“Green human resource management, renewable energy adoption, and corporate sustainability in Saudi enterprises: Evidence from structural equation modeling”

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GREEN HUMAN RESOURCE MANAGEMENT, RENEWABLE ENERGY ADOPTION, AND CORPORATE SUSTAINABILITY IN SAUDI ENTERPRISES: EVIDENCE FROM STRUCTURAL EQUATION MODELING

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Abstract

This study investigates the impact of green human resource management (GHRM) practices on corporate sustainability (CS) and the mediating role of renewable energy adoption (REA) in Saudi enterprises progressing toward a sustainable economy. Data were collected in 2025 through a structured online questionnaire distributed to 386 employees and managers in Riyadh, Saudi Arabia. The study used exploratory and confirmatory factor analyses to identify and validate the measurement structure, and structural equation modeling (SEM) using AMOS to test the proposed relationships. The findings indicate that GHRM practices have a positive and statistically significant total effect on CS ($\beta = 0.166$, $p = 0.004$) both directly and indirectly through REA, highlighting that REA partially mediates this relationship. The association between GHRM and REA is statistically significant yet relatively weak ($\beta = 0.096$, $p = 0.049$), suggesting the mediation should be interpreted as modest rather than substantial. However, REA demonstrated a strong positive effect on CS ($\beta = 0.710$, $p <= 0.001$). Although GHRM explains only 1.5% of the variance in REA, REA accounted for 53% of the variance in CS, indicating that REA supports meaningful but partial mediation between GHRM and CS. The study concludes that these findings reflect associations among respondents' perceptions and should not be interpreted as evidence of objective organizational sustainability performance. However, the relatively weak association between GHRM and REA suggests that REA is driven by a wide range of organizational, technological, financial, and policy-related factors beyond HRM practices.

Keywords green HRM, sustainability, economy, transformation, renewable energy, corporate sustainability, Saudi Arabia

JEL Classification M14, Q42, O44, O15

INTRODUCTION

The global shift toward a green economy has compelled governments and organizations to address environmental risks while striving for steady and sustainable economic growth. Businesses are increasingly reconsidering their strategies, processes, and capabilities to minimize environmental impact while sustaining competitiveness (Georgeson et al., 2017). Around the globe, countries are integrating sustainability into their economic strategies to reduce carbon emissions, expand the use of renewable energy, and encourage eco-friendly practices across industries (Rahmat et al., 2022). This shift reflects a growing global priority to balance economic progress with environmental protection, ensuring a more sustainable future for generations ahead. In this context, GHRM has emerged as an important mechanism for integrating sustainability into human resource practices and supporting the de-

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velopment of environmentally responsible workplace strategies (Mishra, 2017). Incorporating environmental objectives into HR activities such as green recruitment, training, performance appraisal, and reward systems within GHRM helps influence employees' behavior and enhance organizational capability for sustainability. Consequently, there is an increased association between environmental performance, green behavior, and green organizational culture (Ali et al., 2024).

Saudi Arabia increasingly needs to focus on sustainable practices, as sustainable development is a key consideration aligned with the global sustainability agenda and the overall goals of Saudi Vision 2030 (Georgeson et al., 2017). Saudi Vision 2030, as a strategy for economic diversification and sustainability, focuses on achieving economic and social sustainability through renewable energy, which is essential for reducing dependency on hydrocarbons (Sallam et al., 2026; Vityazeva, 2026). Complementing these efforts, the Saudi Green Initiative addresses climate change, energy security, and economic competitiveness through renewable energy development and the circular carbon economy (Vityazeva, 2026). Under Vision 2030, Saudi Arabia aims to produce at least 50% of its electricity from renewable energy sources by 2030 through the development of 58.7 GW of renewable energy capacity, primarily from solar and wind resources (Ali et al., 2021; Rafiq, 2026). This transition is reinforced by substantial investments in renewable energy and green hydrogen projects, including NEOM, along with innovative financing mechanisms and private-sector involvement to strengthen clean energy infrastructure (Sallam et al., 2026; Alhowaish, 2025; Pareeth, 2026). Furthermore, the Kingdom plans to achieve net-zero greenhouse gas emissions by 2060 and reduce emissions by 278 million tons of CO_2 equivalent each year by 2030 through its updated nationally determined contribution (Hamieh et al., 2022).

These initiatives have strengthened the implementation of sustainable practices by governmental and non-governmental organizations and promoted renewable energy through programs such as the National Renewable Energy Program (NREP) and the Saudi Green Initiative (Alshuwaikhat & Mohammed, 2017). For enterprises, REA contributes to lower operating costs, stronger environmental performance, and an improved corporate reputation (Sitompul et al., 2024). However, despite strong policies and demanding sustainability expectations, Saudi firms still face challenges in integrating their sustainability vision at the organizational level. The major challenge is the need for organizations to strengthen internal capacity to coordinate human resource management initiatives with those related to renewable energy and CS. This challenge highlights the importance of understanding how organizational practices can facilitate the successful implementation of sustainability initiatives within the Saudi business environment.

While the global literature has extensively examined the role of GHRM in promoting environmental performance and sustainability, much of this evidence originates from developed economies and manufacturing-intensive contexts. Existing studies suggest that REA is influenced by both external and internal factors, including policy frameworks, regulations, managerial commitment, and organizational capabilities (Clementi & Garofalo, 2023). However, the relationship between GHRM and REA remains underexplored, particularly in emerging and Gulf economies such as Saudi Arabia. More specifically, limited empirical evidence explains how GHRM contributes to REA and, in turn, enhances CS outcomes. Although recent studies indicate increasing interest in GHRM within the Saudi context, empirical understanding of its connection with REA and CS remains limited (Doghan, 2024; Shah et al., 2024). Addressing this gap, the present study examines whether REA serves as a mechanism through which GHRM contributes to CS in Saudi enterprises.

1. LITERATURE REVIEW AND HYPOTHESES

The resource-based view states that sustained competitive advantages arise from resources and capabilities that are valuable, rare, inimitable, and non-substitutable. Extending this theory further, the natural resource-based view (NRBV) emphasizes the role of environmental stewardship in ensuring sustainability and organizational success (Mohammed Roshif & Noushad, 2025). In this context, a GHRM strategy becomes critical because it helps build green human capital through green recruiting, training, performance

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management, and employee participation. These processes are no longer limited to administration but include the development of green knowledge and values that foster green behavior among employees. In this way, GHRM facilitates the creation of unique organizational resources that cannot be replicated by rival organizations (Dey, 2025; Mohammed Roshif & Noushad, 2025).

The capability theory serves as an explanatory framework for how GHRM affects the adoption of environmental innovations. According to dynamic capabilities theory, organizational capabilities denote a firm's ability to integrate, reconfigure, and utilize resources under changing conditions. The role of GHRM in fostering organizational capabilities lies in developing green knowledge and skills at the individual level, which together build higher-order organizational capabilities such as green absorptive and dynamic capabilities. Organizational capabilities help firms identify sustainability-related opportunities, acquire environmental knowledge, and successfully adopt environmentally innovative practices. Therefore, there is no direct association between GHRM and environmental innovation; rather, it operates through a mediating mechanism that allows individual capabilities to foster organizational capabilities (Mohammed Roshif & Noushad, 2025).

The literature suggests that green knowledge and green competencies form the basis of organizational environmental capabilities. GHRM improves environmental knowledge through green training and development activities, such as learning about environmental management systems, renewable energy technologies, sustainability regulations, and environmentally friendly business processes. This green knowledge is then converted into green competencies, such as environmental problem-solving, sustainability leadership, systems thinking, and innovation. Knowledge sharing and organizational learning enable the organization to transform its competencies into capabilities oriented towards environmental decision-making and innovation implementation. Thus, GHRM functions as a capability-building process that improves the organization's ability to carry out sustainability-related changes (Dey, 2025; Mohammed Roshif & Noushad, 2025).

Moreover, REA should be treated as an organizational capability, not simply a technology investment. To implement renewable energy systems successfully, organizations need specific technical competence, organizational learning capacity, and the ability and adaptability to manage new technologies (Shehzad, 2026). Therefore, GHRM cannot be viewed as directly leading to sustainability performance outcomes. Instead, GHRM helps build green knowledge, skills, and capabilities among employees, thereby enhancing the firm's capacity to adopt renewable energy technologies. Thus, REA is the channel through which these capabilities are used to achieve better performance outcomes. The capability-based perspective explains the mediating role of REA in the relationship between GHRM and sustainability performance (Mohammed Roshif & Noushad, 2025; Yin et al., 2026).

Empirical evidence shows that organizations with high levels of green capabilities can implement and sustain renewable energy projects more effectively than organizations without such capabilities, even with favorable policies and technology (Yin et al., 2026). These capabilities develop knowledge, support learning, secure stakeholder support, and adapt to changes necessary to successfully implement renewable energy projects. Sustainability therefore becomes an indirect outcome of GHRM practices, as a process through which sustainability emerges. First, organizational capabilities are developed, followed by the implementation of renewable energy, which in turn results in sustainability outcomes.

The transformation of Saudi enterprises requires a systematic change in people practices with environmental goals embedded in routine work, rather than merely the installation of renewable resources. In this context, GHRM reframes traditional HR functions such as recruitment, training, performance management, and rewards to promote pro-environmental behaviors and build organizational capabilities for sustainability. GHRM provides clear direction aligned with organizational priorities, develops sustainable skills, and aligns employee incentives with corporate environmental goals, thereby transforming employees into active agents of green transition (Awan et al., 2023). Resource-based perspectives and capability theo-

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ries further explain that human capital and routines developed through GHRM become distinctive organizational resources that support sustainable competitive advantage and the implementation of green technologies. Empirical evidence suggests that GHRM improves employee green behaviors and organizational green culture, which act as important mediators between HR practices and sustainability performance (Ali et al., 2024; Christina et al., 2025). These findings indicate that HR policies operate not only through formal regulations but also through socio-psychological mechanisms. In Saudi Arabia, tailored GHRM programs have been found to foster green skills and improve environmental performance in local businesses, making this approach particularly significant.

Environmental sustainability goals are increasingly integrated into organizational operations through HR practices. Early conceptual studies identified GHRM as the deliberate incorporation of sustainable development goals into recruitment, training, performance management, and incentive systems, positioning HR as an enabler of CS (Jackson et al., 2011). Green recruitment and selection help organizations build environmentally conscious workforces by hiring employees with positive attitudes toward environmental values (Pham & Paillé, 2020). Furthermore, GHRM promotes pro-environmental beliefs and behaviors among employees, leading to improved environmental and sustainability performance (Jamal et al., 2021). CS is commonly evaluated through ecological compliance, pollution control, waste reduction, and sustainable operational practices (Algarni et al., 2022). Although businesses increasingly recognize the importance of environmental sustainability, research exploring the direct relationship between GHRM and CS remains limited (Shah et al., 2024). GHRM therefore extends beyond environmental awareness by also considering the social and economic well-being of organizations and employees.

Several GHRM dimensions contribute directly to organizational sustainability and renewable energy practices. Green training develops employee competencies related to renewable technologies and environmentally responsible practices. Environmental training enhances employee awareness and managerial proficiency, improving operational activities such as the operation and maintenance of renewable systems and energy-efficient practices (Daily & Huang, 2001). Green evaluation and performance appraisal systems reinforce environmental goals by integrating renewable-related KPIs into organizational assessments. Integrating environmental criteria into appraisal systems legitimizes green behavior and supports long-term organizational transformation (Renwick et al., 2013). Similarly, green incentives and rewards encourage employees to engage in environmentally responsible behavior. Reward and compensation systems linked to green behaviors significantly improve employee support for renewable energy initiatives (Saeed et al., 2019). Employee participation further strengthens these outcomes by increasing green engagement and encouraging involvement in renewable implementation and problem-solving activities (Tang et al., 2018; Saeed et al., 2019; Khan & Faisal, 2023). These findings collectively support the argument that GHRM practices positively influence REA.

REA has evolved from a technological option into a strategic driver of CS. The triple bottom line approach emphasizes that renewable energy decisions influence environmental, social, and economic dimensions simultaneously (Elkington, 1998). Regarding the environment, REA helps reduce carbon footprints and improve resource efficiency as part of decarbonization efforts. Economically, it promotes energy efficiency, reduces costs, lowers risks associated with fluctuations in energy prices, and helps ensure greater organizational stability. From a social perspective, its use reflects a commitment to sustainable practices, fosters trust among stakeholders, contributes to organizational legitimacy, improves employees' working conditions, and provides additional benefits to neighboring communities. Firms that adopt renewable energy often experience lower operational costs, improved adaptability to energy price fluctuations, reputational gains, and stronger environmental performance, all of which contribute to long-term strategic success. Renewable adoption is increasingly seen as part of environmental, social, and governance (ESG) strategies. Empirical studies show that firms integrating renewable energy into sustainability policies improve both financial and operational per-

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formance (Goyal et al., 2013; Abhishek et al., 2024). Renewable energy initiatives therefore provide competitive and financial advantages in addition to meeting regulatory requirements. Successful REA, however, depends on organizational readiness and employee engagement.

REA can be understood as an organizational innovation that requires managerial commitment, technical capability, and employee support. GHRM contributes by equipping employees with the skills and motivation needed to support technology adoption, maintain renewable systems, and identify additional energy-saving opportunities (Sitompul et al., 2024). Effective environmental management also depends on HR systems, employee involvement, and organizational learning environments that support environmental goals (Daily & Huang, 2001). Behavioral dimensions additionally shape renewable investments, as managerial attitudes, social norms, and perceived behavioral control affect organizational intentions to invest in renewable technologies (Ajzen, 1991).

External institutional and policy environments further shape REA. Legislative incentives, subsidies, and national sustainability plans significantly encourage firms to adopt green technologies. In Gulf countries, national energy transition agendas and vision-level targets provide both incentives and expectations for business engagement. Through the interaction of external pressure and internal HR practices, GHRM strengthens the impact of policy by translating external sustainability expectations into internal routines and employee behaviors that support renewable investments (Woerter et al., 2017). Renewable energy also represents one of the most effective approaches for addressing climate change and reducing dependence on fossil fuels (Moriarty & Honnery, 2016). Sustainable energy resources, including solar, wind, geothermal, bioenergy, hydropower, and ocean-based systems, offer environmentally responsible pathways toward a low-carbon future. Nevertheless, assessing renewable energy potential requires considering technological feasibility, energy return on investment, and the environmental impacts associated with energy production. Broader ecological and climatic implications must also be examined to ensure sustainable transitions (Moriarty & Honnery, 2019). Transparency and accountability mechanisms additionally strengthen the relationship between renewable energy and sustainability outcomes, as environmental disclosures and CSR monitoring increase stakeholder trust and organizational legitimacy (Hung Chen, 2011). Collectively, these studies demonstrate that REA is not only an environmental necessity but also a strategic pathway toward achieving CS.

Recent literature further emphasizes the integrated relationship between GHRM, REA, and CS. GHRM fosters environmentally conscious workplaces and increases employees' ability, motivation, and opportunity to act sustainably while signaling top management commitment to environmental goals (Aggarwal & Agarwala, 2023). Evidence from systematic and empirical studies confirms significant positive relationships between integrated GHRM practices and various dimensions of CS, often mediated by green culture, employee engagement, and empowerment (Khaskhely et al., 2022). These findings indicate that GHRM may contribute to organizational sustainability by encouraging employee behaviors that support environmental initiatives. Within this context, REA can be viewed as a form of green innovation that depends on managerial support and employee engagement (Abhishek et al., 2024; Us et al., 2023). Empirical findings demonstrate the mediating role of renewable energy initiatives in improving socio-economic and environmental sustainability outcomes (Abhishek et al., 2024). Firms that combine renewable technologies with internal capacity-building strategies such as green training, sustainability-focused performance indicators, and employee incentives are more likely to achieve successful implementation and long-term sustainability impact. Previous studies synthesizing earlier research also identified green innovation and pro-environmental behavior as major mediators between GHRM and sustainability outcomes (Khan & Faisal, 2023). REA therefore represents a strong form of green innovation that translates organizational environmental objectives into measurable sustainability performance (Kanan et al., 2023; Khaskhely et al., 2022). Theoretically, GHRM provides the motivational, cognitive, and procedural foundations necessary for successful renewable implementation, while

REA operationalizes these capabilities through reduced emissions and lower energy costs.

Adoption of renewable energy acts as a crucial mediating mechanism in explaining how GHRM contributes to sustainability. Based on capability theory, GHRM helps develop employees' knowledge and skills in green matters, which subsequently enhance organizational capabilities in recognizing, assessing, and adopting renewable energy applications (Mohammed Roshif & Noushad, 2025). In other words, GHRM alone does not produce sustainability; rather, it increases organizations' capacity to adopt renewable energy, thereby contributing to sustainability. By reducing dependence on fossil fuels and lowering carbon emissions, REA is considered a significant factor in sustainability performance (Yin et al., 2026). In addition, organizations with strong capabilities and a supportive organizational environment are better able to adopt renewable energy technology and achieve stronger sustainability performance (Yin et al., 2026).

Therefore, the literature indicates a strong theoretical relationship between GHRM, REA, and CS. However, empirical evidence remains limited on how REA mediates the relationship between GHRM and CS within Saudi enterprises. Addressing this gap is particularly important given Saudi Arabia's transition toward a low-carbon economy and the increasing strategic role of sustainability practices in organizations.

Based on the foregoing discussion, this study aimed to examine the impact of GHRM on CS and the mediating role of REA in the relationship between GHRM and CS among Saudi enterprises. Therefore, the following hypotheses were formulated:

H1: *GHRM will have a positive and significant association with REA.*

H2: *REA will have a positive and significant association with CS.*

H3: *GHRM will have a positive and significant association with CS.*

H4: *REA mediates the association between GHRM and CS.*

2. METHOD

This study employed a quantitative research approach to examine the relationships among GHRM, REA, and CS in organizations operating in Riyadh, Saudi Arabia. The analysis was conducted in 2025 and 2026, and the city predominantly concentrates major public and private organizations that implement sustainability initiatives. To include small, medium, and large enterprises, the study used a convenience sampling technique. Only one respondent among the employees and managers who were directly involved in HR practices, sustainability initiatives, and renewable energy-related activities was recruited from each participating organization to provide an appropriate assessment of green practices and sustainability performance.

Data were collected using a structured online questionnaire distributed through professional and organizational networks. Prior to participation, respondents received a cover letter explaining the purpose of the study and the voluntary nature of participation, while also confirming the anonymity, confidentiality, and impartiality of responses. Informed consent was obtained from all participants before data collection, and no personal identifiable information was collected or disclosed. All procedures involving human subjects were performed in accordance with the appropriate ethical standards and guidelines for institutional research ethics at Prince Sattam Bin Abdulaziz University. The survey data were collected exclusively for this research and have not been used in other publications. The data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to organizational confidentiality, raw survey responses are not publicly available.

The study used a well-established measurement scale and adapted the items from previous relevant studies. GHRM was measured using eight items relevant to green recruitment and selection, green training, green evaluation, green performance appraisal, and green incentives and employee engagement established by Tang et al. (2018), Pham and Paillé (2020), Renwick et al. (2013), Daily and Huang (2001), and Saeed et al. (2019). Sample items were "We prioritize hiring candidates with

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pro-environmental values." REA was measured using four items established by Hung Chen (2011), Dey (2025), and Ajzen (1991). Sample items were "Our organization has invested in renewable energy technologies." CS was measured using seven items established by Goyal et al. (2013), Daily and Huang (2001), and Elkington (1998). Sample items were "Our organization actively reduces carbon emissions." A pilot study involving 30 participants was conducted before the main survey to evaluate item clarity, wording, relevance, and questionnaire structure. Based on the respondent feedback, minor modifications were made to enhance readability and eliminate repetitive statements. A total of 386 valid responses were collected for the final analysis. Given that the measurement items were adapted from multiple validated scales and contextualized to Saudi Arabia, exploratory factor analysis (EFA) was conducted to assess their underlying factor structure and potential cross-loadings, followed by confirmatory factor analysis (CFA) to validate the measurement model. Subsequently, structural equation modeling (SEM) using AMOS software version 26 was conducted to test the hypothesized relationships and mediating effects among the study variables.

Before commencing data analysis, several preliminary screening and diagnostic tests were conducted to confirm the adequacy and reliability of the data. Statistical Package for the Social Sciences (SPSS) version 31 was used to assess missing data, and no missing values were identified, meeting the acceptable threshold (<5%) (Dong & Peng, 2013). In addition, the study analyzed common method variance (CMV) using Harman's single-factor test. Podsakoff et al. (2003) argued that CMV problems occur when one factor accounts for more than 50% of the variance in EFA. In this case, the first factor accounted for 44.32% of the variance, while the second accounted for 11.46%, indicating that CMV was not a concern. Multicollinearity was assessed using variance inflation factor (VIF) and tolerance values. The VIF values ranged from 1.836 to 1.902, while tolerance values ranged from 0.536 to 0.763, indicating that multicollinearity was not a concern (Kock, 2015). Standardized *z*-scores and box plots were examined to identify possible outliers. As suggested by Rousseeuw and Hubert (2018), no extreme values exceeding ±3.29 were identified. Skewness and kurtosis statistics showed that all variables satisfied the assumptions of normality (Korkmaz et al., 2014).

Table 1 presents the demographic characteristics of the participants. A total of 386 participants were surveyed, representing organizations across seven sectors. Most participants were Saudi males with a master's degree (60.88%), were predominantly in the 31 to 40 age group, and held middle-level positions in medium-sized enterprises (45.08%). Industry types included manufacturing (23.84%), information technology (IT) (21.24%), construction (19.69%), healthcare (13.73%), banks and financial services (9.85%), logistics (7.51%), and energy (4.14%). Private sector organizations accounted for most respondents (67.35%), while the remaining respondents came from public sector organizations (32.64%). More than half reported the implementation of renewable energy initiatives (62.70%).

Table 1. Profile of respondents

Demographic	Categories	Frequency	%
Age	Below 20	42	10.88
	21–30	76	19.69
	31–40	118	30.57
	41–50	98	25.39
	Above 50	52	13.47
Gender	Male	236	61.14
	Female	150	38.86
Nationality	Saudi	215	55.70
	Non-Saudi	171	44.30
Education	Bachelor	91	23.58
	Master	235	60.88
	Ph.D.	60	15.54
Size of the enterprise	Small	102	26.42
	Medium	174	45.08
	Large	110	28.50
Job position	Top Level	78	20.21
	Middle Level	198	51.30
	Low Level	110	28.50
Industry	Manufacturing	92	23.84
	Energy	16	4.14
	Construction	76	19.69
	IT	82	21.24
	Banking and Finance	38	9.85
	Logistics	29	7.51
	Healthcare	53	13.73
Ownership	Public	126	32.64
	Private	260	67.35
Renewable energy usage	Yes	242	62.70
	No	144	37.30

3. RESULTS

EFA was conducted to reduce dimensionality by grouping highly correlated variables into distinct factors (Harlow, 2002). The study employed principal component analysis (PCA). In this study, PCA with varimax rotation was conducted on nineteen measurement items. Item-total correlations ranged from 0.559 to 0.768, with all values exceeding the 0.30 validity threshold. Sampling adequacy and factorability were confirmed, with a KMO value of 0.863, which was greater than 0.5 as recommended by Harlow (2002), and a significant Bartlett's test of sphericity (χ^2 = 17658.568, p < 0.001). Scree plots, factor loadings, and total variance explained were examined to validate the factor structure. Only components with eigenvalues above 1 and items with loadings greater than 0.5 were retained. All items loaded strongly on their respective constructs, with values ranging from 0.855 to 0.951. Cross-loadings were checked to ensure construct validity and avoid measurement ambiguity. Table 2 presents the PCA results, with the scree plot shown in Figure 1.

CFA was conducted using AMOS version 26. The measurement model demonstrated strong construct reliability, as indicated by composite reliability values ranging from 0.925 to 0.979, which exceeded the recommended threshold of 0.70 (Nunnally, 1978), as presented in Table 3. The average variance extracted (AVE), which represents the proportion of variance captured by a construct relative to measurement error, ranged from 0.785 to 0.812 and surpassed the 0.50 cutoff suggested by Fornell and Larcker (1981). Baumgartner and Homburg (1996), Bentler (1980), and Kline (2005) suggested the statistically acceptable fit indices shown in Table 4. The overall model exhibited a good fit across multiple indices: relative χ^2 = 2.164 (p < 0.001), GFI = 0.901, CFI = 0.914, RMSEA = 0.064, and SRMR = 0.035. Construct validity was further assessed through convergent and discriminant validity tests. Convergent validity was supported, with factor loadings of the indicators on their respective constructs ranging from 0.771 to 0.939, consistent with the recommendations of Gerbing and Anderson (1988). Discriminant validity was confirmed by comparing the square root of the AVE for each latent variable with the

Table 2. Rotated component matrix

Item	Question	Component		
		1	2	3
GHRM1	We prioritize hiring candidates with pro-environmental values.	0.946		
GHRM2	Environmental responsibilities are included in job descriptions.	0.950		
GHRM3	Employees receive training on renewable energy and eco-friendly practices.	0.951		
GHRM4	Training programs improve awareness of sustainable technologies.	0.929		
GHRM5	Employees are evaluated based on their contribution to sustainability goals.	0.932		
GHRM6	Environmental KPIs are integrated into performance appraisals.	0.930		
GHRM7	Incentives are provided for achieving renewable energy or environmental targets.	0.855		
GHRM8	Employees are encouraged to share and implement green ideas.	0.912		
REA1	Our organization has invested in renewable energy technologies			0.861
REA2	Renewable energy is integrated into our strategic planning.			0.873
REA3	Employees are encouraged to adopt renewable energy solutions in their work.			0.870
REA4	Policies exist to support renewable energy initiatives.			0.877
CS1	Our organization actively reduces carbon emissions.		0.909	
CS2	Energy efficiency is a key part of operations.		0.908	
CS3	Recycling and waste reduction programs are implemented.		0.932	
CS4	Investments in green initiatives improve long-term profitability.		0.917	
CS5	We balance financial performance with environmental goals.		0.929	
CS6	Our company engages in community activities that promote sustainability.		0.922	
CS7	Employees are made aware of sustainability policies.		0.937	
Initial eigenvalues		9.895	6.224	1.363
% of Variance		52.081	32.755	7.172
Cumulative %		52.081	84.836	92.009

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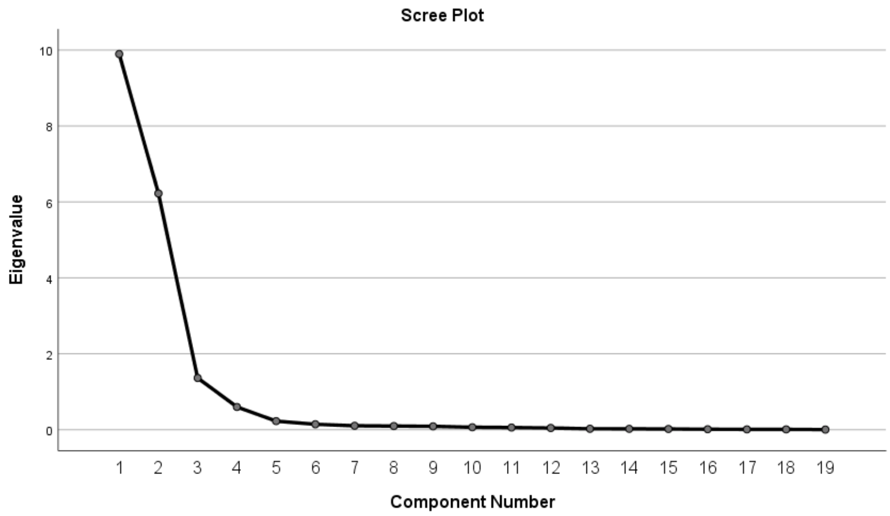

Figure 1. Screen Plot of eigenvalues

Table 3. Reliability and convergent validity

Variable / Construct	Item	Standardized Factor Loading	Cronbach's Alpha	C.R	AVE
GHRM	GHRM1	0.939	0.953	0.966	0.785
	GHRM2	0.925			
	GHRM3	0.915			
	GHRM4	0.867			
	GHRM5	0.861			
	GHRM6	0.863			
	GHRM7	0.771			
	GHRM8	0.936			
REA	REA1	0.892	0.892	0.945	0.812
	REA2	0.886			
	REA3	0.898			
	REA4	0.928			
CS	CS1	0.857	0.942	0.965	0.802
	CS2	0.915			
	CS3	0.895			
	CS4	0.923			
	CS5	0.901			
	CS6	0.862			
	CS7	0.914			

correlations among constructs, ensuring that each construct was distinct from the others.

The measurement model in Figure 2 showed strong reliability and validity for all constructs. Standardized regression weights for GHRM indicators ranged from 0.771 to 0.984, for REA from 0.988 to 0.992, and for CS from 0.945 to 0.984, and all were statistically significant ($p < 0.001$), confirming that the constructs were well measured. The model fit indices indicate a good fit: χ^2/df = 2.164, GFI = 0.901 (Hair et al., 2013), CFI = 0.914 (Hu & Bentler, 1999), NFI = 0.932 (Bentler & Bonett, 1980), SRMR = 0.035 (Hu & Bentler, 1999), and RMSEA = 0.064 (Hu & Bentler, 1999), which satisfy conventional cutoff criteria for CFA.

To test the formulated hypotheses, the study conducted structural equation modeling using AMOS version 26 as shown in Figure 3. The SEM results indicated that the theoretical model demonstrated a good fit, and hypotheses H1, H2, and H3 were tested and supported by the data. Table 5 presents the good fit indices of the structural model, with χ^2 /df = 1.753 ($p < 0.001$), GFI = 0.901, CFI = 0.921, RMSEA = 0.062, and SRMR = 0.035.

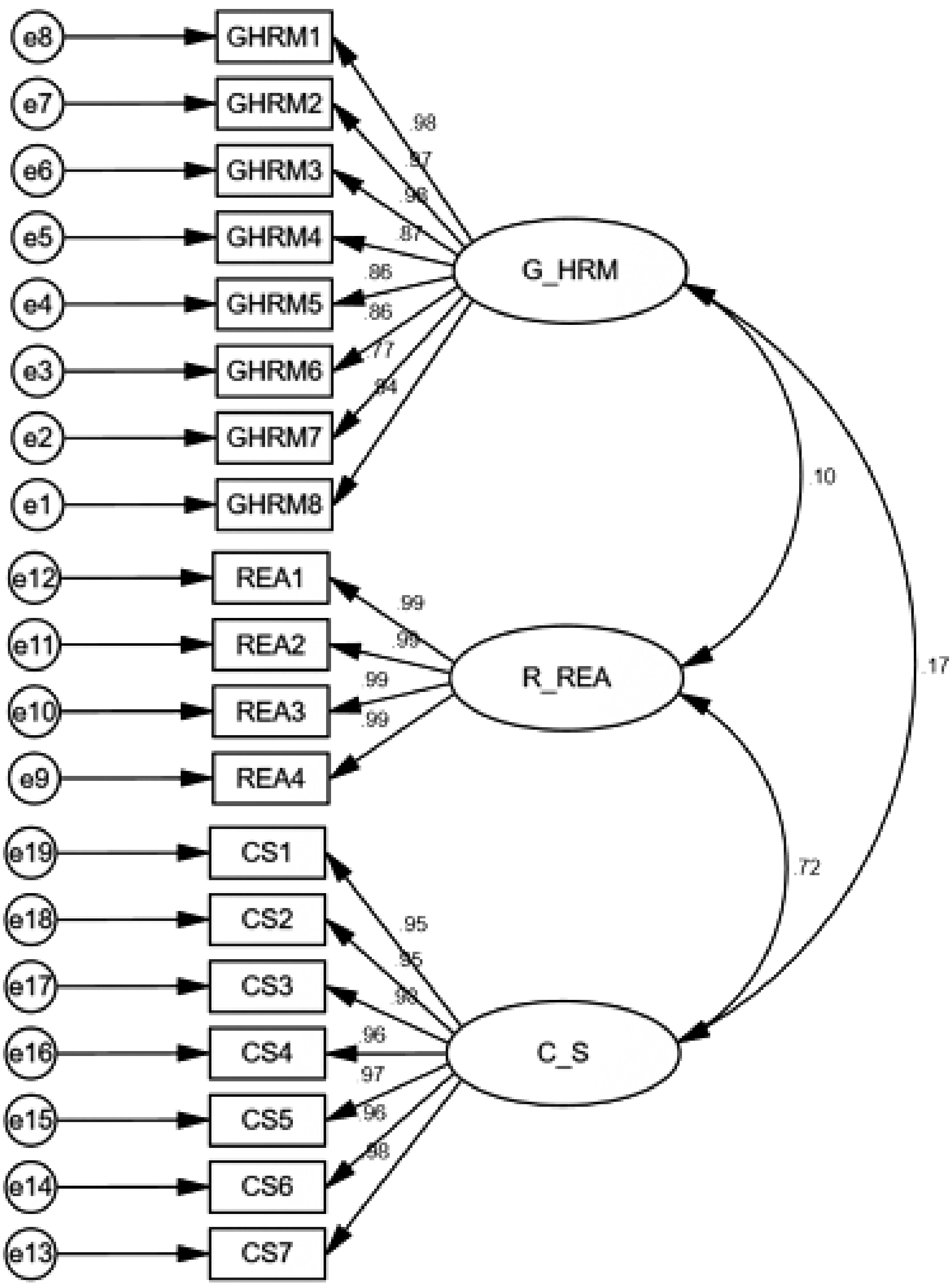

Figure 2. Measurement model

Table 4. Fit indices for measurement model

Goodness of Fit Indices	Acceptable Limit	Values Obtained
χ² /df	<5 moderate fit <3 good fit	2.164
Goodness of fit index (GFI)	>0.90	0.901
Comparative fit index (CFI)	>0.90	0.914
Normed fit index (NFI)	>0.90	0.932
Relative Fit Index (RFI)	>0.85	0.926
Standardized Root Mean Square Residual (SRMR)	< 0.08	0.035
Root mean square error of approximation (RMSEA)	< 0.08	0.064

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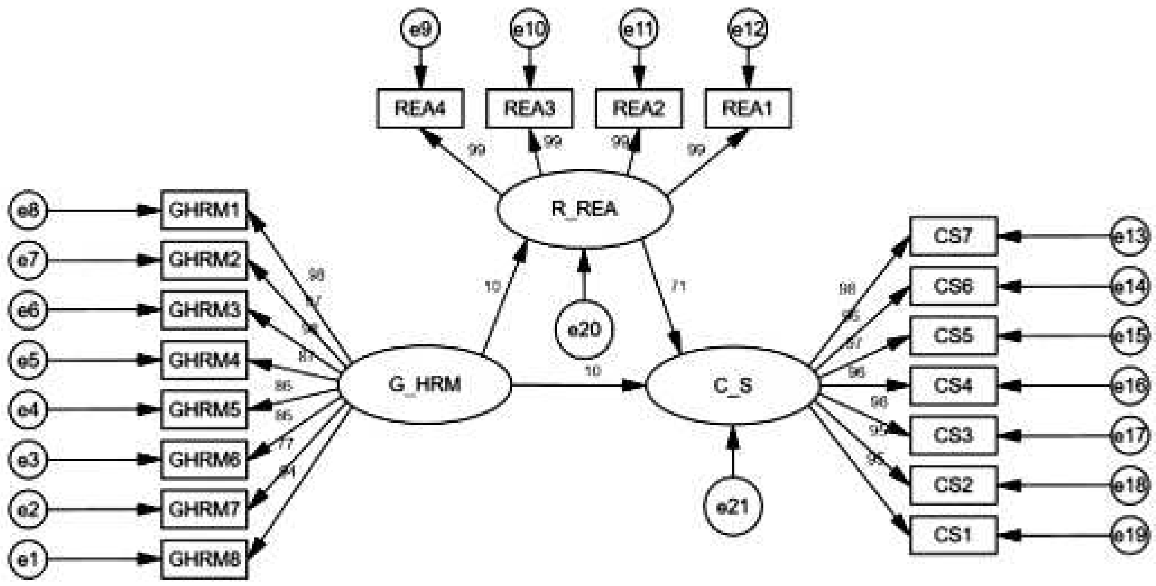

Figure 3. Structural equation model

Table 5. Fit indices of structural model

Goodness of Fit Indices	Acceptable Limit	Values Obtained
χ^2 /df	<5 moderate fit <3 good fit	1.753
Goodness of fit index (GFI)	>0.90	0.901
Comparative fit index (CFI)	>0.90	0.921
Normed fit index (NFI)	>0.90	0.913
Relative Fit Index (RFI)	>0.85	0.893
Standardized Root Mean Square Residual (SRMR)	< 0.08	0.035
Root mean square error of approximation (RMSEA)	< 0.08	0.062

Table 6. Results of direct effects

Hypothesis	Path	Standardized Path Coefficient (β)	p-Value	Result
H1	GHRM → REA	0.096	0.049	Supported
H2	REA → CS	0.710	***	Supported
H3	GHRM → CS	0.098	0.006	Supported

Note: *** p < 0.001.

Table 7. Results of indirect effect

Hypothesis	Path	Standardized Path Coefficient (β)	95% CI		Result
			LB	UB	
H4	GHRM → REA → CS	0.068	0.010	0.085	Supported

The structural model results support the hypothesized relationships. As shown in Table 6, GHRM has a significant positive direct effect on REA (β = 0.096, p = 0.049) and CS (β = 0.098, p = 0.006). REA has a strong positive and statistically significant influence on CS (β = 0.710, p < 0.001). Table 7 presents the bootstrap results for the indirect effect of GHRM on CS through REA (β = 0.068, LB = 0.010, UB = 0.085), indicating that REA partially mediates the relationship between GHRM and CS. Further, the total effect of GHRM on CS is significant (β = 0.166, p = 0.004), showing that GHRM enhances CS both directly and indirectly through REA. In the regression model, GHRM explained only 1.5% of the variance in REA, whereas REA explained 53% of the variance in CS.

4. DISCUSSION

The findings indicate that respondents who had strong perceptions about GHRM were also associated with high perceptions regarding REA and CS. Both the measurement and structural models showed good fit, and the study supported the hypotheses. REA partially mediates the relationship between GHRM and CS. The results also showed that GHRM explained only 1.5% of the variance in REA, while REA accounted for 51.7% of the variance in CS. Since the explained variance (R^2) is very low (0.015), this implies that the adoption of renewable energy depends more on variables other than GHRM, such as regulatory incentives, technological readiness, availability of funds, and organizational strategy. This suggests that although GHRM initiatives such as awareness programs, training, policies, and incentives can contribute to REA, they are not sufficient on their own to drive substantial adoption outcomes. Factors such as cost, government regulations, technology availability, organizational culture, and overall strategy may play a much greater role.

These results align with prior studies that have demonstrated the critical role of GHRM in promoting environmentally responsible practices and sustainability outcomes (Khan & Faisal, 2023; Dey, 2025). Specifically, similar research in Middle Eastern contexts showed that HRM-driven interventions, such as green recruitment, training, and performance management, can foster renewable energy initiatives and enhance overall CS (Dey, 2025). This statement is also consistent with Sitompul et al. (2024), who stated that factors such as cost, government regulations, technology availability, organizational culture, and overall strategy may play a much greater role. This finding also aligns with Renwick et al. (2013), who stated that health and safety practices integrated with green principles further ensure safe and sustainable enterprises.

GHRM practices may support organizations in strengthening sustainability-oriented capabilities that contribute to the transition toward a green economy. For instance, green recruitment ensures the selection of employees with environmental awareness and competencies, while training programs build technical skills for implementing renewable energy solutions. Performance management and reward systems incentivize employees to align with sustainability targets, and employee involvement in green initiatives fosters innovation and collective commitment to environmental goals. To further enhance CS, enterprises can improve these practices along multiple dimensions. At the strategic level, organizations should integrate sustainability objectives into HR policies and link them to corporate KPIs. At the operational level, continuous capacity building through specialized training in renewable technologies and energy management can increase adoption effectiveness. At the behavioral level, fostering a green organizational culture and leadership, promoting employee participation in green projects, and establishing feedback mechanisms for environmental performance can support sustainability goals. These multidimensional improvements can collectively support Saudi enterprises' transition toward a green economy while achieving measurable gains in CS.

4.1. Limitations

This study acknowledges several limitations. First, its scope is confined to Saudi enterprises, which may limit the generalizability of the findings to other regions and cultural contexts. Second, the cross-sectional design, based on data collected at a single point in time, restricts the ability to draw causal conclusions; future longitudinal research could better capture the evolving relationship between GHRM practices and sustainability outcomes. Third, both the EFA and CFA were conducted using the same dataset of 386 participants. Because of sample size limitations, it was not feasible to split the sample into two separate groups to validate the measurement model. Although the results indicated acceptable psychometric properties, this limitation is associated with the risk of sample-specific findings. Future research should use separate samples to test the measurement model. Finally, REA was examined as a single mediating factor, whereas additional mediators such as green

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innovation or employee engagement could provide deeper insight into the mechanisms linking GHRM to CS. All variables were measured using a self-administered questionnaire completed by employees and managers. Therefore, the study reflects respondents' perceptions rather than objective organizational indicators such as audited sustainability reports, renewable energy investments, carbon emissions, ESG disclosures, energy consumption, or sustainability audits.

4.2. Theoretical and practical implications

This study contributes to the GHRM literature by empirically showing a relatively small impact of GHRM on CS, with REA playing a partial mediating role. The findings highlight how the adoption of GHRM may represent one mechanism associated with sustainability. Though previous studies demonstrated that the resource-based and capability perspectives explain mediation, this study shows those theories alone may not fully explain REA, as other external factors appear to play a more substantial role than HRM practices in shaping renewable energy decisions. However, from a practical perspective, organizations need to recognize GHRM as one element of their sustainability approach. Although GHRM may strengthen environmental awareness and organizational preparedness, the implementation of renewable energy is contingent on several other factors, including favorable governmental policy, technology, finance, and leadership. Organizations can achieve this through targeted initiatives such as green recruitment and selection to attract employees with sustainability expertise, green training and development to build technical and behavioral competencies, and performance management systems that link appraisals and incentives to energy efficiency and sustainability goals. Employee involvement in green initiatives, along with the integration of health and environmental safety standards, further fosters acceptance of renewable technologies. Continuous progress can be ensured by aligning HR metrics with sustainability KPIs, cultivating a green culture, and integrating technology adoption goals into HR systems, thereby creating a feedback loop in which employees actively drive REA and long-term CS.

To enhance GHRM implementation, organizations should move beyond symbolic policies by providing employees with targeted training on renewable energy projects and linking HR practices to measurable green initiatives, such as incentives for energy-saving ideas and performance metrics tied to sustainability goals. Addressing barriers to REA requires investment in infrastructure and technology, collaboration with government agencies to access subsidies or tax benefits, and partnerships with suppliers and industry networks to lower costs. Moreover, REA should be integrated into the core corporate strategy rather than treated as a standalone HR initiative, while fostering a green organizational culture in which top management demonstrates visible commitment and employees feel empowered to contribute. Finally, as REA significantly enhances CS, firms should prioritize it as a strategic investment and actively communicate the resulting benefits, such as energy savings and reduced emissions, to stakeholders, thereby strengthening both reputation and market positioning.

4.3. Scope for future research

Future research can build on this study by examining broader mediators such as green innovation, employee engagement, and organizational culture to better understand how GHRM drives sustainability. Longitudinal designs would be particularly valuable for clarifying causal relationships and tracking sustainability progress over time. Comparative studies across countries or industries may also highlight how contextual factors shape the effectiveness of GHRM practices. Furthermore, incorporating objective data, such as ESG reports, carbon emissions, sustainability audits, firm-level controls, energy consumption levels, and renewable investments, would strengthen the findings. Finally, exploring the integration of digital HRM tools and HR analytics could offer innovative perspectives on how technology supports REA and overall sustainability. Further researchers may examine additional mediating or moderating variables, such as organizational culture, governmental policies, technological readiness, and financial capability, to better explain REA and sustainability outcomes across different industrial and regional contexts.

CONCLUSION

This study presents empirical evidence on how GHRM practices promote CS in Saudi firms, with a focus on the mediating role of REA. Theoretically, this study extends understanding of GHRM by framing it as a strategic expansion of environmental capacity rather than merely an administrative function. Based on the research results, the findings indicate that perceived implementation of GHRM practices was positively associated with perceived CS. While GHRM has a modest effect on REA, renewable energy efforts have a significant positive effect on CS, highlighting that REA appears to represent one possible pathway through which GHRM is associated with perceived CS. The findings further indicate that GHRM activities such as green recruitment, environmental training, performance appraisals linked to sustainability targets, and incentives for green innovation may support the integration of renewable energy techniques into organizational structures.

However, the limited variance explained by GHRM in predicting REA suggests that regulatory support, financial incentives, technology readiness, and strategic orientation are all important factors in developing renewable energy integration. This finding reflects the complexity of transitioning toward a green economy, where HR-driven initiatives must be complemented by broader institutional, organizational, and infrastructural enablers. Practically, the study offers valuable insights for policymakers and corporate leaders in Saudi Arabia and other emerging economies striving toward Vision 2030 objectives. Firms can utilize GHRM as one component of broader sustainability in organizational culture, develop renewable energy competencies, and enhance their environmental, social, and governance performance. Overall, the findings indicate that GHRM contributes to CS directly and indirectly through REA. However, because the relationship between GHRM and REA is relatively weak, REA should be viewed as a multidimensional process within an organization driven by other aspects rather than primarily by HRM practices.

AUTHOR CONTRIBUTIONS

Conceptualization: Sania Khan.
Data curation: Sania Khan.
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Funding acquisition: Sania Khan.
Investigation: Sania Khan.
Methodology: Sania Khan.
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Writing – original draft: Sania Khan.
Writing – review & editing: Sania Khan.

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