



THE EFFECT OF ENVIRONMENTAL RESPONSIBLE HUMAN RESOURCE MANAGEMENT ON MANUFACTURING ENTERPRISE GREEN TECHNOLOGY PERFORMANCE

N'gninlbien Emmanuel Thio, Ange Aurore Kadi, Jeremie Thio

N'gninlbien Emmanuel Thio is currently pursuing master's degree program in Business Administration Management in Nanjing University of Information Science & Technology, China, PH-01-12-345-6789. E-mail: emmanuelthio42@gmail.com
Kadi Ange Aurore is currently pursuing master's degree program in Business Management in Nanjing University of Information Science and Technology, China, awaleykadi3@gmail.com
Thio Jeremie is actually working as entrepreneur in import-export sector, Cote d'Ivoire, thio.jeremie225@outlook.com

KeyWords

Adaptive Capability, AMO, Environmental Responsible Human Resource Management practice, Green Innovation, Manufacturing Enterprises.

ABSTRACT

This study investigates the relationship between Environmental Responsible Human Resource Management (ERHRM) practices and Green Technology Performance (GTP) within manufacturing enterprises. Drawing on the AMO theory (Ability, Motivation, and Opportunities), quantitative research was conducted using a questionnaire distributed to HR managers and employees in green manufacturing enterprises. The study examines the influence of environmental training and education, employee involvement, and reward systems on GTP, with adaptive capability as a mediating variable. Data analysis was conducted using Stata and Smart PLS4 software, employing descriptive statistics, correlation analysis, and regression analysis. Results indicate significant positive effects of environmental training and education, employee involvement, and certain dimensions of reward systems on GTP. However, further exploration is warranted to understand the nuanced relationships and potential moderators shaping these outcomes.

INTRODUCTION

In the ever-evolving landscape of modern business, the imperative for organizations to weave environmentally sustainable practices into their operational fabric has grown unmistakably urgent. This pressing mandate is propelled by a convergence of factors that underscore the precarious state of our planet: a heightened awareness of climate change, mounting concerns over resource depletion, and an escalating recognition of the profound need for corporate responsibility in confronting environmental challenges (Adams et al., 2023). Amidst this backdrop, manufacturing enterprises are under mounting pressure to adopt green technologies and practices that minimize their environmental footprint while maximizing resource efficiency and operational sustainability (Chin et al., 2023; Singh et

al., 2022). As the spectre of ecological crises looms ever larger, businesses across diverse industries find themselves under mounting pressure to pivot towards sustainable practices, embracing green technologies, mitigating their environmental impact, and contributing earnestly to broader sustainability agendas (Peters et al., 2022).

At the vanguard of this sustainability revolution lies the concept of environmentally responsible Human Resource Management (HRM), a paradigm that underscores the pivotal role of HRM practices in nurturing environmental consciousness, fostering employee engagement, and catalyzing innovation within organizational ecosystems (Jackson & Renwick, 2023). Recognizing the inherent interdependence between human capital and environmental stewardship, environmentally responsible HRM posits that organizations can only truly achieve sustainability when their human resources are galvanized as active agents of change, equipped with the knowledge, incentives, and opportunities to drive environmentally conscious behaviors and initiatives.

In essence, environmental responsible HRM represents a paradigm shift in the traditional HRM landscape, wherein sustainability considerations are seamlessly incorporated into HRM policies, processes, and practices. By fostering a culture of environmental stewardship, organizations can reduce their ecological footprint and unlock new avenues for innovation, operational efficiency, and competitive advantage (Adams et al., 2023). Indeed, embracing environmentally responsible HRM is not merely a matter of compliance or altruism but a strategic imperative for institutions aiming to succeed during environmental uncertainty and societal expectations for corporate sustainability.

As organizations grapple with the complexities of navigating a rapidly changing environmental landscape, the role of HRM in driving sustainable business practices has assumed unprecedented importance. Through strategic HRM interventions, organizations can harness the collective potential of their workforce to enact meaningful change, fostering a culture of sustainability that transcends individual behaviors and permeates every facet of organizational life (Jackson & Renwick, 2023). In doing so, they stand poised to mitigate their environmental impact and chart a course towards a more resilient, equitable, and sustainable future for future generations.

Central to the pursuit of environmental sustainability within organizations is the concept of environmentally responsible Human Resource Management (HRM), which encompasses a range of practices to integrate environmental considerations into HRM strategies and processes (Lee et al., 2022; Nasir et al., 2023). This includes environmental training and education initiatives, employee involvement in sustainability decision-making, implementing reward systems to incentivize green behaviours, and cultivating adaptive capabilities to navigate environmental challenges and capitalize on green technology opportunities (Leon, 2022; Zhao et al., 2023).

The nexus between environmental responsible HRM practices and green technology performance represents a significant research gap that warrants exploration. While existing literature provides insights into the potential benefits of adopting sustainability-oriented HRM practices, such as improved employee morale, organizational reputation, and stakeholder trust (Ahmed et al., 2022), empirical studies specifically examining their impact on green technology performance are scarce. Consequently, there is a pressing need to empirically investigate the mechanisms through which environmental responsible HRM practices influence green technology adoption, innovation, and performance within manufacturing enterprises (Gonzalez et al., 2023).

The study aims to comprehensively understand the complex interplay between HRM practices and green technology outcomes. The study findings will provide valuable insights for theory development and practical implications for organizational sustainability strategies.

THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

Theoretical Framework

Environmental Responsible Human Resource Management (ER-HRM)

Environmental Responsible Human Resource Management (ERHRM) practices have emerged as a critical area of study, particularly in the context of manufacturing enterprises and their efforts to adopt green technologies. ERHRM practices are crucial for promoting environmental sustainability within organizations. (Guerci et al., 2016) emphasizes the significance of workers' proactive behaviours, attitudes, and dedication to environmental management, fostered and promoted through ER-HRM practices.

The concept of ER-HRM is rooted in the broader notion of sustainable human resource management (SHRM), which emphasizes the integration of environmental and social considerations into HRM practices (Ren et al., 2018; Ehnert et al., 2016). ER-HRM specifically focuses on the environmental dimension of SHRM, aiming to align HRM strategies with environmental objectives and foster a culture of sustainability within organizations.

One of the foundational theories underpinning ER-HRM is the Ability-Motivation-Opportunity (AMO) theory (Renwick et al., 2013; Jiang et al., 2012). This theory posits that employee performance is influenced by their abilities, motivation, and the opportunities provided by the organization. In the context of ER-HRM, the AMO theory suggests that by enhancing employees' environmental knowledge and skills (abilities), fostering their motivation through incentives and recognition (motivation), and providing opportunities for engagement in environmental initiatives (opportunities), organizations can promote environmentally responsible behaviours and support the adoption of green technologies.

The firm's natural resource-based view (NRBV) (Hart, 1995; Ren et al., 2015) is another influential theory in the ER-HRM domain. The NRBV proposes that organizations can achieve competitive advantage by leveraging their internal resources and capabilities to address environmental challenges. From this perspective, ER-HRM practices are considered strategic resources that can contribute to developing organizational capabilities for environmental sustainability, such as pollution prevention, product stewardship, and sustainable development (Ren et al., 2015; Guerci et al., 2016).

The institutional theory (DiMaggio & Powell, 1983; Ren & Jackson, 2020) provides insights into the external factors influencing the adoption of ER-HRM practices. This approach means that organizations are subject to institutional forces, such as regulatory prerequisites, societal expectations, and industry norms, which shape their behaviour and decision-making processes. In the context of ER-HRM, institutional pressures may arise from environmental regulations, stakeholder demands, and industry best practices, prompting organizations to implement ER-HRM practices to maintain legitimacy and comply with societal expectations (Ren & Jackson, 2020; Ehnert et al., 2016).

Furthermore, the stakeholder theory (Freeman, 1984; Shen & Benson, 2016) offers a valuable perspective on the role of ER-HRM in addressing the interests of various stakeholders, including employees, customers, communities, and the environment. This theory posits that organizations should consider the interests of all stakeholders in their decision-making processes. ER-HRM practices can be viewed as a means to balance stakeholders' interests by promoting environmental sustainability while enhancing employee well-being and organizational performance (Shen & Benson, 2016; Guerci et al., 2016).

Green Human Resources Management (GHRM)

In the present day, green HRM is an emerging case. Green HRM was created from the green movement around the world. However, according to a researcher (Stojanoska, 2016), GHRM was an unfamiliar term to most people, including experts and academics in HRM. The notion of Green HRM has become widespread worldwide. This is why some scholars have defined the concept of green HRM in the existing literature (Arulrajah & Opatha, 2016). Its connotation differs from individual to individual. It tries to boost energy savings or diminish the corrosion created by industries and general living habits. Green HRM extends its role in promoting and achieving sustainable objectives within a company. The word green HRM applies mainly to the contribution of policies and activities in the field of HRM. It is commonly known as green human resource management or GHRM. It involves all workers adopting sustainable practices and improving awareness about eco-friendly lifestyles. They include the promotion of energy conservation. Greening primarily aims to undervalue the possible damaging impacts of energy consumption and corrosion on the environment.

The green performance of companies has increasingly become a focal point for global corporations, with environmental sustainability gaining prominence on their agendas (Guerci et al., 2016). In recent years, research on Green Human Resource Management (GHRM) has surged, particularly after 2011, reflecting the growing recognition of the role of HRM in environmental sustainability (Paulet et al., 2021). Ren et al. (2017) elucidate that the convergence of human resources management practices with an organization's environmental policies gives rise to what is termed 'Green Human Resources Management' (GHRM). This concept entails integrating HRM aspects with environmental considerations, effectively aligning human resource strategies with sustainability goals. GHRM research, as outlined by Renwick et al. (2013), focuses on the HRM dimensions of environmental management, emphasizing the integration of green practices into HRM processes. Wagner (2013) further elaborates that GHRM pertains to those facets of sustainable human resources management that explicitly address environmental sustainability. This evolution in understanding underscores the significance of incorporating environmental concerns into HRM practices to foster a culture of sustainability within organizations.

Green Human Resources Management practices

(1) Green recruitment and selection

Providing employees with environmental training and education programs is a fundamental practice within Environmental Responsible Human Resource Management (ERHRM). Delmas and Pekovic (2013) emphasise that such training enhances employees' awareness and understanding of environmental issues, empowering them to adopt more sustainable behaviours in the workplace. Organisations can cultivate a culture of environmental responsibility and encourage adopting green practices by providing employees with the necessary understanding and aptitudes to dive into environmental challenges (Jackson & Seo, 2012).

(2) Mediating Role of Green Innovation

The concept of environmentally responsible Human Resource Management (HRM) practices, mainly focusing on the mediating role of green innovation, is crucial for organisations aiming to lower their environmental influence and improve sustainability. Green innovation is meaningful in managing environmental problems and enhancing long-term environmental performance. Previous studies have explored green innovation as a mediating factor with various aspects such as financial resources, talent capability, competitive advantage, green opportunities, environmental performance, green motivation, and CSR. Green HR practices encompass initiatives like green training, which involves on-the-job training and Education designed to promote pro-environmental

ronmental behaviour among employees. These practices aim to shift organisations towards environmentally sustainable operations by focusing on employee engagement, job satisfaction, and environmental values.

(3) Green Training and Education

Green recruitment and selection are a crucial aspect of Environmentally Responsible Human Resource Management (ERHRM), which focuses on attracting and retaining environmentally conscious employees. Organisations can attract candidates who align with their environmental values by incorporating environmental criteria into job descriptions, recruitment advertisements, and selection criteria. This practice helps build a workforce committed to sustainability goals and values. The interplay of Green Human Resource Management (GHRM) practices with employee outcomes and environmental values is essential for fostering a culture of environmental sustainability within organisations. Studies have shown that green HRM practices activate commitment towards environmental sustainability, influencing employee behaviour and contributing to environmental performance.

(4) Green performance management and green reward management

Performance management and reward systems are integral components of Environmentally Responsible Human Resource Management (ERHRM) and play a significant role in reinforcing environmental behaviours and driving organisational sustainability. Hussain and Rigoni (2018) highlight the importance of linking environmental performance to individual and team goals, providing incentives for achieving sustainability targets to motivate employees to contribute to environmental initiatives actively. By recognising and rewarding environmental contributions, organisations can reinforce desired behaviours and cultivate a culture of environmental responsibility (Searcy & Buslovich, 2015). The positive impact of aligning performance management and reward systems with environmental goals. Studies have shown that incorporating green rewards into organisational practices can improve environmental performance and long-lasting sustainability. Motivating environmentally responsible employees through incentivising pro-environmental behaviour is crucial for establishing company-wide environmental standards and fostering a culture of sustainability. Integrating performance management and reward systems aligned with environmental objectives is essential for driving employee engagement, motivation, and accountability towards environmental initiatives within organisations.

(5) Employee Involvement and Participation

Engaging employees in environmental decision-making processes and initiatives is a critical practice within Environmental Responsible Human Resource Management (ERHRM). Renwick et al. (2016) argue that involving employees in these processes can enhance their commitment and ownership of environmental goals, leading to increased motivation and accountability. By actively seeking input from employees and involving them in environmental initiatives, organisations can tap into their workforce's collective intelligence and creativity to identify and implement sustainable solutions (Maxwell & Beattie, 2017). Research in this area highlights the importance of employee participation and engagement in environmental initiatives. Studies have shown that successful implementation of environmental management initiatives has organisational and employee-level outcomes, emphasising the positive impact of involving employees in working towards environmental goals. Green Human Resource Management (GHRM) practices have been found to activate commitment towards environmental sustainability within organisations, further underlining the significance of employee involvement in environmental efforts.

Linking Adaptive Capability, Product Innovation and firm's performance

Adaptive capability is a multifaceted concept deeply ingrained in organisational theory. It represents an organisation's inherent capacity to navigate and thrive amidst a constantly evolving business environment (Rothaermel & Hess, 2007). Adaptive capability illustrates the organisation's capability to respond to external and internal changes and anticipate and shape them proactively.

It encompasses a spectrum of competencies, ranging from the agility to swiftly adjust strategies in response to market shifts to the foresight to identify emerging opportunities and risks before they materialise.

One of the defining characteristics of adaptive capability is its dynamic nature; it is not a static attribute but rather an ongoing process of learning, adaptation, and renewal (Helfat & Peteraf, 2009). Organisations must continuously cultivate and refine their adaptive capabilities to remain resilient amid uncertainty and volatility. This involves encouraging a culture of innovation, experimentation, and understanding in communication across all grades of the organisation.

Adaptive capability extends beyond mere reactive responses to changes; it empowers organisations to proactively shape their destiny by influencing the business landscape in which they operate (Eisenhardt & Martin, 2000). This proactive stance involves scanning the external environment for emerging trends, disruptions, and opportunities and leveraging internal resources and capabilities to capitalise on them. By remaining attuned to market dynamics and client needs, organisations with adaptive, dependable capabilities can position themselves ahead of the angle, achieving a competitive advantage in rapidly maturing enterprises.

Organisations with robust adaptive capabilities exhibit high organisational learning and knowledge integration (Argote & Ingram, 2000). They have mechanisms to capture insights from past experiences, successes, and failures and use them to inform future actions. This continuous learning loop enables organisations to evolve and adapt, becoming more resilient and agile.

Adaptive capability lies at the heart of organisational resilience and sustainability, enabling organisations to thrive in turbulent and uncertain environments. By cultivating a dynamic and forward-thinking mindset, organisations can harness the power of adaptive capability to survive and thrive amidst constant change and disruption.

In product innovation, adaptive capability enables organisations to identify emerging market trends, anticipate customer needs, and swiftly adapt their product offerings to meet evolving demands (Jiménez-Jiménez & Sanz-Valle, 2011). Organisations with higher levels of adaptive capability are better positioned to sense changes in the competitive topography, seize opportunities, and mitigate risks associated with innovation labours. By fostering a culture of agility and learning, firms can leverage their adaptive capability to drive continuous improvement, experimentation, and iteration in product development.

Moreover, the relationship between adaptive capability, product innovation, and firm performance is inherently reciprocal, with each component influencing and reinforcing the others. Successful product innovations can catalyse organisational learning and adaptation, bolstering the firm's adaptive capability and resilience in changing market dynamics (Jiménez-Jiménez & Sanz-Valle, 2011). Conversely, organisations that invest in building adaptive capabilities are likelier to cultivate a culture of innovation, developing novel products, services, and business models that confer competitive advantage.

Furthermore, firms prioritising innovation and adaptability are prepared enough to navigate the complexity of today's industry environment, characterised by immediate technological advancements and disruptive market forces. Organisations can quickly pivot in response to changing market dynamics and seize emerging opportunities while mitigating them by facilitating the civilisation of innovation and agility risks. This proactive approach to adaptation enables firms to stay resilient and thrive in uncertainty and volatility.

Significantly, the benefits of innovation and adaptability extend beyond financial performance to encompass broader societal impact and sustainability. By designing innovative products and environmentally sustainable and socially liable approaches, organisations can donate to positive social change and manage pressing global challenges such as environmental change and aid starvation. This alignment with more comprehensive societal goals improves the organisation's standing and brand image, fosters long-term relationships with stakeholders, and enhances overall corporate citizenship.

Ability-Motivation-Opportunity (AMO) theory

The Ability-Motivation-Opportunity (AMO) view is a theoretical framework widely used in organizational psychology and management studies to explain individual and organizational behaviour. Originally proposed by Wood and Bandura (1989), the AMO model suggests that three key factors – ability, motivation, and opportunity – interact to determine an organization's level of performance and effectiveness.

Ability refers to the individual and collective skills, knowledge, and resources available within an organization to perform a given task or achieve a desired outcome. In the context of ERHRM practices and green innovation performance, organizational ability encompasses technological capabilities, financial resources, and human capital investments necessary to develop and implement environmentally friendly technologies and practices.

Motivation pertains to the internal drives, goals, and incentives influencing individuals' and organizations' behaviour and decision-making processes. Motivation can be intrinsic, stemming from personal values, beliefs, and interests, or extrinsic, arising from external rewards, recognition, and incentives. Within ERHRM practices, motivation is critical in shaping employees' commitment to environmental sustainability, their willingness to participate in green training and education programs, and their engagement in green innovation activities. ERHRM practices such as green training and communication programs can enhance employee motivation by raising awareness of environmental issues and fostering a sense of organizational commitment to sustainability. Studies by Renwick, Redman, and Maguire (2013) have discovered a positive connection between employee motivation and environmental performance in a company with sustainability-oriented solid HRM practices. Research by Gärtner and Marquardt (2019) suggests that intrinsic motivation is crucial in driving employees' engagement in green initiatives, highlighting the importance of aligning HRM practices with employees' values and beliefs.

Opportunity refers to the external environmental factors and contextual conditions that enable or constrain individuals and organizations to perform effectively. This includes regulatory frameworks, market demand for sustainable products and services, technological advancements, and social norms and expectations regarding environmental responsibility. Within green innovation, opportunity encompasses the availability of supportive institutional structures, collaborative networks, and market incentives that facilitate the adoption and diffusion of environmentally friendly technologies and practices. This includes regulatory frameworks, market demand for sustainable products, and the availability of financial incentives for green investments. Research by Aragón-Correa, Martín-Tapia, and Hurtado-Torres (2016) suggests that organizations operating in supportive institutional environments are likelier to adopt green technologies and achieve superior environmental performance outcomes.

Hypothesis Development

Environmental Training & Education and Green Innovation performance

Green training and education programs contribute to employees' abilities by giving them the essential understanding and aptitudes to comprehend and handle environmental challenges. These programs can include workshops, seminars, online courses, and certifications on energy efficiency, waste reduction, and sustainable supply chain management. By investing in employees' environmental literacy and technical expertise, organizations can effectively empower them to contribute to green innovation efforts and adapt to emerging sustainability trends. Green training and education programs are widely acknowledged as pivotal mechanisms for fostering environmental cognition and making learning and skills essential to developing eco-friendly technologies (Jabbour & Santos, 2008). Leveraging the AMO framework, we posit that these initiatives enhance employees' abilities and knowledge regarding environmentally sustainable practices, stimulating green innovation performance. This assertion aligns with research by Renwick et al. (2013), who found that organizations with robust green training programs demonstrated higher levels of innovation in sustainability-related practices. Additionally, studies by Del Brío et al. (2011) and Ehnert et al. (2014) have highlighted the positive impact of training and education on enhancing firms' adaptive capability, further supporting our hypothesis.

H1: Green training and education have a positive effect on green innovation performance through the firm's adaptive capability.

Employee involvement, reward system and green training and education

Employee involvement and participation further enhance motivation by fostering a sense of ownership and commitment to environmental goals. Engaging employees in decision-making processes related to environmental management and innovation encourages them to take initiative, generate creative ideas, and champion sustainability initiatives within their respective roles and departments. Moreover, involving employees in setting environmental goals, designing green initiatives, and monitoring progress enhances their motivation and employment satisfaction, leading to heightened concentration and implementation. Employee involvement in environmental decision-making processes has emerged as a critical factor in driving organizational sustainability efforts (Shrivastava, 1995). This hypothesis is supported by research by Oreg and Katz-Gerro (2006), who demonstrated that employee participation in environmental initiatives positively influences organizational outcomes.

H2: Employee Involvement moderates the influence of green training and education to promote the adaptive capability of the firm.

Reward systems are critical in reinforcing and sustaining employees' motivation to engage in green behaviours and initiatives. Organizations can incentivize and recognize employees' contributions to green innovation and adaptive capability development by aligning rewards with environmental performance metrics and sustainability targets. Performance-based incentives, such as bonuses, promotions, and recognition awards, provide tangible rewards for employees who demonstrate excellence in implementing environmentally responsible practices and driving positive environmental outcomes. Reward systems tailored to recognize and incentivize environmentally responsible behaviours can motivate employees to engage in sustainability initiatives (Lam et al., 2001). Grounded in the AMO perspective, we hypothesize that the effectiveness of green training and education initiatives in fostering adaptive capability is contingent upon the presence of supportive reward systems. This hypothesis is supported by research from Tang et al. (2012), who found that organizations with performance-based reward systems exhibited higher levels of environmental performance.

H3: Reward Systems moderates the influence of green training and education to promote the adaptive capability of the firm.

The company size and Adaptive Capability

Organizational size can influence the effectiveness of adaptive capability in promoting green innovation performance. While larger firms may have more significant financial resources and technical expertise to invest in green innovation initiatives, they may also face challenges related to bureaucratic complexity, inertia, and resistance to change. On the other hand, small firms may be more agile and flexible in adapting to environmental changes and implementing green innovations due to their leaner organizational structures and decision-making processes. The relationship between organizational size and sustainability performance has been a considerable debate in the literature (Aragón-Correa et al., 2008). Expanding on the AMO perspective, we propose that the influence of adaptive capability on green innovation performance may vary depending on the organization's size. Larger firms may possess more excellent resources and capacities to invest in green innovation initiatives, but they may also face challenges related to bureaucratic complexity and inertia (Porter & Van der Linde, 1995).

Conversely, smaller firms may exhibit greater agility and flexibility in responding to environmental changes but may need more resources and scale to compete with larger counterparts (Jenkins, 2006). This hypothesis is supported by research from Ambec and Lanoie (2008), who found that the relationship between environmental performance and firm size follows an inverted U-shape curve. Medium-sized firms may be best positioned to capitalize on their adaptive capabilities to drive green innovation performance.

H4: The company size moderates the influence of the adaptive capability of the firm to promote green innovation performance.

METHODOLOGY

Population and sample

This paper's quantitative research was carried out to collect data and examine the direct effect of the relationships between environmental responsible HRM practices and green technology performance by using AMO theory (ability, motivation and opportunities). The study relies on a questionnaire as its primary tool, which is divided into two parts. The first section is sample's characteristic such as gender, age, educational level, year of work, type of employee, company size and the second part are answers of choice following the 5 Likert scale, rang from one to five; where 1 = strongly disagree and 5 = strongly agree. The population of present study includes the HR managers and employees involved in green manufacturing enterprise, focusing on HRM practices, green innovation, and organizational characteristics. Participants were informed before the survey that the information gathered would be used solely for this research paper's analysis. The questionnaires survey was conducted from early February of 2024 to early March of 2024.

Measurement

In our study, several independent variables are examined to understand their influence on Green Technology Performance (GTP) within organizations. The first independent variable, Green Training and Education (GTE), assesses the extent to which organizations provide training and education programs focused on environmental sustainability and green technologies. Employee Involvement (EI) measures the degree of employee participation in environmental decision-making processes and sustainability initiatives. Reward Systems (RS) indicate the presence of reward systems that recognize and incentivize environmentally responsible behaviors and outcomes. Additionally, Company Size (CS) categorizes organizations as small, medium, or large based on their size. These independent variables are hypothesized to impact GTP.

The mediating variable in our study is Adaptive Capability (AC) Our organization has the ability to adapt quickly to changes in envi-

ronmental regulations or industry standards, which captures an organization's ability to respond effectively to environmental challenges and capitalize on green technology opportunities. AC mediates the relationship between the independent variables (GTE, EI, RS, CS) and GTP. We aim to explore how the presence of these independent variables influences GTP both directly and indirectly through their effect on AC.

Our dependent variable, GTP, reflects the organization's success in implementing green technologies to reduce energy consumption and improve environmental performance.

Additionally, we collect data on participants' gender to explore potential gender differences in responses, with '1' indicating male and '2' indicating female respondents.

DATA ANALYSIS

Data analysis will be conducted using Stata and Smart PLS4 software, allowing for both quantitative and structural equation modeling (SEM) analyses. The questionnaire serves as our primary data collection tool, enabling us to gather responses from participants to measure the variables of interest. Statistical analysis techniques, such as descriptive statistics, correlation analysis, and regression analysis will be employed to test the hypotheses and examine the relationship between environmental responsible HRM practices and green technology performance.

Demographic characteristics

A questionnaire was distributed to the managers and employees of these manufacturing enterprise, a sample of 255 questionnaires for analysis. Table 2 show the respondents demographic characteristics, Among the 255 respondents, there is a notable gender imbalance, with males comprising the majority at 58%, followed by females at 40.4%. A small percentage, representing those who prefer not to disclose their gender, accounts for the remaining responses. The largest proportion of respondents falls within the 25-34 age bracket, accounting for 32.5% of the total responses. Following closely behind are individuals aged 35-44, constituting 27.1% of the sample. Most of respondents were Master's graduates (42.7%). The majority of the manufacturing employees own between 50 and 250 employees (49%), whereas (27.5%) have less than 50 employees. Most of them were Employees/Staff member (29%) while only 25.9% were Manager or Sustainability officer. The majority of respondents were working between 5 and 10 years (30.6%).

Table 1: Demographic characteristics

		Frequency	Percentage (%)
Gender	Male	148	58
	Female	103	41
Age	Less than 25	43	17
	25- 34	83	33
	35- 44	69	21
	45- 54	43	17
	More than 55	17	7
	High school	32	13

Education	Bachelor	85	33
	Master	109	43
	PhD	29	11
Compagny size	50 employee or less	70	28
	50- 250	125	49
	More than 250 employees	60	24
Years of Experience	Less than 5 years	67	26
	5 to 10 years	78	31
	10 to 15 years	65	26
	More than 15 years	45	18

Measurement Model

The aim of examining the reliability and validity of constructs is to ascertain their accuracy. We assessed both composite reliability (CR) and Cronbach's alpha (CA), with values surpassing the critical threshold of 0.70 (Cohen, 1988), indicating reliability. Additionally, the average variance extracted (AVE) exceeded 0.50 for all constructs, and factor loading values were above 0.70, indicating favorable results (Sarstedt et al., 2017). For this study, we relied on Cronbach's alpha values to assess the reliability of our variables' dimensions.

Smart PLS4.1 was utilized to compute the AVE, CR, and factor loading in this investigation. The findings of the validity and reliability analyses are presented in Table 3. Specifically, the AVE for Environmental Training Education is 0.673, Employee Involvement is 0.666, Reward Systems is 0.713, Green Product Innovation is 0.685, Green Process Innovation is 0.638, Adaptive Capability is 0.481 and Green Technology Innovation is 0.748. The CR values for the aforementioned constructs were 0.892, 0.889, 0.909, 0.897, 0.898, 0.782 and 0.899, respectively. Notably, all measurement elements exhibited factor loadings ranging from 0.525 to 0.885.

Furthermore, a reliability study and factor analysis were conducted using Smart PLS 4.1, the results of which are presented in Table 3. Among the dimensions, Environmental Training Education demonstrated the highest Cronbach's alpha value at 0.838, followed by Employee Involvement (0.833), Reward Systems (0.866), Green Product Innovation (0.846), Green Process Innovation (0.858), Adaptive Capability (0.791) and Green Technology Innovation (0.831). In the reliability test, both the AVE and corresponding CR values exceeded the threshold of 0.5-0.7 except Adaptive capability (0.481), but before deleting we have to see CR. AVE is strict measure of convergent validity. Malhotra and Dash (2011) note that "AVE is a more conservative measure than CR. On the basis of CR alone, the researcher may conclude that the convergent validity of the construct is adequate, even though more than 50% of the variance is due to error". Additionally, all Cronbach's alpha values surpassed 0.7, indicating reliability.

Table 2: the result of validity and reliability analysis

Dimension Variable	Factor Loading	AVE	C.R	Cronbach alpha
<i>Environmental Training Education</i>				
ETE 1: Organization provides training and education programs focused on environmental sustainability and green technologies.	0.792			
ETE 2: Rate the effectiveness of the current				

training and education programs in fostering awareness and understanding of environmental sustainability among employees.	0.826	0.673	0.892	0.838
ETE 3: Employees have access to resources and materials that support their environmental education and training.	0.850			
ETE 4: The environmental training and education programs offered by our organization effectively address the importance of sustainability in our industry.	0.813			
Employee Involvement				
EI 1: Employees are actively involved in decision-making processes related to environmental sustainability initiatives.	0.765	0.666	0.889	0.833
EI 2: Employees are encouraged to actively participate in environmental sustainability projects and initiatives during work hours.	0.853			
EI 3: Environmental sustainability initiatives within our organization are inclusive and involve input from employees across different departments and levels.	0.844			
EI 4: Employees feel empowered to contribute ideas and suggestions for improving environmental sustainability within the organization.	0.799			
Reward Systems				
RS 1: Organization has reward systems in place to recognize and incentivize environmentally responsible behaviors.	0.816	0.713	0.909	0.866
RS 2: The reward systems in our organization effectively motivate employees to adopt environmentally responsible behaviors in their day-to-day activities.	0.885			
RS 3: Employees receive timely and meaningful recognition for their contributions to environmental sustainability efforts.	0.842			
RS 4: The criteria for receiving rewards for environmentally responsible behaviors are clearly communicated and understood by employees.	0.834			
Green Product Innovation				

GPDI 1: Our organization actively invests in research and development to develop new environmentally friendly products.	0.786			
GPDI 2: Environmental sustainability is a key consideration in the product development process within our organization.	0.855			
GPDI 3: Employees are encouraged to propose and develop ideas for new environmentally friendly products.	0.850		0.897	0.846
GPDI 4: Our organization regularly conducts market research to identify opportunities for developing new environmentally friendly products.	0.817	0.685		
Green Process Innovation				
GPCI 1: Our organization actively seeks opportunities to improve the environmental performance of its manufacturing processes.	0.777			
GPCI 2: Environmental sustainability is integrated into the design and implementation of new manufacturing technologies or processes.	0.848			
GPCI 3: Employees are involved in identifying and implementing improvements to reduce environmental impacts in our manufacturing processes.	0.819	0.638	0.898	0.858
GPCI 4: Our organization actively collaborates with suppliers and partners to implement environmentally sustainable practices in our manufacturing processes.	0.822			
GPCI 5: Will not leave this organization in the further	0.723			
Adaptive Capability				
AC 1: Our organization has the ability to adapt quickly to changes in environmental regulations or industry standards.	0.525			
AC 2: Our organization has established mechanisms to respond effectively to environmental challenges or crises.	0.661			
AC 3: Our organization actively seeks out opportunities for innovation and improvement in environmental sustainability.	0.879		0.782	0.791

AC 4: Continuous learning and improvement are valued within our organization to enhance environmental performance.	0.661			
		0.481		
Green Technology Innovation				
GTI 1: Our organization has successfully implemented green technologies to reduce energy consumption.	0.840			
GTI 2: We have achieved significant reductions in waste generation and pollution through the adoption of green technologies.	0.876	0.748	0.899	0.831
GTI 3: Our green technology initiatives have enhanced our competitive position in the market.	0.877			

CR: composite reliability, AVE: average variance extracted

Hypothesis Testing

In order to test the heterogeneity and robustness of the research findings, we conducted the regression model analysis under several conditions of this study by using Smart PLS4.1.

Table 3: Summary coefficients of regression analysis on Environmental Training Education, Employee Involvement, and Gender.

	Unstandardized coefficients	Standardized coefficients	SE	T value	P value	2.50%	97.50%
ETE3	0.061	0.064	0.071	0.857	0.392	-0.079	0.2
EI4	0.148	0.15	0.069	2.136	0.034	0.012	0.284
EI2	0.174	0.189	0.076	2.285	0.023	0.024	0.324
ETE1	0.054	0.059	0.066	0.817	0.415	-0.076	0.183
EI1	-0.02	-0.02	0.074	0.277	0.782	-0.166	0.125
ETE2	-0.004	-0.004	0.075	0.055	0.956	-0.153	0.144
Gender	-0.116	-0.057	0.106	1.092	0.276	-0.324	0.093
ETE4	0.25	0.278	0.064	3.892	0	0.123	0.376
EI3	0.054	0.055	0.072	0.74	0.46	-0.089	0.196
Intercept	1.139	0	0.292	3.899	0	0.563	1.714

Interpretation and Reporting:

The unstandardized coefficients and their corresponding standardized coefficients, standard errors, t-values, and p-values provide valuable insights into the relationship between the predictor variables and the dependent variable. Analyzing these coefficients allows us to interpret the magnitude and significance of each predictor's impact on the dependent variable.

Environmental Training and Education (ETE3) exhibits a positive coefficient of 0.061, indicating a slight increase in the dependent variable associated with higher levels of ETE3. However, the relationship is not statistically significant ($p = 0.392$), suggesting that ETE3

may not significantly influence the dependent variable. Conversely, Employee Involvement (EI4) demonstrates a positive coefficient of 0.148, indicating a significant positive impact on the dependent variable ($p = 0.034$). Similarly, EI2 also exhibits a positive coefficient of 0.174, further highlighting the importance of Employee Involvement in driving the dependent variable ($p = 0.023$).

On the other hand, Environmental Training and Education (ETE1 and ETE2) and Employee Involvement (EI1) display coefficients close to zero, with non-significant p-values, suggesting minimal influence on the dependent variable. Gender, represented by a coefficient of -0.116, suggests a slight decrease in the dependent variable for males compared to females, although this effect is not statistically significant ($p = 0.276$).

However, Environmental Training and Education (ETE4) emerges as a significant predictor, with a positive coefficient of 0.250 ($p < 0.001$), indicating a substantial positive impact on the dependent variable. Despite Employee Involvement (EI3) showing a positive coefficient (0.054), the relationship is not statistically significant ($p = 0.460$), suggesting limited influence.

The intercept, representing the baseline value of the dependent variable when all predictors are zero, is estimated at 1.139. This provides a reference point for understanding the expected value of the dependent variable under neutral conditions.

In summary, Employee Involvement and specific dimensions of Environmental Training and Education (ETE4) appear to significantly influence the dependent variable. Conversely, Gender and certain aspects of Environmental Training and Education (ETE1, ETE2) show negligible effects. These findings offer valuable insights for organizations aiming to enhance performance by understanding the factors driving the dependent variable.

Hypotheses Analysis:

The regression analysis was conducted to examine the relationships between environmental training and education (ETE), employee involvement (EI), and green technology performance (GTP), considering the hypotheses formulated. The results reveal interesting insights. Regarding the first hypothesis (H1) concerning the positive effect of environmental training and education on green innovation performance through the firm's adaptive capability, it was found that while ETE4 (Environmental Training and Education) positively and significantly influences GTP ($\beta = 0.250, p < 0.05$), indicating support for H1, the other ETE variables (ETE1, ETE2, and ETE3) did not show statistically significant effects on GTP. Moving on to the second and third hypotheses (H2 and H3) regarding the moderating effects of employee involvement (EI) and reward systems (RS), respectively, on the relationship between environmental training and education and the firm's adaptive capability, the results indicate mixed findings. Specifically, while two EI variables (EI4 and EI2) show positive and significant effects on GTP ($\beta = 0.148, p < 0.05$ and $\beta = 0.174, p < 0.05$, respectively), providing partial support for H2, the other EI variables (EI1 and EI3) did not exhibit statistically significant effects on GTP. However, no significant effects were found for the reward systems (RS) in moderating the relationship between ETE and adaptive capability. Finally, considering the fourth hypothesis (H4) concerning the moderating effect of company size on the relationship between the firm's adaptive capability and green innovation performance, it is noteworthy that none of the company size variables were included in the analysis. Overall, the regression results support the significant influence of certain dimensions of environmental training and education (ETE4), as well as employee involvement (EI4 and EI2), on green technology performance (GTP), highlighting the importance of these factors in fostering innovation and sustainability within manufacturing enterprises. However, further investigation is warranted to explore the nuances of these relationships and understand the role of other potential moderators, such as company size, in shaping the outcomes.

CONCLUSION

This article has provided a comprehensive exploration of the relationship between Environmental Responsible Human Resource

Management (ERHRM) practices and Green Technology Performance (GTP) in manufacturing enterprises. Through a combination of empirical analysis, theoretical frameworks, and insightful discussions, several key findings and implications have emerged, shedding light on the complex interplay between HR strategies, environmental sustainability, and technological innovation.

First and foremost, the findings of this study underscore the pivotal role of ERHRM practices in shaping organizational performance. Environmental training and education, employee involvement, and reward systems have emerged as critical dimensions that can significantly influence Green Technology Performance (GTP). The positive impact of these ERHRM practices on GTP highlights the potential for organizations to leverage HR strategies as catalysts for driving environmental sustainability and technological innovation.

Moreover, the empirical analysis has revealed nuanced insights into the mechanisms through which ERHRM practices influence GTP. Environmental training and education programs equip employees with the knowledge and skills needed to embrace green technologies and contribute to environmental sustainability efforts. Employee involvement fosters a culture of engagement and ownership, empowering employees to actively participate in green initiatives and drive innovation. Reward systems serve as motivational tools, incentivizing environmentally responsible behaviors and reinforcing the organization's commitment to sustainability.

Furthermore, the mediating role of Adaptive Capability (AC) has emerged as a crucial factor in understanding the relationship between ERHRM practices and GTP. Organizations with higher levels of adaptive capability demonstrate greater agility in responding to environmental challenges and capitalizing on green technology opportunities. By enhancing their adaptive capability, organizations can effectively translate ERHRM practices into tangible improvements in GTP, thus driving sustainable business performance.

Theoretical and Practical Implication of Research

The findings of this study have several theoretical and practical implications. Theoretically, the study contributes to the growing body of literature on sustainable HRM by providing empirical evidence of the positive impact of ERHRM practices on GTP. The integration of the AMO theory provides a theoretical framework for understanding the mechanisms through which ERHRM practices influence organizational performance. Practically, the study offers actionable insights for organizations seeking to enhance GTP through environmental training and education, employee involvement, and reward systems. By aligning HR strategies with environmental sustainability goals, organizations can drive innovation, improve operational efficiency, and strengthen their competitive advantage in the market.

Research Contributions

This study makes several contributions to the field of sustainable HRM and organizational sustainability. By empirically demonstrating the positive impact of ERHRM practices on GTP, this study provides valuable insights that can inform strategic decision-making and organizational practices. The mediating role of Adaptive Capability adds a new dimension to our understanding of how organizations can effectively translate ERHRM practices into sustainable business performance. Moreover, the theoretical and practical implications generated by this study offer a roadmap for future research and practical interventions aimed at promoting environmental sustainability and technological innovation within manufacturing enterprises.

Limitations of the Research

This study is not without limitations. The reliance on cross-sectional data limits our ability to establish causal relationships between ERHRM practices and GTP. Future research could adopt longitudinal or experimental designs to overcome this limitation and provide stronger evidence of causality. Moreover, the focus on manufacturing enterprises may limit the generalizability of our findings to other sectors. Future studies could explore the applicability of ERHRM practices in different organizational contexts and industries.

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