimensions and items related to GHRM, including green recruitment and selection, green training,

green performance appraisal, green compensation and rewards, as well as green work engagement, environmental performance, and moral reflection. All scales utilized a 7-point Likert scale, where 1 denotes "strongly disagree" and 7 denotes "strongly agree," as the 7-point scale is considered to offer a finer differentiation of respondents' perspectives compared to the 5-point scale[65]. Specifically, the GHRM scale comprises four dimensions with a total of 12 measurement items[7]; the scale measuring green work engagement includes 6 measurement items[46]; the moral reflection scale encompasses 5 measurement items [25]; and the environmental performance scale consists of 14 measurement items[9].

3.2. Data collection

This study employed a purposive sampling technique, focusing on the academic staff and employees of higher education institutions in Thailand that participated in the 2022 UI GreenMetric ranking and were listed among the top ten universities nationwide. Faculty members and staff, as primary stakeholders within higher education institutions, constitute critical elements in the sustainable development of universities, actively engaging in the execution and assimilation of sustainability policies, assuming roles such as initiators and facilitators[7]. Consequently, this research pays particular attention to these individuals from a micro-level perspective. Upon liaising with the relevant institutions, seven universities were selected to participate in the questionnaire distribution process, with 100 questionnaires allocated to each institution. The questionnaires were distributed to the target population via an online platform, utilizing Google Forms to generate either QR codes or direct links. A total of 670 responses were gathered, and after the exclusion of invalid entries, 502 valid questionnaires were retained, yielding a 74.9% validity rate, which suffices for subsequent analysis[66].

3.3. Data analysis approach

Upon the retrieval of data, large-scale data analysis was conducted to verify the research hypotheses posited in this study using the pertinent statistical software, SPSS 23.0 and AMOS 28.0. Initially, descriptive statistical analysis was performed to ascertain the structural characteristics of the sample. Subsequently, analyses including common method bias, reliability, validity, and correlation were carried out. Thereafter, hierarchical regression analysis was employed to validate the influence relationships among the variables, and the Bootstrap method was utilized to confirm the mediating role of green work engagement between green human resource management and environmental performance.

4. Results

4.1. Descriptive statistics

The total number of respondents in this study amounts to 502 individuals, whose fundamental characteristics are delineated as follows: Concerning gender distribution, females constitute the majority, comprising 53.59%. Regarding age distribution, the cohort aged between 31 to 40 years represents the highest proportion, accounting for 51.2%. In terms of educational attainment, respondents possessing a bachelor's degree predominate, constituting 57.77%. With respect to occupational roles, the category of staff members constitutes 68.73%. Lastly, when examining the length of service, respondents with a tenure of 4 to 6 years represent the largest segment, accounting for 43.63%.

4.2. Common method bias analysis

The data for this study were primarily collected through purposive sampling, targeting the surveyed population via questionnaire distribution. To mitigate potential validity concerns arising from the uniformity of the questionnaire source or the consistency of the testing environment, a Harman's single-factor test was employed to assess the presence of significant common method bias. Utilizing SPSS software, all variables

were subjected to an exploratory factor analysis, specifically principal component analysis, which identified seven principal components. The total variance explained by the first principal component was 45.195%, which is below the standard threshold of 50%[67]. Consequently, the results of this study indicate that severe common method bias is not a concern.

4.3. Reliability

To ensure the stability and reliability of the measurement tools, thereby enhancing the credibility and validity of the research findings, this study employed the Cronbach's α coefficient, commonly abbreviated as the α coefficient, to conduct reliability measurement. Following the reliability analysis of the research scale, it was observed that the reliability coefficients for all variables and dimensions ranged between 0.794 and 0.969, indicating a commendable level of reliability in the data quality[68]. The research data is therefore deemed authentic and reliable. The detailed data is presented in **Table 1**.

Table 1. Results of the confidence analysis.

Variable	Dimension	Item	Cronbach's α (Dimension)	Cronbach's α (Variable)
Green Human Resource Management	Green Recruitment & Selection	3	0.849	0.859
	Green Training	3	0.849	
	Green Performance Appraisal	3	0.851	
	Green Compensation and Rewards	3	0.794	
Green Work Engagement		6		0.951
Environmental Performance		14		0.969
Moral Reflection		5		0.884

4.4. Validity

To ensure the scientific validity and rationality of the design of the research items (typically referred to as questionnaire scale items), this study conducted a thorough examination of both content validity and construct validity on the collected data. Firstly, the scales utilized in this study were derived from existing research and have been repeatedly employed and validated by previous researchers, thus exhibiting a high degree of reliability. Secondly, several scholars were invited to participate in the translation process of this study. Through multiple discussions and revisions with experts and scholars, the scale was further refined, thereby ensuring robust content validity. Moreover, to explore the inherent logical structure of the research items, confirmatory factor analysis (CFA) was employed to examine the corresponding relationships, including the assessment of convergent validity and discriminant validity.

In this study, confirmatory factor analysis (CFA) was conducted on four variables: GHRM, Green Workplace Environment (GWE), Employee Performance (EP), and Moral Reflection (MR), encompassing a total of 37 items. Utilizing the statistical software AMOS 28.0, the analytical results reveal that the measurement model demonstrates satisfactory fit indices, as indicated by $\chi 2/df$= 2.117, RMSEA=0.047, SRMR=0.039, TLI=0.952, CFI=0.956, and NNFI=0.952. The comprehensive data supporting these fit indices are meticulously detailed in **Table 2.** Moreover, the outcomes derived from **Table 3**. illustrate that the standardized factor loadings of the items all exceeded 0.7, and the Average Variance Extracted (AVE) values for the dimensions or variables were all greater than 0.5. Additionally, the Composite Reliability (CR) values were all above 0.7, indicating that the data from this analysis exhibited strong convergent validity[68]. The detailed data are presented in **Table 3.**

Table 2. Indices of model fit.

Index	*χ2*	*df*	*χ2/df*	RMSEA	SRMR	TLI	CFI	NNFI
Values			<3	<0.10	<0.1	>0.9	>0.9	>0.9
	1287.164	608	2.117	0.047	0.039	0.952	0.956	0.952

Table 3. Convergent validity.

Variable	Dimension	Item	Standardized Factor Loading	AVE	CR
GHRM	Green Recruitment and Selection	1	0.799	0.664	0.855
		2	0.742		
		3	0.896		
	Green Training	4	0.787	0.671	0.859
		5	0.797		
		6	0.871		
	Green Performance Appraisal	7	0.819	0.656	0.851
		8	0.809		
		9	0.801		
	Green Compensation and Rewards	10	0.751	0.570	0.799
		11	0.788		
		12	0.725		
Green Work Engagement		1	0.887	0.768	0.952
		2	0.899		
		3	0.889		
		4	0.873		
		5	0.949		
		6	0.749		
Environmental Performance		1	0.857	0.692	0.969
		2	0.821		
		3	0.859		
		4	0.855		
		5	0.880		
		6	0.849		
		7	0.855		
		8	0.820		
		9	0.826		
		10	0.829		
		11	0.862		
		12	0.743		
		13	0.752		
		14	0.829		
Moral Reflection		1	0.713	0.607	0.885
		2	0.734		
		3	0.828		
		4	0.806		
		5	0.808		

By employing the method of comparing the square root of the AVE with the correlation coefficients, it was observed that the square root of the AVE for each factor exceeds the maximum correlation coefficient between that factor and other factors. This finding indicates that the data exhibit strong discriminant validity [68]. Detailed data are presented in Table 4. Furthermore, an examination of the mean values and standard deviations of the scale data reveals that the subjects under study perceive a high level of GHRM within

higher education institutions. Similarly, their engagement in green work practices and the degree of moral reflection they exhibit are also relatively high. The standard deviations for green recruitment and selection, green training, green performance evaluation, green compensation and rewards, green work engagement, environmental performance, and moral reflection range between 0.808 and 1.329. Additionally, the Pearson correlation coefficients indicate significant correlations among all variables, with all coefficients exceeding 0, suggesting a positive relationship among the variables under investigation. Consequently, it is feasible to proceed with subsequent regression analyses to further explore these relationships. Detailed data are provided in **Table 4**.

Table 4. Mean, standard deviation, correlation coefficient, and discriminant validity.

Variable	Mean	SD	GRS	GT	GPA	GCR	GWE	EP	MR
GRS	5.403	1.124	**0.815**						
GT	5.688	0.897	0.388**	**0.819**					
GPA	6.037	0.931	0.289**	0.426**	**0.810**				
GCR	5.892	0.808	0.280**	0.391**	0.438**	**0.755**			
GWE	4.311	1.329	0.400**	0.495**	0.556**	0.499**	**0.877**		
EP	4.186	1.043	0.389**	0.466**	0.487**	0.494**	0.575**	**0.832**	
MR	5.330	1.086	0.511**	0.554**	0.499**	0.389**	0.549**	0.546**	**0.779**

Note: *GRS= Green Recruitment & Selection; GT= Green Training; GPA= Green Performance Appraisal; GCR= Green Compensation and Rewards; GWE= Green Work Engagement; EP= Environmental Performance; MR= Moral Reflection*

4.5. Testing of research hypothesis

The hypotheses of this study were empirically tested using hierarchical regression analysis, The comprehensive analysis encompasses the examination of direct effects, mediating effects, and moderating effects. The direct effect is analyzed by incorporating control variables, followed by the integration of relevant analytical variables within a regression framework. Conversely, the mediating effect is tested using regression analysis combined with the Bootstrap resampling methodology, enabling an in-depth mediation effect verification. The specific procedures are delineated in **Table 5** and **Table 7**. Furthermore, the moderating effect is scrutinized by initially generating three regression models, with the subsequent implementation of a mean-centering process, as elaborated in **Table 6.**The comprehensive analysis encompasses the examination of direct effects, mediating effects, and moderating effects. The direct effect is analyzed by incorporating control variables, followed by the integration of relevant analytical variables within a regression framework. Conversely, the mediating effect is tested using regression analysis combined with the Bootstrap resampling methodology, enabling an in-depth mediation effect verification. The specific procedures are delineated in **Table 5** and **Table 7.** Furthermore, the moderating effect is scrutinized by initially generating three regression models, with the subsequent implementation of a mean-centering process, as elaborated in **Table 6.**

Utilizing a methodologically rigorous hierarchical regression analysis, each hypothesis pertaining to the direct effects, mediation mechanisms, and moderating influences was systematically evaluated and empirically validated along with the results presented in **Table 5.** The findings reveal a positive and significant correlation between GHRM and environmental performance (β=0.624, p<0.001), with all four

dimensions of GHRM also exhibiting a positive and significant relationship with environmental performance (β=0.168, p<0.001; β=0.198, p<0.001; β=0.237, p<0.001; β=0.263, p<0.001). Consequently, the hypotheses H1, H1a, H1b, H1c, and H1d are supported. Furthermore, the study indicates that both GHRM and its four dimensions demonstrate a positive and significant correlation with green work engagement (β=0.666, p<0.001; β=0.161, p<0.001; β=0.202, p<0.001; β=0.323, p<0.001; β=0.235, p<0.001), thereby lending support to the hypotheses H2, H2a, H2b, H2c, and H2d. The relationship between green work engagement and environmental performance is similarly positive and significant (β=0.571, p<0.001), supporting hypothesis H3.

When synthesizing the data from **Table 5 and Table 7**, it becomes evident that the inclusion of green work engagement as a mediating variable causes the regression coefficient to decrease from 0.624 (p<0.001) to 0.436 (p<0.001), while the influence of green work engagement on environmental performance is significant at 0.282 (p<0.001). Hence, green work engagement partially mediates the relationship between green human resource management and environmental performance, thus affirming hypothesis H4.

As elucidated in **Table 6**, the interaction term between GHRM and moral reflection exhibits significant statistical relevance (β=0.151, p<0.001). This finding implies that when examining the influence of GHRM on green work engagement, the degree of impact varies significantly across different levels of the moderating variable, moral reflection, thereby confirming the existence of a moderation effect. This phenomenon is further substantiated by the simple slope diagram (**Figure 2**) and the detailed analysis provided in **Table 8**. Specifically, when moral reflection is at a lower level, the positive impact of GHRM on green work engagement is comparatively weaker, with a regression coefficient value of β=1.019 (p<0.001), and a 95% confidence interval ranging from [0.847, 1.190]. Conversely, when moral reflection is at a higher level, the positive influence of GHRM on green work engagement is markedly stronger, as evidenced by a regression coefficient value of β=1.360 (p<0.001), and a 95% confidence interval ranging from [1.131, 1.590]. These results indicate that when the moral reflection levels among higher education institution employees are elevated, the positive effect of GHRM on green work engagement is significantly enhanced. Thus, research hypothesis H5 is empirically supported.

Table 5. Regression analysis of the direct effect.

Variable	EP				GWE				EP		EP	
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 1	
	β	***VIF***	***β***	***VIF***	***β***	***VIF***	***β***	***VIF***	***β***	***VIF***	***β***	***VIF***
Gender	0.017	1.014	0.018	1.020	0.035	1.014	0.037	1.020	-0.019	1.010	0.007	1.016
Age	-0.022	1.078	-0.010	1.111	0.012	1.078	0.029	1.111	-0.036	1.077	-0.025	1.078
Education Level	-0.037	1.050	-0.038	1.051	-0.034	1.050	-0.037	1.051	-0.037	1.051	-0.027	1.052
Years of Work Experience	0.001	1.034	-0.001	1.035	0.026	1.034	0.025	1.035	-0.017	1.034	-0.006	1.035
GHRM	0.624***	1.013			0.666***	1.013					0.436***	1.184
GRS			0.168***	1.222			0.161***	1.222				
GT			0.198***	1.446			0.202***	1.446				
GPA			0.237***	1.399			0.323***	1.399				
GCR			0.263***	1.350			0.235***	1.350				
GWE									0.571***	1.008	0.282***	1.806
R^2	0.396		0.407		0.446		0.464		0.335		0.440	

Adj. R^2	0.390	0.397	0.441	0.455	0.328	0.433
F	*F*(5,496)=65.013, *p*=0.000	*F*(8,493)=42.258, *p*=0.000	*F*(5,496)=79.950, *p*=0.000	*F*(8,493)=53.303, *p*=0.000	*F*(5,496)=49.931, *p*=0.000	*F*(6,495)=64.774, *p=0.000*

Table 5. *(Continued).*

*Note 1: * p<0.05 ** p<0.01 *** p<0.001*

Note 2: β means Regression Coefficient Value

Note 3: GRS= Green Recruitment & Selection; GT= Green Training; GPA= Green Performance Appraisal; GCR= Green Compensation and Rewards; GWE= Green Work

Engagement; EP= Environmental Performance; GHRM= Green Human Resources Management.

Table 6. Regression analysis of the moderating effect (moral reflection).

Variables	GWE					
	Model 1		Model 2		Model 3	
	β	***VIF***	***β***	***VIF***	***β***	***VIF***
Gender	0.035	1.014	0.026	1.019	0.03	1.02
Age	0.012	1.078	0.018	1.080	0.015	1.081
Education Level	-0.034	1.050	-0.032	1.050	-0.033	1.051
Years of Work Experience	0.026	1.034	0.033	1.037	0.016	1.054
GHRM	0.666***	1.013	0.544***	1.879	0.610***	2.159
MR			0.180***	1.878	0.202***	1.910
GHRM*MR					0.151***	1.468
R^2	0.446		0.464		0.479	
Adj. R^2	0.441		0.457		0.472	
F	*F*(5,496)=79.950, *p*=0.000		*F*(6,495)=71.281, *p*=0.000		*F*(7,494)=64.880, *p*=0.000	

*Note 1: * p<0.05 ** p<0.01 *** p<0.001*

Note 2: β means Regression Coefficient Value

Note 3: GWE= Green Work Engagement; MR= Moral Reflection; GHRM= Green Human Resources Management.

Table 7. Mediating effect of green work engagement (Bootstrap testing method).

Variables	c Cumulative Effect	a	b	a*b (95% BootCI)	c' Direct Effect	Testing Result
GHRM→GWE→EP	0.624***	0.666***	0.282***	0.130 ~ 0.249	0.436***	Partial

Table 8. Simple slope analysis of the moderating effect (moral reflection).

Level of Moderating Variable	Regression Coefficient	Standard Error	*t*	*p*	95% CI	
Mean	1.190	0.093	12.777	0.000	1.007	1.372
High Level（+1SD）	1.360	0.117	11.643	0.000	1.131	1.590
Low Level（-1SD）	1.019	0.088	11.632	0.000	0.847	1.190

5. Conclusions and recommendations

5.1. Conclusions

This study, grounded in the AMO theory and the SCT, conducts a comprehensive examination of the influence of GHRM on the environmental performance of higher education institutions. The AMO theory posits that augmenting employees' competencies, stimulating their motivation, and offering opportunities collectively serves as an effective mechanism to bolster organizational performance. Operating within this theoretical framework, the research delves into how GHRM, via strategies such as green recruitment, employee training, and incentive structures, heightens the green engagement of the workforce, thus improving environmental outcomes. In addition, social cognitive theory substantiates the relevance of moral reflection as a moderating variable, elucidating how employees' ethical awareness exerts a significant impact on their environmentally conscious behaviors. The synthesis of AMO theory with SCT provides nuanced insights into the micro-level dynamics of GHRM's influence on environmental performance, while highlighting the pivotal roles of green work engagement and moral reflection in this process. These findings furnish practical implications for higher education institutions in leveraging GHRM strategies to advance their environmental performance. The detailed research findings are outlined below.

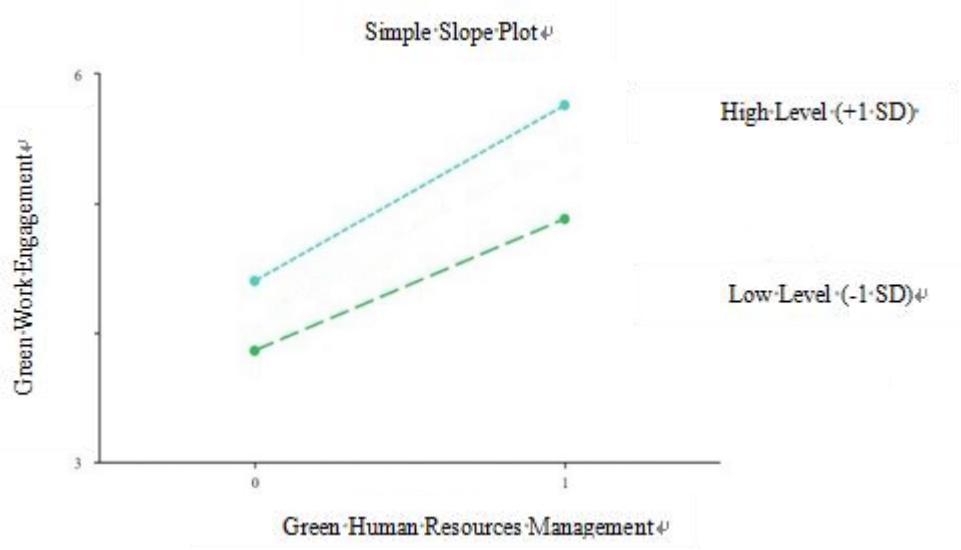

Figure 2. Moderating effect of moral reflection.

a) The findings indicate that the implementation of GHRM significantly contributes to the enhancement of environmental performance within higher education institutions. As an integral component of the HRM system, GHRM is closely aligned with organizational vision and mission and is regarded as a crucial determinant of improved environmental outcomes[32]. This research, adopting a sustainability perspective, examines the ways in which GHRM facilitates the advancement of environmental performance and validates the positive correlation between GHRM practices and environmental outcomes. GHRM is conceptualized as an integrated framework encompassing green recruitment, selection, training, performance evaluation, remuneration, and reward systems. The results reveal that green recruitment and employee training play a critical role in fostering environmental performance. By attracting personnel with a strong green awareness and equipping them with enhanced environmental knowledge and skills through structured training programs, institutions cultivate an environmentally conscious workforce, which in turn drives eco-friendly behaviors.

As employees develop a deeper understanding of environmental sustainability, their focus on environmental performance intensifies, leading to proactive engagement in eco-positive activities in their professional routines. Additionally, green performance assessments and incentive schemes were found to exert a favorable influence on environmental outcomes. Employees equipped with environmental competencies demonstrate a heightened motivation to actively participate in environmentally beneficial behaviors when incentivized through green performance evaluations and remuneration systems. By setting explicit environmental objectives and recognizing exceptional environmental contributions, institutions motivate their staff to further environmental performance improvements. Ultimately, GHRM fosters a supportive institutional environment for environmental stewardship, providing the necessary resources and opportunities for staff to engage in green initiatives, thereby reinforcing institutional environmental performance.

b) The present study examines the intermediary role of green work engagement, conceptualized as a singular construct encompassing a positive mindset and a willingness to engage, in the nexus between GHRM and environmental performance[46]. The findings demonstrate that GHRM significantly enhances institutional environmental outcomes by fostering employees' active participation in environmentally sustainable behaviors. When employees perceive the implementation of green-oriented practices, including recruitment, selection, training, performance appraisal, and remuneration rewards, their green work engagement correspondingly intensifies. Specifically, green recruitment attracts personnel who resonate with environmental values, while green training fortifies their environmental competencies and awareness, thereby deepening their emotional commitment to environmental stewardship. Performance appraisals and reward systems that align employee contributions with environmental performance further promote their proactive involvement in sustainability initiatives. Furthermore, green work engagement serves as a pivotal mediator between GHRM and environmental performance within higher education institutions. Employees exhibiting heightened levels of green engagement are more inclined to execute their duties and responsibilities in an environmentally conscientious manner, thus bolstering institutional environmental performance. This mediating mechanism elaborates the theoretical framework linking GHRM to environmental performance[21].

c) The effect of perceived GHRM on green work engagement among faculty and staff within higher education institutions is moderated by the extent of their moral reflection. In this research, environmental concerns are framed as moral imperatives [27]. When employees regard environmental protection as a moral duty and actively reflect on the environmental implications of their professional conduct, they exhibit elevated moral reflection. GHRM amalgamates human resource management with environmental governance, thereby embodying the institution's ethical responsibility toward societal environmental preservation. Drawing upon social cognitive theory[26], moral reflection, as an individual cognitive process, exerts a profound influence on employees' moral behavior. For instance, when institutions mandate waste segregation, employees' cognitive perceptions and attitudes critically shape their behavioral responses. Individuals with higher moral reflection levels are more likely to embrace GHRM practices and actively participate in environmental management initiatives. Conversely, employees with lower moral reflection may perceive such practices as obligatory mandates, potentially fostering resistance and diminishing the efficacy of green work engagement. This finding corroborates scholarly assertions that employees' reactions to HRM practices are contingent upon the meanings they assign to these practices[59].

5.2. Implications

The prevailing trend toward sustainable development is compelling industries to elevate their environmental performance, with higher education institutions also advancing their green development initiatives by augmenting environmental performance measures[69]. This research substantiates that higher

education institutions implement eco-friendly policies through GHRM, influencing not only employee behavior but also exerting a broader positive influence on the academic community at large. These initiatives are intrinsically aligned with the overarching objectives of sustainable development, ensuring the seamless integration of environmental considerations into institutional operations and strategic frameworks, thereby contributing meaningfully to the global sustainable development agenda. Accordingly, this research is of considerable theoretical and practical relevance below.

Initially, from a theoretical standpoint, this study evaluates the impact of GHRM on environmental performance, identifying GHRM as a pivotal determinant in enhancing environmental performance and addressing a research gap in the field of GHRM within higher education institutions[8,9,70]. Although global attention toward GHRM has seen a marked increase, extant research has primarily concentrated on the corporate sector, leaving the academic sector relatively underexplored[16,18]. This research, conducted within the context of higher education institutions in Thailand, delves further into the GHRM-environmental performance nexus, thereby contributing to the expansion of literature in this domain. By centering on the academic personnel in Thailand, this study also makes a salient contribution to the discourse on GHRM within the Thai cultural framework. In light of the escalating environmental degradation challenges, various sectors in Thailand are mandated to address environmental sustainability imperatives[71]. However, as critical systems for fostering environmentally conscious professionals, studies examining GHRM within higher education institutions remain scarce[56,72]. This research offers a fresh perspective on the body of literature within Thailand's GHRM sector, bridging the existing gap.

Then, the study constructs a mediation model with moderating variables, meticulously examining the intermediary effects of green work engagement and moral reflection on the relationship between GHRM and environmental performance, thereby advancing and enhancing the prevailing theoretical constructs. This investigation concentrates on the micro-level aspects of employee green work engagement and moral reflection, elucidating how GHRM mechanisms can effectively heighten employees' involvement in green initiatives, ultimately leading to improved environmental performance. Empirical evidence demonstrates that GHRM, through strategic initiatives such as green recruitment, training, performance assessment, and incentivization, significantly bolsters employees' engagement in green work practices, subsequently enhancing environmental performance. The moderating effect of moral reflection emerges as critical in this dynamic, with employees demonstrating higher levels of moral reflection showing a more pronounced responsiveness to GHRM and a greater propensity to engage actively in environmental sustainability endeavors, thus furthering environmental performance. This finding not only augments the theoretical correlation between GHRM and environmental performance but also underscores the pivotal role of individual characteristics in green management practices, providing a robust methodological foundation for future inquiries.

On the other hand, from a pragmatic standpoint, this study provides significant managerial insights to assist higher education administrators in fostering institutional sustainability as follows.

Firstly, the proactive advancement of GHRM: Higher education institutions are encouraged to adopt comprehensive strategies encompassing green recruitment, professional development, performance appraisal, remuneration, and reward systems, to identify and cultivate personnel with an acute environmental consciousness. This, in turn, fortifies the institution's environmental ethos and elevates the ecological responsibility of the workforce. By integrating GHRM into the broader institutional strategy and establishing dedicated green management departments, alongside refining incentive structures and evaluative feedback

frameworks, organizations can holistically enhance environmental outcomes and contribute substantively to sustainable progress.

Secondly, fostering an elevated degree of green work engagement among academic and administrative personnel: The degree to which faculty and staff engage in environmentally responsible work activities has a profound impact on both institutional environmental performance and corporate social responsibility. As paragons of environmental stewardship, universities are well-positioned to spearhead green campus initiatives through the active engagement of their personnel, thereby augmenting their societal standing and gaining broader public recognition. Empirical research suggests that faculty and staff's enthusiasm and commitment to green work directly influence their environmental conduct and the institution's overall ecological performance. Consequently, higher education institutions must prioritize the enhancement of green work participation through targeted environmental education and training programs, the promotion of ecological awareness, and the implementation of well-crafted environmental policies and incentivization mechanisms, all aimed at facilitating campus sustainability and achieving long-term environmental objectives, thus contributing to global ecological preservation.

Lastly, augmenting the moral reflection capacities of academic personnel: Enhancing the moral reflexivity of faculty and staff is critical in fostering a deeper alignment with environmental values, which in turn can significantly amplify their participation in green work and improve environmental performance outcomes. Higher education institutions must adopt a systematic and multi-faceted approach to embedding environmental ethics and sustainability education within both pedagogical frameworks and practical applications. This approach not only sharpens the moral reflection abilities of educators but also nurtures students' ecological awareness, ultimately advancing the dual objectives of achieving sustainable educational outcomes while simultaneously elevating academic quality and environmental stewardship.

5.3. Recommendations

It is noteworthy that this study bears certain limitations, which future research endeavors may seek to address and ameliorate. Firstly, there are constraints related to the research sample. This study was conducted within a specific national context, with the research subjects concentrated solely on a select number of higher education institutions in Thailand. Consequently, the generalizability of the research findings is constrained, potentially limiting their applicability to other cultural contexts or industries. Future research could consider expanding the scope of the sample, incorporating participants from a broader range of cultural backgrounds and industries, or engaging in comparative studies.

Secondly, the data collection in this study was limited to cross-sectional data, which may not adequately capture the effects of temporal changes. Future research could consider employing longitudinal studies to better understand the long-term impacts of green human resource management on environmental performance within institutions, thereby yielding more comprehensive and in-depth results.

Thirdly, this study, based on the perspective of employees, examined the impact of green human resource management on environmental performance, wherein green work involvement mediated the relationship between green human resource management and environmental performance. Moreover, it focused on the moderating role of employees' moral reflection in this process, thereby offering new insights into how higher education institutions can enhance environmental performance to achieve sustainable development. Nonetheless, there remain other factors that may explain the relationship between green human resource management and environmental performance. Future research could explore these factors from different perspectives, such as by integrating a multi-level approach that considers both managerial and employee perspectives. Additionally, future research should take into account other variables that may

potentially influence the underlying mechanisms between green human resource management and environmental performance.

Author contributions

Conceptualization, C.Y. and C.C.; methodology, C.Y.; software, C.Y.; validation, C.Y. and C.C.; formal analysis, C.Y.; investigation, C.Y.; resources, C.Y.; data curation, C.Y.; writing—original draft preparation, C.Y. and C.C.; writing—review and editing, C.Y., C.C. and L.W.; supervision, C.Y. and C.C.; project administration, C.Y.; All authors have read and agreed to the published version of the manuscript."

Conflict of interest

The authors declare no conflict of interest.

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