Research Square

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Green human resource management impacts sustainable performance through the mediating roles of green innovation and green knowledge management

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Abstract

This study investigates the impact of Green Human Resource Management (GHRM) on environmental, social, and governance (ESG) performance in food and beverage enterprises in Ho Chi Minh City, Vietnam. It also examines the mediating roles of green innovation (GI) and green knowledge management (GKM). Grounded in the ability, motivation, and opportunity (AMO) framework, the study explains how green human resource practices contribute to sustainable environmental, social, and governance outcomes. Data were collected from 250 employees and managers working in food and beverage firms and analyzed using Partial Least Squares Structural Equation Modeling. The findings indicate that GHRM positively and significantly influences all three dimensions of sustainable performance. Among them, the strongest effect is observed on social performance, suggesting that green human resource practices play a critical role in improving employee well being, enhancing social responsibility, and strengthening stakeholder relationships. The results further reveal that GKM acts as a comprehensive mediator between GHRM and all dimensions of ESG performance. In contrast, GI only mediates the relationship between GHRM and social performance, while its mediating effects on environmental and governance performance are not supported. This study enriches the application of AMO theory in the sustainability context and highlights the importance of green knowledge management as a key mechanism through which organizations can transform green human resource practices into tangible ESG outcomes and long term competitive advantages.

1. Introduction

Environmental challenges have emerged as one of the most pressing global concerns of the twenty first century of the 21st century, we find ourselves compelled to work harder toward making the world greener [1]. The rise of challenges such as climate change and resource degradation has led to an urgent call for implementing governance, social, and environmental sustainable development within businesses [2]. Sustainable performance is often concretized through the ESG framework, where Environmental, Social, and Governance performance reflects a firm's ability to balance governance profit with social responsibility and environmental conservation, ensuring development that meets present needs without compromising future generations. For the food and beverage industry, ESG is not merely a reporting indicator but also a measure of green transformation capacity through resource optimization and community welfare enhancement.

In Vietnam, following the Net Zero commitment at COP26, the pressure for green transformation has become even more pressing, particularly for the F&B sector, a resource intensive industry facing close scrutiny from the community [3]. Statistics show that the F&B industry's revenue in 2024 reached 688.8 trillion VND, of which Ho Chi Minh City currently accounts for approximately 30 to 35 percent of all F&B outlets nationwide. Ho Chi Minh City contributes the largest share due to its high population density and modern consumption habits. Although revenue increased by 16.6 percent compared to the previous year, the market has also witnessed a market restructuring, with at least 30,000 outlets forced to close due to rising operational costs [4]. According to the Ho Chi Minh City Environmental Status Report [5], the total

amount of domestic solid waste in Ho Chi Minh City in 2025 is estimated at approximately 14,116 tons per day, with urban areas accounting for the majority at 11,663 tons per day. Domestic wastewater volume has also increased sharply, reaching about 1,496,000 cubic meters per day in 2025. The F&B industry is one of the largest generators of domestic waste and single use plastics in urban areas. Ho Chi Minh City has implemented an environmental pollution reduction program for the 2020 to 2030 period and is utilizing specific mechanisms from Resolution 98/2023/QH15 to promote green production models [5].

Green human resource management not only helps F&B businesses comply with local legal frameworks but also serves as a core strategy to minimize operational costs and build sustainable competitive advantages. Sustainability is not merely an ethical obligation but is also viewed as a competitive strategy that realizes an organization's core values and goals [6]. In this context, every organization today must not only focus on financial profit but also has an obligation to balance sustainable objectives to maintain a competitive advantage in the era of globalization [7].

Many previous studies have focused solely on individual aspects of environmental performance, such as emission reduction or resource savings, while often overlooking governance and social performance within their models [8], [9]. Green human resource management represents the integration of traditional human resource activities, including recruitment, training, performance management, and reward systems, with an organization's environmental protection goals [10]. Green human resource management plays a strategic role in enhancing employee awareness, shaping environmentally friendly attitudes and behaviors, and consequently driving both environmental performance and the overall sustainable performance of the enterprise [11]. Beyond green human resource management, green innovation and green knowledge management have also been identified as key drivers of modern development [12]. Green innovation encompasses product and process improvements that minimize negative impacts on natural resources and enhance competitive capacity by creating ecosystem friendly solutions [13]. Meanwhile, green knowledge management serves as a core foundation, involving the acquisition, storage, sharing, and application of specialized environmental knowledge to address strategic challenges and create sustainable competitive advantages [7].

Although the roles of green human resource management, green innovation, and green knowledge management in promoting sustainability have been widely discussed, studies that simultaneously integrate all three factors into a unified theoretical framework remain very scarce. Most current research continues to examine green knowledge management and green human resource management as separate domains, leaving a significant gap in understanding the mechanisms by which green knowledge can drive green human resource practices and green innovation to achieve sustainable outcomes [11]. Particularly in developing countries and within the F&B business sector, transforming intangible resources into tangible sustainable performance remains a challenge that requires resolution.

To address the issues outlined above, this study will answer the following research questions. Research question one: Does green human resource management impact the ESG performance of F&B enterprises

in Ho Chi Minh City? Research question two: Do green knowledge management and green innovation truly act as mediating variables in the relationship between green human resource management and ESG performance? Research question three: What is the magnitude of the impact of various factors on ESG performance? Research question four: What managerial implications and strategic recommendations should be proposed to enhance ESG performance for F&B enterprises?

Based on the theoretical and practical gaps identified, the findings of this study will provide important theoretical and practical contributions. This research enriches the AMO theoretical framework by developing a fully integrated model that clarifies the mechanism through which green human resource management influences ESG performance via the parallel mediating roles of green knowledge management and green innovation. The study offers a concrete pathway to help F&B managers in Vietnam understand how to transform intangible resources into specific sustainable outcomes. The research findings ultimately contribute to enhancing the long term resilience of the F&B industry in the green economy era.

2. Literature review

2.1. Green Human Resource Management and Sustainable Performance

According to Renwick et al. [14], we understand Green Human Resource Management, or GHRM, as the utilization of human resource policies, practices, and systems aimed at encouraging employees within an organization to become more environmentally friendly for the benefit of individuals, businesses, and society at large. GHRM encompasses core activities including green recruitment, green training, green performance management, and green employee involvement [15]. Sustainable performance is a multidimensional concept that reflects development meeting present needs without compromising the ability of future generations. The practices arising from GHRM help disseminate environmental management philosophies across all departments, thereby cultivating a dedicated workforce equipped with the necessary skills and motivation to implement green initiatives [16]. When employees are trained and encouraged to participate in environmental protection activities, we find that businesses can achieve Governance performance by minimizing energy and material costs. Simultaneously, socially oriented human resource policies help enhance brand reputation and stakeholder loyalty [17]. In our view, GHRM is not merely an internal management tool but also a core driver enabling businesses to realize comprehensive sustainability goals [15].

We measure sustainable performance through three components: governance, environmental, and social factors [18]. Governance performance relates to cost optimization, productivity, and long term profitability. Environmental performance focuses on minimizing emissions, waste, and resource consumption, while social performance reflects a firm's commitment to employee health, safety, and the well being of local communities.

According to recent studies, GHRM not only exerts a direct impact but also operates through mediating factors to optimize ESG outcomes. The research by Awwad Al-Shammari et al. [16] confirms that GHRM

has a significant positive effect on corporate sustainable performance, with green innovation serving as a mediator that helps transform human resource inputs into environmental and governance results. Similarly, Wang and Makhbul [15] point out that GHRM is a strong predictor of ESG performance. Meanwhile, Issa et al. [17] provide a deeper insight by arguing that the impact of GHRM on environmental and social performance needs to be channeled through the development of a green organizational culture and organizational flexibility, which help businesses adapt swiftly to sustainability requirements. In this study, we systematically integrate the relationship between GHRM and ESG performance into a research model to further explore this influence.

2.2. The Ability Motivation Opportunity Theory

The Ability Motivation Opportunity theoretical framework, or AMO framework, defines work performance as the outcome resulting from the combination of three core components: ability, motivation, and opportunity [19]. Ability refers to the cognitive capabilities, skills, and specialized knowledge that enable individuals to perform tasks effectively. Motivation represents the forces that direct and sustain behavior, reflecting employees' willingness and desire to complete their work. Opportunity encompasses contextual or environmental factors beyond an individual's direct control that either enable or constrain performance execution. Previous studies have utilized AMO theory to demonstrate the relationship between Green Human Resource Management and various outcomes. Khawaja and Janjua [6] employ AMO to demonstrate that organizational sustainability results from green knowledge, while Singh et al. [9] emphasize the role of green transformational leadership in monitoring AMO components to foster green innovation. William [20] focuses on how AMO theory directly improves green performance through employee selection and skill enhancement. Kanan et al. [21] integrate AMO with the Resource Based View theory to create a more comprehensive perspective on sustainable performance.

In this study, we adopt AMO theory as the theoretical framework to concretize GHRM practices. Specifically, we view green recruitment and training as playing the role of building ability. We consider green performance management as creating motivation. We see green involvement as constructing opportunities for employees to act on behalf of the environment. Through this lens, F&B businesses not only transform intangible resources into concrete sustainable outcomes across governance, social, and environmental dimensions, but also illuminate the strategic pathway through the mediating roles of green knowledge management and green innovation. This approach thereby affirms the critical importance of building a green human resource management system in the green economy era.

2.3. Hypotheses and Research Model

Yang and Li [13] argue that businesses can promote employee innovative behavior by integrating environmental management concepts into human resource management processes to realize the organization's strategic green plans. Concurrently, Song et al. [22] have demonstrated a direct and positive relationship between employees' perceived GHRM practices and green innovation. Accordingly, we understand that GHRM contributes to enhancing capabilities, developing ecological value systems, and equipping employees with the necessary creative skills to implement innovative behaviors in

processes and products. GHRM not only directly stimulates creative thinking but also serves as a crucial prerequisite enabling the organization to provide greener products and services through waste and pollution reduction in operational processes [21]. Therefore, we propose the following hypothesis:

H1: Green human resource management (GHRM) has a positive impact on green innovation (GI).

Research by Wang and Makhbul [15], together with Al-Shammari et al. [16], confirms that GHRM acts as a powerful catalyst for sustainable performance. We find that green human resource policies help improve brand reputation, increase market attractiveness, and drive long term profitability through resource optimization. Furthermore, implementing training programs and reward systems oriented toward the environment enhances employee satisfaction and productivity while minimizing negative impacts on the ecosystem [17]. Although the effectiveness of GHRM may vary according to the size and specific context of each organization, most scientific evidence supports a positive link between green human resource practices and overall ESG performance. Based on these theoretical foundations, we propose the following hypotheses:

H2a: Green human resource management (GHRM) has a positive impact on environmental performance (EP).

H2b: Green human resource management (GHRM) has a positive impact on social performance (SP).

H2c: Green human resource management (GHRM) has a positive impact on Governance performance (GP).

Businesses can promote the formation and accumulation of environmental knowledge by integrating green standards into recruitment and training processes [6]. Li and Li [23] have demonstrated a direct and positive relationship between GHRM and green knowledge sharing, showing that supportive human resource policies encourage employees to proactively exchange ecosystem protection solutions. GHRM contributes to raising awareness and equipping the necessary skills for personnel to participate effectively in the storage and application of green knowledge within the organization. Therefore, we propose the following hypothesis:

H3: Green human resource management (GHRM) has a positive impact on green knowledge management (GKM).

Green innovation contributes directly to improving ESG performance by minimizing waste, optimizing resources, and promoting positive social and governance outcomes [9]. Research by Li et al. [24] and Makumbe [20] shows that GI not only helps reduce negative impacts such as emissions but also improves ecological design processes, thereby enhancing the overall sustainable performance of the enterprise. Therefore, we propose the following hypotheses:

H4a: Green innovation (GI) has a positive impact on environmental performance (EP).

H4b: Green innovation (GI) has a positive impact on social performance (SP).

H4c: Green innovation (GI) has a positive impact on Governance performance (GP).

According to Kuo et al. (2022), green innovation serves as an important bridge enabling businesses to effectively utilize human resources to achieve sustainable outcomes. We argue that GHRM stimulates green innovations and through this mechanism positively impacts sustainable performance. The following hypotheses are therefore formulated:

H5a: Green human resource management (GHRM) has a positive impact on environmental performance (EP) through green innovation (GI).

H5b: Green human resource management (GHRM) has a positive impact on social performance (SP) through green innovation (GI).

H5c: Green human resource management (GHRM) has a positive impact on Governance performance (GP) through green innovation (GI).

Green knowledge management serves as a strategic asset helping businesses integrate environmental issues into operational and decision making processes [12]. Recent studies have shown that GKM helps organizations closely align their activities with sustainable development goals, supporting waste reduction and resource optimization [10]. Therefore, we propose the following hypotheses:

H6a: Green knowledge management (GKM) has a positive impact on environmental performance (EP).

H6b: Green knowledge management (GKM) has a positive impact on social performance (SP).

H6c: Green knowledge management (GKM) has a positive impact on Governance performance (GP).

Beyond its direct impact, GKM also plays a mediating role in transforming GHRM activities into concrete sustainable outcomes. We propose that GHRM creates the motivation and capacity for employees to accumulate ecological knowledge, and then GKM utilizes these intangible resources to address strategic challenges and drive sustainable performance [7]. This relationship ensures that sustainability initiatives do not remain merely at the policy level but are realized through practical knowledge based solutions. Therefore, we formulate Hypothesis H7 as follows:

H7a: Green human resource management (GHRM) has a positive impact on environmental performance (EP) through green knowledge management (GKM).

H7b: Green human resource management (GHRM) has a positive impact on social performance (SP) through green knowledge management (GKM).

H7c: Green human resource management (GHRM) has a positive impact on Governance performance (GP) through green knowledge management (GKM).

3. Methodology

3.1 Measurement scale

The measurement scales were inherited by our research team from previous studies. However, we carefully adjusted the content to ensure it was suitable for the Vietnamese market and the specific context of the food and beverage industry. We employed an expert interview method with five specialists to refine and validate the measurement scales. Detailed information regarding the scales is presented in Table 1. Subsequently, we constructed a survey questionnaire employing a five point Likert scale to evaluate the proposed research model.

Table 1
Description of the variables and data source.

Source: Synthesis by the author

Code	Content	Source
GR	**GREEN RECRUITMENT**	[15]
GR1	My company always prioritizes environmental protection when recruiting new employees.	
GR2	Committing to environmental protection is a plus that helps my company attract many talented candidates.	
GR3	During the interview, we prioritize candidates who have a sense of responsibility towards the environment.	
GR4	Questions about environmental awareness always appear in our recruitment process.	
GT	**GREEN TRAINING**	[15]
GT1	The purchasing team is guided on how to find clean, environmentally friendly raw materials.	
GT2	The company regularly holds training sessions for employees on how to manage and protect the environment.	
GT3	Extracurricular activities on sustainable living are regularly organized for employees.	
GT4	Employees participate in specialized training sessions to develop green skills.	
GPM	**GREEN PERFORMANCE MANAGEMENT**	[25]
GPM1	Each department has specific environmental protection goals such as saving electricity and reducing waste.	
GPM2	The environmental protection efforts of employees are an important part of the reward and evaluation process.	
GPM3	Green living indicators are integrated into the daily work management system.	
GPM4	Our superiors often praise or give feedback to help us improve our environmental goals.	
GPM5	My organization considers green behaviors in the workplace of employees in the performance evaluation system.	
GEI	**GREEN EMPLOYEE INVOLVEMENT**	[25]
GEI1	Company employees are always encouraged to contribute ideas to solve environmental issues.	
GEI2	We have channels for employees to participate in environmental management, such as newsletters, suggestion boxes, green action groups, etc.	

Code	Content	Source
GEI3	Employees collaborate with leadership to discuss and develop long-term environmental strategies.	
GEI4	The management team uses group work formats such as the Green Squad team, the Green Living team, etc., to raise awareness about environmental issues.	
GEI5	Our organization always encourages employees to actively participate in environmental issues.	
GI	**GREEN INNOVATION**	[20]
GI1	My company prioritizes using the least polluting materials when designing and developing products.	
GI2	The company prioritizes materials that help save energy during product development.	
GI3	The processing and production process has been improved to minimize hazardous waste.	
GI4	My company operates processes that allow the reuse of treated waste.	
GKM	**GREEN KNOWLEDGE MANAGEMENT**	[12]
GKM1	Finding knowledge about green living at my company is very easy and convenient.	
GKM2	The company always proactively learns environmental protection experiences from partners and stakeholders.	
GKM3	My company has clear and systematic methods for departments to share the most effective green living experiences with each other.	
GKM4	We regularly hold exchange sessions, regular meetings, or joint projects for everyone to discuss environmental protection information.	
GKM5	The company always proactively applies new knowledge to overcome environmental challenges together, regardless of any department.	
EP	**ENVIRONMENTAL PERFORMANCE**	[10]
EP1	The companies are increasingly complying with environmental protection regulations and standards more seriously and effectively.	
EP2	We have saved a significant amount of electricity, water, and other energy sources during operation.	
EP3	The amount of harmful emissions such as CO2 from the company's activities has been significantly reduced.	
EP4	The company has minimized the use of materials that are harmful to the environment.	
EP5	Our products and packaging are designed to be easily reusable or recyclable.	
SP	**SOCIAL PERFORMANCE**	[10]

Code	Content	Source
SP1	The enterprise has contributed to improving the overall living standards and welfare for all stakeholders such as employees, customers, partners, and others.	
SP2	We have minimized the negative impacts and environmental risks to the surrounding community.	
SP3	The working environment at the company is becoming safer, and employees' health is being better cared for.	
SP4	The company always raises awareness and effectively protects the rights of the community we serve.	
GP	**GOVERNANCE PERFORMANCE**	[10]
GP1	Thanks to sustainable development efforts, the company's market share is continuously expanding.	
GP2	Our brand's position and reputation are becoming increasingly stronger in the market.	
GP3	The company's profits have improved thanks to the implementation of green activities.	
GP4	The company's return on investment has increased significantly.	

3.2 Data collection and analysis method

The survey participants of our study focused on employees and managers currently working at food and beverage enterprises located in Ho Chi Minh City. We conducted the data collection process using a convenience sampling method, distributing paper surveys directly to the units to ensure interaction and the accuracy of the feedback information. After screening and eliminating invalid responses, our final research sample comprised 250 valid observations that met the standards for subsequent analysis.

We applied a mixed research method approach. We conducted in depth interviews with five experts who have extensive experience in management and the food and beverage industry to refine the language and content of the measurement scales, thereby ensuring their relevance to the actual context in Vietnam. In the quantitative research phase, we performed linear structural model analysis using the partial least squares structural equation modeling method. We used SmartPLS4 software as our primary analysis tool. We also assessed the reliability of the measurement scales through Cronbach's Alpha and composite reliability, evaluated convergent validity through average variance extracted, and examined discriminant validity using the Fornell Larcker criterion and the heterotrait monotrait ratio before testing our hypotheses concerning direct relationships and mediating roles within the research model.

4. Results

4.1 Reliability of the Measurement Scales

To assess the internal consistency reliability of the latent constructs within our measurement scales, we employed Cronbach's Alpha coefficient and composite reliability. The analysis results presented in Table 2 show that all constructs met the required reliability thresholds, with Cronbach's Alpha values exceeding 0.7 and ranging from 0.802 to 0.902. According to Hair et al. [26], these values confirm the internal consistency of our measurement scales.

According to Hair et al. [27], a measurement scale achieves convergent validity when the average variance extracted coefficient exceeds 0.5. This indicates that the scale explains at least 50 percent of the variance observed in the indicators. The average variance extracted results in Table 2 all exceed the threshold of 0.5, ranging from 0.597 to 0.774. Among these, the construct "Green Performance Management" has the lowest average variance extracted value at 0.597, while "Social Performance" achieves the highest convergent validity at 0.774. We therefore conclude that our measurement scales demonstrate good convergent validity and are suitable for subsequent analysis steps..

Table 2
Construct reliability and validity *Source: The author's research results*

Governance performance	**Cronbach's alpha**	**rho_a**	**Composite reliability**	**Average variance extracted (AVE)**
	0.878	**0.919**	**0.915**	**0.729**
Environmental performance	0.894	0.895	0.922	0.703
Green employee involvement	0.854	0.859	0.896	0.632
Green innovation	0.802	0.808	0.871	0.628
Green knowledge management	0.889	0.890	0.919	0.693
Green performance management	0.831	0.837	0.881	0.597
Green Recruitment	0.812	0.812	0.876	0.639
Green Training	0.810	0.816	0.875	0.638
Social Performance	0.902	0.903	0.932	0.774

4.2 Reliability of Observed Variables

According to Hair et al. [26], we consider observed variables to meet the reliability requirements when their outer loading coefficients exceed 0.7. The detailed analysis results are presented in Table 3. The outer loading coefficients range from 0.711 to 0.899, substantially exceeding the minimum threshold of 0.7. Among these, the observed variable GP2, belonging to the "Governance performance" construct, achieves the highest loading coefficient at 0.899, followed by GP1 at 0.885 and SP4 at 0.887. The observed variable with the lowest loading coefficient is GI1 at 0.711. All loading coefficients are high and

statistically significant, which confirms to us that the observed variables adequately represent their corresponding latent constructs..

Table 3
Outer loadings *Source: The author's research results*

EP1	EP	GEI	GI	GKM	GP	GPM	GR	GT	SP
	0.846								
EP2	0.843								
EP3	0.851								
EP4	0.832								
EP5	0.818								
GEI1		0.807							
GEI2		0.843							
GEI3		0.828							
GEI4		0.733							
GEI5		0.759							
GI1			0.711						
GI2			0.781						
GI3			0.814						
GI4			0.857						
GKM1				0.828					
GKM2				0.848					
GKM3				0.843					
GKM4				0.823					
GKM5				0.822					
GP1					0.885				
GP2					0.899				
GP3					0.805				
GP4					0.824				
GPM1						0.804			
GPM2						0.743			
GPM3						0.724			

EP1	EP	GEI	GI	GKM	GP	GPM	GR	GT	SP
	0.846								
GPM4						0.786			
GPM5						0.801			
GR1							0.807		
GR2							0.787		
GR3							0.793		
GR4							0.810		
GT1								0.814	
GT2								0.828	
GT3								0.814	
GT4								0.735	
SP1									0.876
SP2									0.875
SP3									0.880
SP4									0.887

4.3 Discriminant Validity of the Measurement Scales

According to the Fornell Larcker criterion, discriminant validity is established when the square root of the average variance extracted for each construct is larger than the correlation coefficients between that construct and other constructs in the model. The analysis results presented in Table 4 show that the diagonal values, which represent the square roots of the average variance extracted for all latent constructs, are considerably higher than the off diagonal correlation coefficients. We therefore confirm that discriminant validity has been established for all measurement scales in our research model. Furthermore, to reinforce this conclusion, we also examined the heterotrait monotrait ratio, the results of which are displayed in Table 5.

Table 4
Fornell-Larcker criterion *Source: The author's research results*

EP	EP	GEI	GI	GKM	SP
	0.854				
GEI	0.280	0.838			
GI	0.007	0.111	0.793		
GKM	0.216	0.532	0.025	0.833	
SP	0.168	0.395	0.422	0.295	0.879

Our study additionally assessed discriminant validity through the heterotrait monotrait ratio. According to Henseler et al. [28], discriminant validity is established when all heterotrait monotrait values between pairs of latent constructs are below the threshold of 0.9. We found that all heterotrait monotrait coefficients between variable pairs ranged from 0.066 to 0.663, which completely satisfies the acceptable standard threshold.

Table 5
Heterotrait - Monotrait Ratio (HTMT) *Source: The author's research results*

EP	EP	GEI	GI	GKM	GP	GPM	GR	GT	SP
GEI	0.312								
GHRM	0.359	0.663							
GI	0.132	0.103							
GKM	0.595	0.091	0.073						
GP	0.310	0.258	0.066	0.234					
GPM	0.123	0.104	0.371	0.066	0.122				
GR	0.219	0.102	0.383	0.207	0.113	0.332			
GT	0.230	0.119	0.300	0.197	0.151	0.400	0.308		
SP	0.438	0.275	0.495	0.328	0.188	0.544	0.552	0.576	

4.4 Model Stability and Predictive Capability

The analysis results presented in Table 6 reveal that the adjusted R^2 values for all constructs are very close to the R^2 values. This finding demonstrates to us that our model exhibits high stability and that no multicollinearity issues are present.

Table 6
Testing with R^2 and R^2 adjusted *Source: The author's research results*

EP	R-square	R-square adjusted
	0.320	**0.312**
GI	0.149	0.145
GKM	0.032	0.028
GP	0.078	0.067
SP	0.536	0.530

To assess the predictive capability of our research model, we employed the Q^2predict index along with error metrics including the root mean square error and the mean absolute error. According to the criteria established by Hair et al [27], a Q^2 value greater than zero indicates that the model has satisfactory predictive relevance for a specific latent construct. The analysis results presented in Table 7 show that all Q^2predict values for the dependent variables in our model exceed zero. This finding confirms to us that our model demonstrates appropriate predictive capability.

Table 7
Q^2 Predict analysis results *Source: The author's research results*

GI	Q^2predict	RMSE	MAE
	0.135	**0.939**	**0.719**
GKM	0.020	0.994	0.906
EP	0.067	0.972	0.856
GP	0.031	0.992	0.862
SP	0.456	0.745	0.567

4.5 Model Fit

Before testing our research hypotheses, we evaluated the overall fit of the structural model using the indices presented in Table 8. The analysis results show that the standardized root mean square residual for our estimated model is 0.066, which falls below the standard threshold of 0.08. This finding confirms to us that our model has a good fit with the empirical data. Furthermore, the normed fit index achieved a value of 0.837, approaching the threshold of 0.9. This reflects an acceptable level of model fit within the context of our partial least squares structural equation modeling analysis.

Table 8
Model_fit *Source: The author's research results*

SRMR	Saturated model	Estimated model
	0.059	**0.066**
d_ULS	1.220	1.545
d_G	0.383	0.397
Chi-square	553.102	570.434
NFI	0.842	0.837

4.6 Testing Mediating Relationships

We employed a bootstrapping technique with 5000 resamples to test our hypotheses concerning the direct and indirect relationships among latent constructs. The detailed results of this analysis are summarized in Table 9.

Table 9
Hypothesis testing results *Source: The author's research results*

Hypothesis	Impact relationship	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result
H1	GHRM -> GI	0.386	0.391	0.059	6.565	0.000	Accepted
H2a	GHRM -> EP	0.184	0.185	0.061	3.005	0.003	Accepted
H2b	GHRM -> SP	0.580	0.583	0.045	12.971	0.000	Accepted
H2c	GHRM -> GP	0.196	0.198	0.066	2.975	0.003	Accepted
H3	GHRM -> GKM	0.179	0.186	0.064	2.806	0.005	Accepted
H4a	GI -> EP	0.028	0.028	0.060	0.467	0.640	Rejected
H4b	GI -> SP	0.194	0.192	0.058	3.344	0.001	Accepted
H4c	GI -> GP	-0.073	-0.074	0.067	1.093	0.275	Rejected
H5a	GHRM -> GI -> EP	0.011	0.011	0.024	0.449	0.654	Rejected
H5b	GHRM -> GI -> SP	0.075	0.076	0.027	2.753	0.006	Accepted
H5c	GHRM -> GI -> GP	-0.028	-0.029	0.027	1.048	0.295	Rejected
H6a	GKM -> EP	0.498	0.499	0.051	9.754	0.000	Accepted
H6b	GKM -> SP	0.186	0.184	0.048	3.894	0.000	Accepted
H6c	GKM -> GP	0.183	0.186	0.062	2.956	0.003	Accepted
H7a	GHRM -> GKM -> EP	0.089	0.092	0.033	2.714	0.007	Accepted
H7b	GHRM -> GKM -> SP	0.033	0.034	0.015	2.221	0.026	Accepted
H7c	GHRM -> GKM -> GP	0.033	0.034	0.016	2.013	0.044	Accepted

The results show that most of our hypotheses regarding direct effects were supported at a statistical significance level of $p < 0.05$. Green human resource management exhibited its strongest positive impact on social performance ($\beta = 0.580$, $p = 0.000$). The effects of green human resource management on governance performance and environmental performance were also confirmed, with β coefficients of 0.196 and 0.184 respectively. Green knowledge management demonstrated a significant role by

positively influencing all three dimensions of sustainable performance: environmental performance (β = 0.498), social performance (β = 0.186), and governance performance (β = 0.183), all with $p < 0.01$. However, the direct effects of green innovation on environmental performance and governance performance were rejected as they did not achieve statistical significance ($p > 0.05$). Green innovation only had a positive impact on social performance (β = 0.194, p = 0.001).

Furthermore, green knowledge management served as a comprehensive mediator connecting green human resource management to all three outcome variables, environmental performance, social performance, and governance performance, with corresponding p values of 0.007, 0.026, and 0.044. Thus, hypotheses H7a, H7b, and H7c were all accepted. Green innovation only played a mediating role in the relationship between green human resource management and social performance (β = 0.075, p = 0.006), whereas its mediating roles concerning environmental performance and Governance performance were not supported ($p > 0.05$).

Source: The author's research results

4.7 Mean Value Analysis

The mean value analysis results presented in Table 10 show that the level of agreement ranged from moderate to fairly high, spanning from 3.04 to 4.39. We observed particularly notable results for green performance management, where most observed variables in this group achieved mean values above 4.3. Among these, the observed variable GPM4 recorded the highest level of agreement across our entire survey, with a mean value of 4.39. In contrast, the variables belonging to the green knowledge management and Governance performance groups had lower mean values, ranging from 3.04 to 3.22. Specifically, variable GP2 had the lowest value at 3.04. We interpret this disparity as reflecting an actual situation within the Vietnamese food and beverage industry context. Specifically, enterprises are focusing strongly on building management foundations and internal culture, yet the values of green knowledge management as well as the output outcomes regarding governance factors still require more time to be transformed into clearer performance results.

Table 10
Mean Value Analysis Results *Source: The author's research results*

Factors		N	Mean	Std. Deviation
GR	GR1	250	3.93	1.045
	GR2		3.82	.990
	GR3		3.83	1.062
	GR4		3.80	1.031
GT	GT1	250	3.76	1.060
	GT2		3.92	1.008
	GT3		3.78	1.066
	GT4		3.76	1.070
GPM	GPM1	250	4.37	.761
	GPM2		4.31	.749
	GPM3		4.33	.703
	GPM4		4.39	.726
	GPM5		3.86	1.095
GEI	GEI1	250	3.73	1.000
	GEI2		3.80	.948
	GEI3		3.87	.933
	GEI4		3.81	1.043
	GEI5		3.65	1.031
GI	GI1	250	4.21	.876
	GI2		3.93	1.069
	GI3		3.97	1.090
	GI4		3.86	1.090
GKM	GKM1	250	3.13	1.264
	GKM2		3.22	1.343
	GKM3		3.22	1.358
	GKM4		3.13	1.329

Factors		N	Mean	Std. Deviation
	GKM5		3.18	1.310
EP	EP1	250	3.42	1.288
	EP2		3.52	1.233
	EP3		3.45	1.273
	EP4		3.44	1.344
	EP5		3.46	1.255
SP	SP1	250	4.18	1.102
	SP2		4.22	1.048
	SP3		4.10	1.102
	SP4		4.14	1.079
GP	GP1	250	3.13	1.329
	GP2		3.04	1.330
	GP3		3.12	1.311
	GP4		3.10	1.257

5. Discussion

Our analysis results have demonstrated that green human resource management has a direct impact on all three components of ESG performance. Specifically, we found that GHRM acts as a driving force for environmental performance, social performance, and Governance performance. This result proves that applying green human resource policies helps food and beverage enterprises not only comply with environmental regulations but also promotes governance and social outcomes. Furthermore, we identified green knowledge management as a comprehensive mediating factor that successfully connects GHRM to all three elements of ESG performance. GKM helps transform employee capabilities and motivation derived from GHRM policies into practical knowledge solutions for addressing strategic challenges. However, green innovation only played a mediating role in the relationship between GHRM and social performance with a β coefficient of 0.076, while its direct effects on environmental performance and Governance performance, as well as its mediating roles in the relationships between GHRM and environmental performance and Governance performance, were rejected in our study. The strongest direct effect in our research model belonged to the relationship between GHRM and social performance with a β coefficient of 0.575. Among the mediating factors, GKM had a very strong impact on environmental performance with a β coefficient of 0.495. Additionally, GHRM also strongly impacted green innovation with a β coefficient of 0.379. In contrast, green innovation had the weakest impact,

affecting only one of the three ESG performance components, namely social performance, with a β of 0.200, while its impacts on environmental performance and Governance performance were rejected.

Our finding regarding the positive impact of GHRM on ESG performance fully supports the studies by Andi et al. [7] in the energy sector and Khawaja and Janjua [6] in the textile industry. This result proves that investing in people through green recruitment and training is always a solid foundation for improving organizational performance, regardless of the industry. However, while previous studies found that environmental performance was the most strongly affected factor, our research reveals that in the Vietnamese food and beverage context, social performance is actually the dimension most strongly impacted, with a β of 0.575. Another key finding is that GKM connects GHRM to all three ESG components. This finding reinforces the findings of Khawaja and Janjua [6] that green knowledge sharing is a crucial factor for transforming GHRM practices into organizational sustainability. A noteworthy difference emerged when we compared our results with the study by Bhattarai et al. [1], in which managers' environmental knowledge did not demonstrate a mediating role for employees' green behavior. We interpret this difference as being explained by our study's focus on green knowledge management rather than merely on the knowledge factor alone, thereby creating a more powerful practical impact on ESG performance.

Notably, the role of green innovation in our study provides a different perspective compared to previous research. While Kanan et al. [21] and Singh et al. [9] affirm that GI is an important bridge promoting both environmental and Governance performance, our results within the food and beverage industry in Ho Chi Minh City show that GI only plays a mediating role for social performance. We believe this difference reflects that food and beverage enterprises in Vietnam generally, and in Ho Chi Minh City specifically, are currently in the early stages of green transition. In this stage, innovations such as eco friendly packaging primarily serve to build brand image and generate social value rather than immediately producing quantifiable emission reduction indicators or cutting operational costs in the short term. Furthermore, our research results are consistent with the study by Yang and Li [13] as both studies indicated that GHRM has a direct and positive impact on GI.

Our findings paint a comprehensive picture of how GHRM impacts ESG performance within the food and beverage industry in Ho Chi Minh City. While GKM plays the crucial role of transforming GHRM into sustainable performance, GI reflects a very specific characteristic of Vietnamese enterprises in the early stages of green transition, where efforts currently focus only on promoting social value. This finding not only reinforces the core theoretical foundation of previous studies but also provides important practical value. To simultaneously optimize all three ESG components, we recommend that food and beverage managers shift from short term green innovation initiatives toward building a synchronized system of green knowledge management and green human resource management.

6. Conclusion

This study was conducted with four research objectives. First, we aimed to assess the impact of GHRM on the ESG performance of food and beverage enterprises in Ho Chi Minh City. Second, we focused on clarifying the mediating roles of GKM and GI in transforming GHRM into concrete sustainable outcomes concerning environmental, social, and Governance performance. Third, we sought to determine the impact levels of GHRM, GKM, and GI on each specific aspect of ESG performance, including environmental, social, and governance dimensions, to highlight the differences within the food and beverage industry context. Finally, we aimed to propose practical managerial implications.

Our analysis results have outlined a promising transformation pathway in which GHRM is not merely an internal management system but becomes a direct driver of all three sustainability factors. Notably, we found that GHRM impacts social performance most strongly with a β of 0.575, reflecting a clear superiority and indicating that enterprises are prioritizing the use of human resource policies to build community reputation and employee welfare. However, we observed that the transformation from intangible resources to concrete outcomes is only fully realized when GKM appears as a comprehensive mediator, helping to convert green human resource capabilities and motivation into practical knowledge solutions that simultaneously optimize environmental, social, and governance aspects. A particularly noteworthy finding in our model concerns the role of GI. Contrary to traditional theoretical expectations, within the food and beverage industry context, beyond its direct impact on SP and its mediating role in facilitating GHRM's impact on SP, GI had no effect on either Governance performance or environmental performance. We interpret this as reflecting an authentic picture of the early stage of green transition, where enterprises are focusing strongly on building cultural foundations and fostering engagement from management levels before they can achieve breakthrough advances in technology or green profitability. Therefore, we propose several managerial implications to enhance ESG performance for food and beverage enterprises in the Vietnamese market generally and in Ho Chi Minh City specifically.

First, we recommend optimizing reward and encouragement processes from management levels, as GPM4 recorded the highest agreement level, to promote social performance. Since GHRM impacts SP most strongly with a β of 0.575, enterprises should leverage the high employee consensus regarding appreciation from superiors to integrate social goals into daily communication. We suggest that food and beverage managers in Vietnam shift from behavioral control approaches toward providing spiritual support, regularly praising employee teams that develop initiatives to protect community health or support local causes, thereby building trust and sustainable engagement. Food and beverage enterprises need to synchronize solutions across their human resource processes. First, environmental protection criteria should be embedded into candidate screening processes, as reflected in GR1, to select teams that share ecological values from the outset. Simultaneously, maintaining practical environmental management skill guidance sessions, as reflected in GT2, will help employees master energy saving procedures and minimize workplace waste. We also recommend that enterprises create open dialogue spaces where employees can join leadership in discussing and contributing ideas to long term environmental strategy, as reflected in GEI3.

Second, we advise digitalizing and sharing green knowledge to enhance environmental performance. Because GKM has a very strong impact on environmental performance with a β of 0.495, and within this construct GKM2 and GKM3 recorded the highest agreement levels, food and beverage enterprises need to establish strategic partner networks and join industry alliances to stay updated on practical experiences. Concurrently, we recommend digitalizing green handbooks on internal platforms such as Zalo, Viber, and Zoom, combined with cross departmental workshops.

Third, we encourage employee participation in process innovation. Given the positive impact on GI with a β of 0.379, enterprises should create weekly competitions with rewards for practical idea contributions, enabling employees to propose ideas for improving packaging or developing less polluting processing procedures, as reflected in GI1. We advise management levels to integrate these indicators into performance evaluation systems to encourage proactive initiative from their workforce.

We acknowledge that our study still has several limitations. The survey scope was limited to Ho Chi Minh City with a sample size of 250 observations, which may reduce the representativeness of the entire food and beverage industry in Vietnam. Furthermore, our research model has not yet integrated additional moderating variables. To address these limitations, we suggest that future studies should expand the geographical scope to a national scale and increase the sample size to enhance generalizability and reliability. Additionally, incorporating moderating variables will help enterprises gain deeper and more practical insights into their pathway toward achieving sustainable development goals.

Declarations

Clinical Trial Number

Not applicable.

Ethics approval and consent to participate:

The study was approved by the Research Ethical Committee of Industrial University of Ho Chi Minh City (IUH), and all procedures were carried out in accordance with relevant guidelines and regulations. A formal ethics approval document has been issued by the Research Ethical Committee of IUH and can be provided upon request. This study involved survey participants who are employees and managers working in food and beverage companies. Their participation was entirely voluntary, and respondents were informed of the research purpose prior to data collection. No sensitive or personally identifiable information was requested. Informed consent was obtained from all participants before the survey, and respondents were assured of confidentiality and anonymity throughout the research process

Consent to publication:

Not applicable.

Since this study does not involve any identifiable images or personal data, participant consent for publication is not required.

The authors affirm that the participants provided consent for their anonymized responses to be used for research and publication purposes. All findings are reported in aggregate form, ensuring that no individual respondent can be identified.

Competing interests:

The authors declare no competing interests.

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Author Contribution

Trinh Doan Tuan Linh conceptualized the research and designed the methodology. Vo Huu Khanh performed the numerical simulations and analyzed the results. Trinh Doan Tuan Linh and Vo Huu Khanh contributed to the theoretical framework and provided critical insights during discussions. Vo Huu Khanh wrote the first draft of the manuscript, and Trinh Doan Tuan Linh reviewed, revised, and approved the final manuscript.

Data Availability

The datasets analysed during the current study are available from the corresponding author on reasonable request.

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Figures

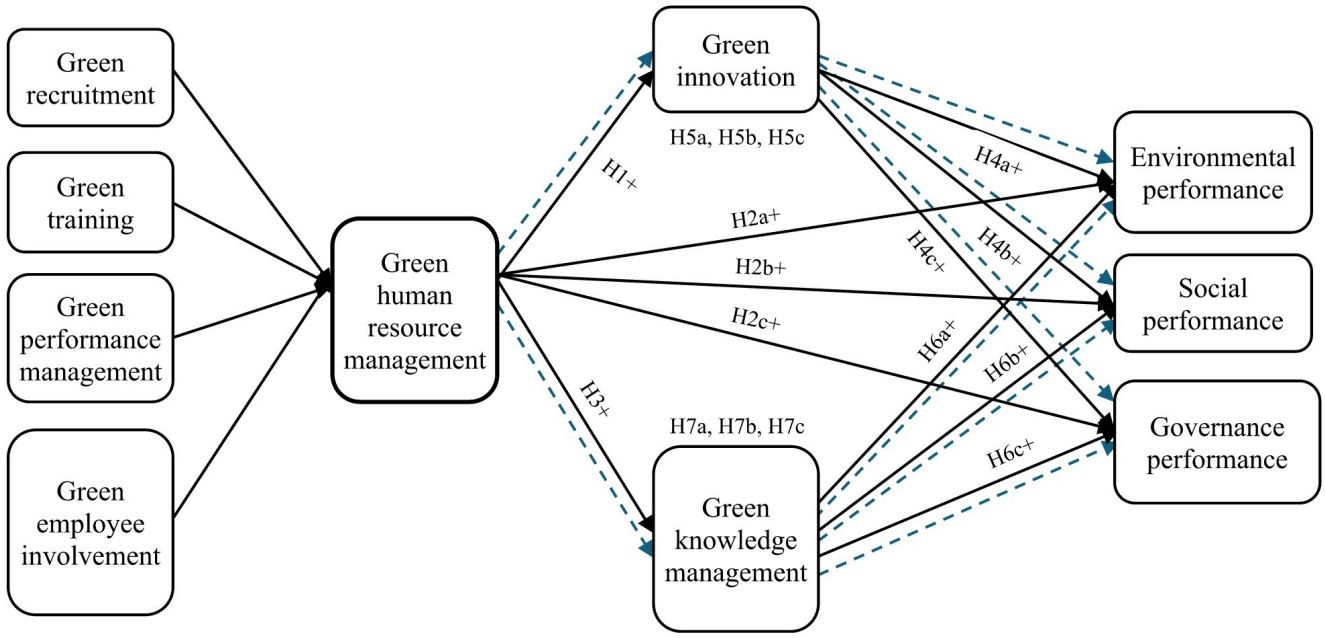


Figure 1

Research model

Source: Author's Proposal

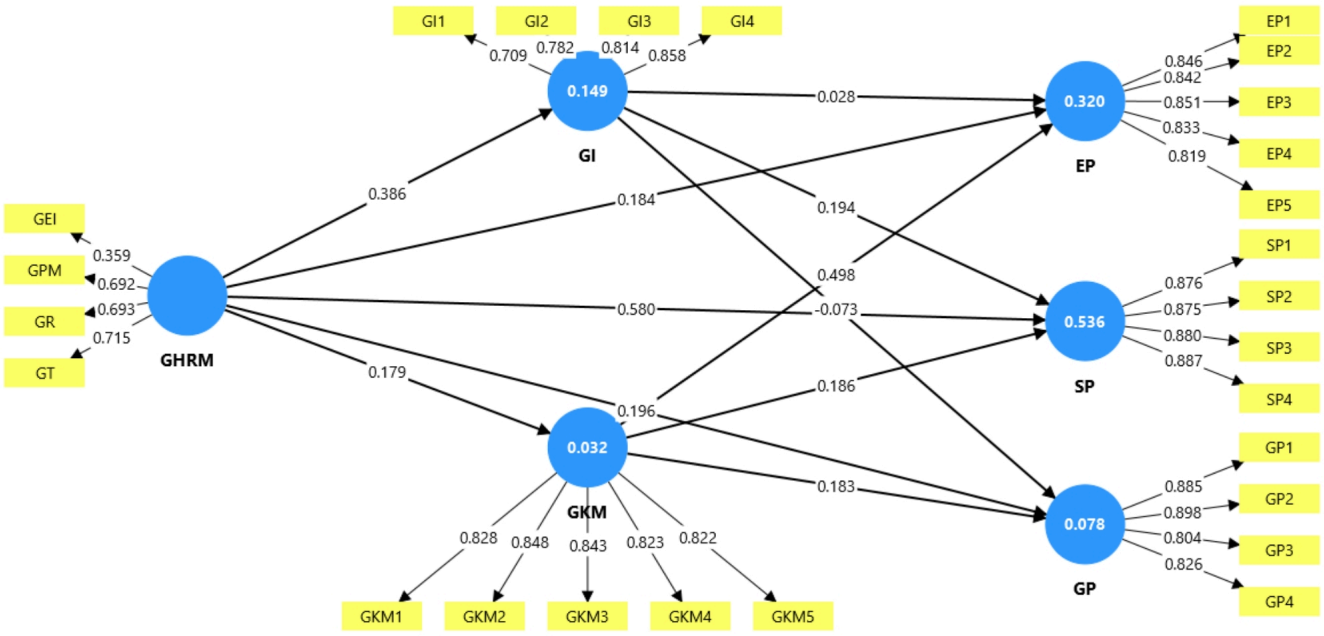


Figure 2

PLS-SEM model estimation results

Source: The author's research results