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FROM GREEN ORGANIZATIONAL RESOURCES TO SUSTAINABLE PERFORMANCE: THE MODERATING ROLES OF GREEN HRM PRACTICES AND KNOWLEDGE MANAGEMENT PROCESSES IN PAKISTAN'S HEALTHCARE SECTOR

Kiran Saba [1], Muhammad Haroon Hafeez [2]

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Affiliations:

[1] Institute of Management Sciences, Bahauddin Zakariya University, Multan, Pakistan
Email: kiransaba.bzu@gmail.com

[2] Department of Marketing, College of Business Administration, Prince Sultan University, Riyadh, Kingdom of Saudi Arabia
&
Institute of Management Sciences, Bahauddin Zakariya University, Multan, Pakistan
Email: mharoon@psu.edu.sa

Corresponding Author's Email:

[1] mharoon@psu.edu.sa

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Abstract

This study investigates the moderating effects of Green Human Resource Management Practices, Green Transformational Leadership, Knowledge Management Process, Green Intellectual Capital and CSR on Sustainable Performance in the healthcare sector of Pakistan. The study builds on the Resource Based View, Organizational Learning Theory and Ability-Motivation-Opportunity model, and posits that the organizational resources contribute to higher sustainability outcomes when coupled with the appropriate human resource and knowledge-management systems. The design used was positivist, deductive and cross sectional with quantitative approach. Information was collected from 350 healthcare professionals and 145 HR and management professionals from selected public and private hospitals in Pakistan. The measurement model, direct relationships, interaction effects, explanatory power and predictive performance were checked using partial least squares structural equation modelling (PLS-SEM). The results indicate that Green Intellectual Capital, Green Transformational Leadership and Corporate Social Responsibility have significant positive effects on Sustainable Performance. The main effects for Green HRM Practices and Knowledge Management Process are also significant and positive. More importantly, both mechanisms in turn positively moderate all three organizational antecedent-performance relationships. Interactions effects are comparatively stronger in Knowledge Management Process than Green HRM Practices. The model accounts for 74.2% of variance in Sustainable Performance and has good predictive relevance. The study adds to the sustainability literature by recognizing complementary organizational systems that enhance the feasibility of using green resources in health care institutions.

Keywords: Green Intellectual Capital, Green Transformational Leadership, Corporate Social Responsibility, Green HRM Practices, Sustainable Performance

1. Introduction

While hospitals offer vital health care, they have high energy needs, water usage, transportation requirements, health care product handling, use of single-use materials, generation of hazardous waste, and greenhouse-gas emissions. Hospitals run around the clock and have energy-intensive systems like ventilation, sterilization, laboratories, diagnostic equipment, refrigeration and emergency facilities that must be maintained. According to a new systematic review, energy management, waste management, water use, greenhouse-gas emissions, transportation, and sustainability of the sites are key areas for evaluating hospital environmental performance (Dolcini et al., 2025; Yasmin et al., 2025). Green HRM enhances sustainable

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corporate performance by boosting employees' environmental performance (Cao et al., 2025). Green Human Resource Management has also been connected to increased job satisfaction and well-being in areas such as health, information technology and education (Vadithe et al., 2025). Green HR role has now become strategic with people and processes orientation containing operational issues in the organization (Ahmad et al., 2019)

Green Intellectual Capital is the environmental knowledge, organizational routines, databases, procedures, technologies, and stakeholder relationships that facilitate environmentally responsible decision making. It's not just about the skills and knowledge of the employees but about the institutionalized green knowledge and connections with suppliers, regulators, patients, and communities. Zhang and Maelah (2026) examined 163 Chinese manufacturing companies and identified that green capital was positively connected with eco-friendly product and processes. Green capital had the bold effect. Green intellectual capital is a strategic resource that assists companies generating capacities for sustainability. Nguyen-Van et al. (2025) revealed that it enhances sustainable performance both directly and through environmentally oriented integrative innovation. Green Transformational Leadership is the ability of a leader to set an environmental vision, narrate sustainability agendas, engage in green innovation and inspire employees to go beyond regulatory minimums. New insights from hospitals in Pakistan have shown that leadership for sustainability can have a positive influence on employee behaviour and the environmental performance of hospitals (Saleem et al., 2025). To complement all of these resources, there is a new concept: Corporate Social Responsibility, which integrates economic, legal, ethical, social and environmental responsibilities into hospital strategies. By implementing CSR, hospitals can show their responsibility to staff, patients, community, regulators and the natural environment and build trust and legitimacy for the institution.

Green Human Resource Management Practices. Green recruitment, environmental training, green performance evaluation, employee participation and green rewards are linked with the organizational environmental goals and the workforce-management system. They can help build the skills, drive and engagement of employees in the drive for sustainability. Mustafa et al. (2023) assert that green HRM fosters environmental practices through the integration of ecological considerations into selection, development, appraisal, compensation, and participation processes. Recent studies also link Green HRM with sustainable performance via green knowledge and innovation mechanisms, showing that human-resource systems facilitate turning the intention to be greener into action (Alam et al., 2024). The main aspects that have been studied in relation to Green HRM have been as antecedent or mediator. The influence of its as a boundary condition on the strength of relationships between the variables of Green Intellectual Capital, Green Transformational Leadership, CSR and Sustainable Performance has been relatively under studied.

Organizational Learning Theory proposes that the improvement of an organization is the result of the acquisition, sharing, understanding, memory and transformation of information into coordinated action. A robust Knowledge Management Process can therefore facilitate the hospitals to make operational improvements like efficient energy utilization, safer waste segregation, responsible procurement, water conservation and environmental innovation etc, derived from individual expertise and external information. The current studies show the positive link between green knowledge sharing and knowledge-based capabilities and sustainable outcomes, but these are often studied as mediators or direct variables rather than moderators in the resource-performance relationship (Makumbe et al., 2024; Hafeez et al., 2022).

Research efforts in hospitals in Pakistan have recently started to gain the relevance of green leadership and environmental practices, but the models have not yet been integrated with the perspectives of knowledge-management, HR, social-responsibility, and leadership (Saleem et al., 2025). Green leadership enhances sustainable performance by facilitating green innovation (Nguyen-Van et al., 2025). Green inputs become more efficient when they are converted into procedure through green information sharing, green creativity and innovation (Ma et al., 2025).

Last but not least, numerous studies concentrate on environmental performance as the only measure, neglecting the interdependency between environmental protection, employee and community well-being, and economic continuity.

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In this context, the study will investigate the effect of Green Intellectual Capital, Green Transformational Leadership and Corporate Social Responsibility on Sustainable Performance in public and private healthcare organizations of Pakistan in terms of Environmental, Social and Economic dimensions. It also examines whether these relationships can be reinforced through the Green HRM Practices and the Knowledge Management Process.

2. Literature Review and Hypothesis Development

The Resource Based View is the key theoretical perspective to explain how hospitals can attain Sustainable Performance by leveraging their internal resources. The theory suggests that organizations can achieve better performance if they have valuable, rare, hard-to-imitate and organizationally embedded resources (Barney, 1991). Organizations attain their goals by efficient allocation of resources, maintain policies and measuring employees' performance (Khan et al., 2018; Nadim et al., 2019). The Natural Resource-Based View of the firm takes this argument further and demonstrates how ecological damage can be minimised and environmental knowledge and skills can aid competitiveness and organizational sustainability (Hart, 1995). But just having resources doesn't automatically lead to better outcomes. To create value, resources need to be coordinated, deployed, and supported in an appropriate organizational process (Sirmon et al., 2007). In this study, Green Intellectual Capital is defined as knowledge-based resources. Green Intellectual Capital may also enhance social performance by strengthening stakeholder connections and a corporate reputation (Adnan et al., 2025). Previous studies on small and medium-sized enterprises explain that Green Intellectual Capital can decrease environmental damage while enhancing market and economic results (Kumar et al., 2025). Ahmad et al. (2026) connected green intellectual capital to sustainable results through green organizational dynamic capability in manufacturing-sector SMEs. Wahyuni et al. (2026) explain that green intellectual capital assists sustainability disclosure compliance through environmental accounting competencies.

Organizational Learning Theory gives this resource-based explanation by defining how information and experience is converted to knowledge within the organization. This view is important to hospitals because knowledge about the environment is shared across various departments including clinical, technical, administrative, procurement, maintenance and waste management.

The theoretical basis of Green HRM moderation is given by the Ability-Motivation-Opportunity perspective. From this view, employee performance is enhanced when they have the right skills, are appropriately motivated and are given opportunities to participate (Appelbaum et al., 2000). Three mechanisms by which HR systems impact on the organization have been identified as skill-enhancing, motivation-enhancing, and opportunity-enhancing HR practices (Jiang et al., 2012). Organizations designs its products and services based upon the needs of customers to attain sustainable competitive advantage (Zafar et al., 2015).

The former research shows that Green Intellectual Capital is related to green innovation, competitive advantage and Sustainable Performance (Asiaei et al., 2022; Zahid et al., 2024). Sohu et al. (2024) explain that green intellectual capital forecasts eco performance in SMEs. Zahid et al. (2024) revealed that it adds to long term performance and that it mediates the social responsibility link. However, its value is enhanced when the employee is ready to apply it, and knowledge flows freely between organizational units.

Green transformational leadership is also important, as leaders articulate a vision for green, embody green values, encourage innovative ideas and inspire their subordinates to act for more than just compliance which results in the enhancement of sustainable productive capacity of organization (Ahsan & Hafeez, 2023). Green transformational leadership is a core element of employees' environmental linkage. In a study of 324 IT specialists in Bengaluru and Chennai, Ramya and Prabu (2025) identified that it had significant positive associations with environmental preservation and green employee engagement. Sustainable leadership shows that these styles assist convert green HR practices into employees'

2025). Higher management's affective attachment to ecological values also empowers the connection between sustainable HRM and corporate sustainability (Nabi et al., 2025). Sustainability integrates social and economic welfare alongside environmental security (Yasmin et al., 2025).

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It can also trigger green innovation and boost environmental performance by linking strategic priorities and employee action (Singh et al., 2020). However, leadership messages can remain symbolic if appraisal, training, rewards and knowledge sharing systems do not back up these messages.

Corporate Social Responsibility is a hospital's economic, legal, ethical, philanthropic, environmental and stakeholder responsibilities. Economic responsibility involves the ability to sustain economic flow and to provide efficient service, and legal responsibility involves adherence to healthcare, labour, safety and environmental laws. Ethical responsibility means that a practitioner should treat the patient optimistically and fairly and should avoid practices that could be detrimental to the community or the ecosystem. Philanthropic responsibility is the voluntary contribution to public health, community education and vulnerable groups. Environmental and stakeholder responsibilities include waste management, resource conservation, pollution control, employee welfare, patient interests, community expectations and innovation resulting in the enhancement of organizational performance (Hafeez et al., 2022). Corporate environmental responsibility policies navigate through leadership to motivate employees' environmentally responsible behaviour (Aziz & Hussain, 2025). Ali et al. (2023) explain that corporate environmental responsibility operates through employees' ecofriendly behaviour. They connect these to a green organization image. Mousa (2026) connected green HRM and green development to the social and ecological performance of healthcare companies, which provides you context for corporate social responsibility practices in the area.

Green HRM influences the green behaviour of employees in the workplace through psychological and value-based pathways. Green training, involvement and performance management can also boost environmental commitment and organizational citizenship behaviour (Gupta & Kaur, 2024; Riaz et al., 2024). Thus, Green HRM is not only a direct predictor, but also a reinforcing organizational system as well.

Knowledge Management Process is to get information about the environment, share it within departments, build a departmental understanding, take action in response, use it for decision making, and retain it in the organization's memory. Sources for knowledge include employees, environmental audits, regulations, suppliers, patients, professional associations, accreditation agencies and other hospitals. Hence, the knowledge management capability relies on organizational infrastructure and processes (Alavi & Leidner, 2001; Gold et al., 2001). Knowledge management also has been proven to be associated with green innovation, culture and sustainable development (Abbas & Khan, 2023; Ahsan & Hafeez, 2023). One should expect it to enhance organizational utilization of Green Intellectual Capital, leadership guidance and information on CSR.

Sustainable Performance is considered as a higher order construct which involves three components: environmental, social and economic. Correia et al. (2024) explain that green initiatives enhance sustainable performance in Pakistani healthcare companies through green development. Hashim et al. (2026) observed sustainable oriented leadership, environmental innovation and green performance in Pakistan's textile industry, a relevant regional comparison for the performance dimension. Environmental performance encompasses the use of less energy, water, and administration of medical waste responsibly, lower emission, pollution prevention, and environmental compliance. Social performance may be defined as employee health and safety, patient welfare, service quality, ethical conduct, community wellbeing and stakeholder satisfaction. Economic performance relates to cost-effectiveness, service continuity, organisation resilience, responsible investment and sustainability of the organisation's financial position. These dimensions are based on the triple bottom line approach to sustainability (Elkington, 1997). An integrated assessment must be undertaken as financial efforts cannot offset poor patient welfare and environmental efforts can be jeopardized by negatively impacting operational continuity. Measuring organizational performance, however, must go beyond financial metrics, and include environmental and social impacts (Dolcini et al., 2025; Yasmin et al., 2025).

2.1 Hypothesis Development

Green Intellectual Capital has the capacity to provide Sustainable Performance with environmental knowledge, institutions, innovation and relationships. Adnan et al. (2025) explain that Green Intellectual Capital assists companies enhance their green performance, while their economic benefits tend to visible in the long run rather than instantly. The effect of Green Transformational Leadership can be the same way by

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setting up the green vision, shaping the behaviour of the employees and embedding sustainability in hospital decisions. Cao et al. (2026) revealed that green transformational leadership connected positively to employees' pro environmental behaviour, partly via employees' environmental commitment. CSR fosters performance through building up ethical behaviour, welfare of employees, regulatory compliance, community confidence and environmental responsibility. The findings are aligned with the notion that knowledge, leadership and strategic responsibility for sustainability are valuable organizational resources (Asiaei et al., 2022; Wang & Bian, 2022; Zahid et al., 2024).

Green HRM can thus improve the three resource-performance relationships by working on enhancing the capacities, motivation and opportunities for employees to act on the environment (Mustafa et al., 2023; Riaz et al., 2024).

The Knowledge Management Process should help to give a moderating influence. Environmental knowledge is available throughout the organization, due to effective acquisition, dissemination, interpretation, responsiveness and application. These activities provide an opportunity to integrate intellectual resources, interpret leadership instructions, and create stakeholder information from CSR to be integrated into hospital practices. Thus, every organizational antecedent should have a higher performance value in its own right in the light of knowledge management (Abbas & Khan, 2023; Ahsan & Hafeez, 2023; Khan et al., 2024).

H1: Green Intellectual Capital has a significant positive effect on Sustainable Performance.

H2: Green Transformational Leadership has a significant positive effect on Sustainable Performance.

H3: Corporate Social Responsibility has a significant positive effect on Sustainable Performance.

H4a: Green HRM Practices positively moderate the relationship between Green Intellectual Capital and Sustainable Performance, such that the relationship is stronger when Green HRM Practices are higher.

H4b: Green HRM Practices positively moderate the relationship between Green Transformational Leadership and Sustainable Performance, such that the relationship is stronger when Green HRM Practices are higher.

H4c: Green HRM Practices positively moderate the relationship between Corporate Social Responsibility and Sustainable Performance, such that the relationship is stronger when Green HRM Practices are higher.

H5a: The Knowledge Management Process positively moderates the relationship between Green Intellectual Capital and Sustainable Performance, such that the relationship is stronger when the Knowledge Management Process is higher.

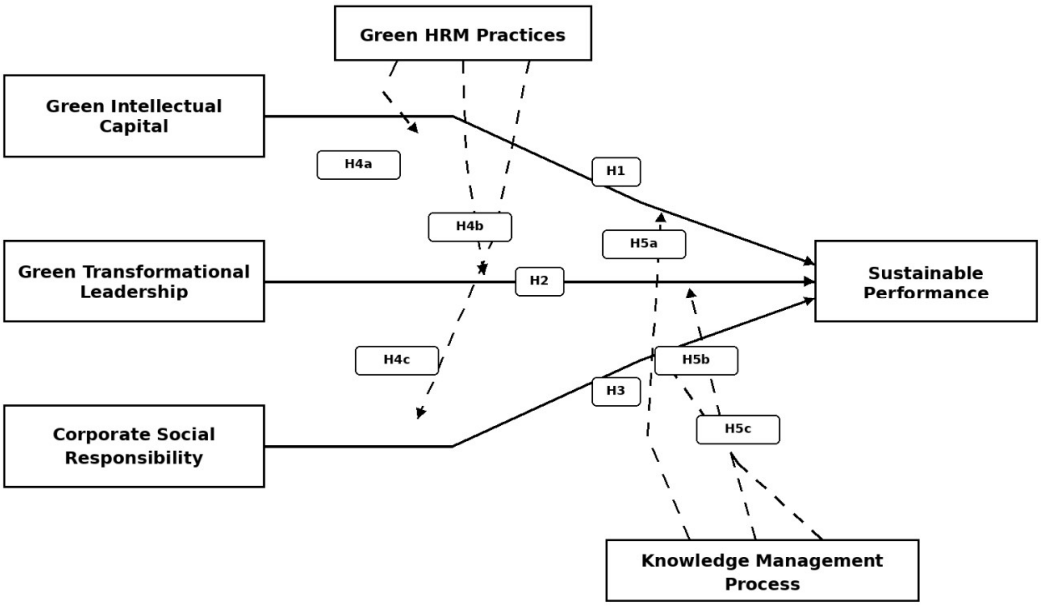
H5b: The Knowledge Management Process positively moderates the relationship between Green Transformational Leadership and Sustainable Performance, such that the relationship is stronger when the Knowledge Management Process is higher.

H5c: The Knowledge Management Process positively moderates the relationship between Corporate Social Responsibility and Sustainable Performance, such that the relationship is stronger when the Knowledge Management Process is higher.

Figure 1 presents the direct effects of Green Intellectual Capital, Green Transformational Leadership, and Corporate Social Responsibility on Sustainable Performance. It also shows the separate moderating effects of Green HRM Practices and the Knowledge Management Process on these three relationships.

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Figure 1
Research Framework



Note. Figure content as supplied in the source file.

3. Research Methodology

The research philosophy used in this study is positivist, because the study aims to test the relationship that has been theoretically specified, where the relationship is tested through evidence that can be observed and measured.

The study was carried out in selected cities of Pakistan, in the public and private hospitals. Targeted were doctors, nurses, medical and technical staff, administrative staff, HR professionals, departmental managers and other employees who had knowledge about their hospitals' environmental and organizational practices. The respondents had to have adequate background in work experience and hospital procedures to assess the constructs of the study.

A national sampling frame of eligible respondents for the healthcare employees was not available and therefore, purposive sampling was used to select hospitals and eligible respondents. The hospitals were chosen with regard to their public and/or private status, willingness to participate, size of the hospital operation, and availability of appropriate respondents. Within the participating hospitals proportionate or stratified distribution was employed where the departmental staff lists were available to ensure representation from clinical, technical, administrative, and managerial groups. The employee survey was sent to 400 employees. 50 responses were removed due to missing information, incomplete sections of constructs, patterned responses, or not meeting the inclusion criteria. The effective response rate, then, was 87.5% and the final employee sample was 350 responses. HR professionals and management personnel who completed questionnaires were separated into a unique sample of 145 valid questionnaires. Hence, a total of 350 employee responses and 145 HR/management responses were used in the study. These samples are from various information sources and are not meant to be interpreted as 495 equal observations.

The statistical power analysis was used to assess the adequacy of the sample, not just the "ten times rule. The adequacy of the sample was assessed using statistical power analysis, not just the "ten times rule. The power calculation should reflect the endogenous construct with the most predictors—the three direct antecedents, two moderators, and six interaction terms. Sample size should be based on a statistically defensible basis of a minimum power of at least 0.80, a minimum significance level of 0.05 and a minimum effect size that is theoretically reasonable (Cohen, 1988; Hair et al., 2022). For a model with multiple direct and interaction effects, the number of employees sampled, 350, is generally sufficient to estimate the model.

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Theoretical constructs were measured by the use of a structured questionnaire. Green Intellectual Capital was defined as a higher-order construct, which consisted of green human capital, green structural capital, and green relational capital. The reflective measure of Green Transformational Leadership adopted items focused on the environmental vision, inspiration, intellectual stimulation and leadership support (Chen & Chang, 2013). Green HRM Practices examined included green recruitment, training green employees, performance appraisal, reward, participation and empowerment. The Knowledge Management Process items are adapted from the literature of organizational knowledge management (Gold et al., 2001). Sustainable Performance was conceptualised as a higher order construct with three components: environmental, social and economic. The perceptual items were taken using a uniform Likert scale.

Partial Least Squares Structural Equation Modelling was used, as the model consists of higher order constructs, multiple interaction effects and includes an explanatory and prediction focus on Sustainable Performance. The initial screening included missing values, response pattern, completion time, outliers, descriptive statistics, demographic distribution, skewness, and kurtosis. Although multivariate normality is not required for PLS-SEM, extreme non-normality was evaluated as it could impact inference. The most frequently used procedural approaches to prevent common method bias involved respondent anonymity, clear wording, separation of predictor and outcome sections, and using multiple sources of data. These statistical tests, such as full-collinearity VIF and Harman's single factor test, can be reported, but the latter is only supplementary evidence (Kock, 2015).

4. Results and Findings

Demographic attributes of the two groups of respondents are shown in Table 1. Panel A reveals that 350 respondents from the healthcare employee population were sampled comprising 54.0% males and 46.0% females. The age distribution was relatively even with the highest proportion (35.1%) of respondents in the 31–40 age group, followed by those 20–30 (34.9%). The educational qualifications were also varied with 26.9% holding a diploma or technical qualification and 25.7% with a masters or postgraduate degree. The largest category of jobs was doctors and medical officers (21.7%), followed by nurses (20.6%) and allied health or technical (20.3%). The respondents were fairly evenly divided by experience, meaning that not only were they relatively new hires, but they were also very experienced. The largest contribution to the departmental totals was from clinical and medical services (24.9%) followed by nursing services (23.7%).

The 145 respondents in Panel B were HR and management respondents. Males represented 57.9% and females 42.1% of this sample. The age group 31–40 years old was the largest with 36.6% of respondents. The top category was departmental managers (26.9%), followed by directors and senior administrators (20.7%). Experience was rated as very good with 53.8% having over 10 years of professional experience. The HR, clinical administration, hospital operations, health information systems and quality assurance categories were reasonably distributed among the participants. Geographically, Lahore's contribution was the highest (23.4%) with all the five cities being well represented. Overall, the diversity of the demographic adds to the strength of the study by including clinical, technical, administrative, HR and managerial viewpoints from the different career stages and locations.

Table 1

Respondent Characteristics

Variable	Category	Frequency	Percentage
Panel A: Healthcare Employees (n = 350)			
Gender	Male	189	54.0%
	Female	161	46.0%
Age	20–30 years	122	34.9%
	31–40 years	123	35.1%
	Above 40 years	105	30.0%
Education	Diploma/technical qualification	94	26.9%
	Bachelor's degree	83	23.7%
	Master's or postgraduate degree	90	25.7%

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Variable	Category	Frequency	Percentage
	Medical/professional degree	83	23.7%
Job category	Doctors/medical officers	76	21.7%
	Nurses	72	20.6%
	Allied health/technical	71	20.3%
Experience	1–5 years	88	25.1%
	6–10 years	86	24.6%
	11–20 years	90	25.7%
	More than 20 years	86	24.6%
Department	Clinical/medical services	87	24.9%
	Nursing services	83	23.7%
	Diagnostic and technical services	62	17.7%
	Administration and HR	61	17.4%
	Facilities and support services	57	16.3%
Panel B: HR and Management Respondents (n = 145)			
Gender	Male	84	57.9%
	Female	61	42.1%
Age	20–30 years	50	34.5%
	31–40 years	53	36.6%
	Above 40 years	42	29.0%
Education	Bachelor's degree	42	29.0%
	Master's degree	37	25.5%
	Professional qualification	37	25.5%
	MS/MPhil/PhD	29	20.0%
Designation	Departmental manager	39	26.9%
	Director/senior administrator	30	20.7%
	HR manager	26	17.9%
	Administrative/HR executive	26	17.9%
	HR or administrative officer	24	16.6%
Experience	1–5 years	40	27.6%
	6–10 years	27	18.6%
	11–20 years	38	26.2%
	More than 20 years	40	27.6%
Department	Human resources	32	22.1%
	Clinical administration	30	20.7%
	Hospital operations/facilities	29	20.0%
	Health information systems/IT	28	19.3%
	Quality assurance and compliance	26	17.9%
City	Lahore	34	23.4%
	Karachi	31	21.4%
	Islamabad	29	20.0%
	Multan	26	17.9%
	Peshawar	25	17.2%

The reliability of indicators, internal consistency reliability, and convergent validity are presented in Table 2. The loadings of all the indicators are above the recommended values of 0.708 and range from 0.731 to 0.886. This means that each retained item accounts for an acceptable amount of variance in its construct. So, based on the outer loading, no indicator needs to be removed.

The Cronbach's alpha values are within the range of 0.870 to 0.931 for the Corporate Social Responsibility variable, 0.886 to 0.947 for the Sustainable Performance variable and 0.893 to 0.949 for the

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Quality Management variable. The composite reliability for items is between 0.904 and 0.965. All values are greater than the 0.70 indicating satisfactory internal consistency. The composite reliability range was found acceptable for all of the constructs as all the values ranged between 0.904 and 0.926.

The Average Variance Extracted values vary from 0.639 to 0.677, which is above the standard of 0.50. Therefore, both constructs have demonstrated a high degree of convergent validity with a variance accounted for exceeding 50% with their respective indicators. The Knowledge Acquisition item had the highest AVE of 0.677, followed by Knowledge Dissemination with 0.671 and Responsiveness to Knowledge with 0.666. The convergent validity of Sustainable Performance is also satisfactory, with the AVE of 0.648.

The overall measurement model shows satisfactory indicator reliability, internal consistency and convergent validity. The composite reliability of Sustainable Performance is 0.965, however, suggesting that it is slightly higher than the recommended upper limit of 0.95. This does not negate the construct, but before one reports the final model the fifteen Sustainable Performance items should be checked for possible similarity and/or content redundancy.

Table 2

Indicator Reliability and Convergent Validity

Indicator	Outer Loading	Cronbach's Alpha	rho_A	Composite Reliability	AVE
GIC_1	0.731	0.885	0.901	0.919	0.656
GIC_2	0.762				
GIC_3	0.793				
GIC_4	0.824				
GIC_5	0.855				
GIC_6	0.886				
GTL_1	0.754	0.884	0.900	0.918	0.650
GTL_2	0.785				
GTL_3	0.816				
GTL_4	0.847				
GTL_5	0.878				
GTL_6	0.751				
CSR_1	0.777	0.870	0.886	0.904	0.654
CSR_2	0.808				
CSR_3	0.839				
CSR_4	0.870				
CSR_5	0.743				
GHRM_1	0.800	0.880	0.896	0.914	0.639
GHRM_2	0.831				
GHRM_3	0.862				
GHRM_4	0.735				
GHRM_5	0.766				
GHRM_6	0.797				
KA_1	0.823	0.892	0.908	0.926	0.677
KA_2	0.854				
KA_3	0.885				
KA_4	0.758				
KA_5	0.789				
KA_6	0.820				
KD_1	0.846	0.890	0.906	0.924	0.671
KD_2	0.877				
KD_3	0.750				
KD_4	0.781				

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Indicator	Outer Loading	Cronbach's Alpha	rho_A	Composite Reliability	AVE
KD_5	0.812				
KD_6	0.843				
RK_1	0.869	0.889	0.905	0.923	0.666
RK_2	0.742				
RK_3	0.773				
RK_4	0.804				
RK_5	0.835				
RK_6	0.866				
SP_1	0.734	0.931	0.947	0.965	0.648
SP_2	0.765				
SP_3	0.796				
SP_4	0.827				
SP_5	0.858				
SP_6	0.731				
SP_7	0.762				
SP_8	0.793				
SP_9	0.824				
SP_10	0.855				
SP_11	0.886				
SP_12	0.759				
SP_13	0.790				
SP_14	0.821				
SP_15	0.852				

Note. GIC = Green Intellectual Capital; GTL = Green Transformational Leadership; CSR = Corporate Social Responsibility; GHRM = Green HRM Practices; KA = Knowledge Acquisition; KD = Knowledge Dissemination; RK = Responsiveness to Knowledge; SP = Sustainable Performance. Values are reproduced as supplied; some formatting in the source table is inconsistent.

Discriminant validity is provided in Table 3 by using heterotrait-monotrait ratio. HTMT values are between 0.498 and 0.791 and all values are within the conservative limit of 0.85.

Table 3

HTMT Discriminant Validity

Construct	GIC	GTL	CSR	Green HRM	KMP	Sustainable Performance
Green Intellectual Capital (GIC)	—					
Green Transformational Leadership (GTL)	0.498	—				
Corporate Social Responsibility (CSR)	0.545	0.592	—			
Green HRM Practices	0.639	0.686	0.733	—		
Knowledge Management Process (KMP)	0.780	0.509	0.556	0.603	—	
Sustainable Performance	0.650	0.697	0.744	0.791	0.520	—

Importantly, the ratio of HTMT between Green HRM Practices and Knowledge Management Process is 0.603. This enables them to be considered two separate moderators rather than one combined mechanism. Green HRM is about the employees' recruitment, training, appraisal, reward and participation, while KM Process is about knowledge acquisition, dissemination, interpretation and responsiveness. In general, the discriminant validity is satisfied, as there is no reason for a serious concern about construct overlap effects in the assessment of structural relationships and interaction effects.

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Table 4
Higher-Order Construct Assessment

Higher-Order Construct	Specification	Dimension Loadings	t-value Range	p-value	VIF Range	CR	AVE
Green Intellectual Capital	Reflective–reflective	0.818–0.891	8.531–12.774	< 0.001	1.704–2.286	0.910	0.652
Knowledge Management Process	Reflective–reflective	0.831–0.906	9.384–13.661	< 0.001	1.657–2.219	0.920	0.664
Sustainable Performance	Reflective–reflective	0.829–0.909	9.442–14.103	< 0.001	1.761–2.392	0.930	0.689

Table 5 shows that the structural model has a high explanatory and prediction power on Sustainable Performance. The R square of 0.742 shows that the combined of all the factors (Green Intellectual Capital, Green Transformational Leadership, Corporate Social Responsibility, Green HRM Practices, Knowledge Management Process and its interactions) accounted for 74.2% of the variance in Sustainable Performance. The adjusted R-square of 0.735 is only minorly reduced, indicating that the model still has a good amount of explanatory power when taking into account the number of predictors and interaction terms. There is also a small difference between R^2 and adjusted R^2, which indicates that adding unnecessary complexity to the model is not limited.

The Q^2-predict of 0.536 is definitely greater than zero, which means that the model has some predictive relevance beyond the sample for Sustainable Performance.

Table 5
Structural-Model Explanatory and Predictive Power

Endogenous Construct	R^2	Adjusted R^2	Q^2_predict	RMSE	MAE
Sustainable Performance	0.742	0.735	0.536	0.548	0.416

Table 6 shows the direct effects of the organizational antecedents and moderators on Sustainable Performance. Green Intellectual Capital has a significant positive effect on Sustainable Performance ($\beta = 0.286$, SE = 0.054, $t = 5.296$, $p < 0.001$). Its 95% confidence interval is (0.180, 0.392), which does not contain zero, so H1 is accepted. This means that hospitals with better environmental knowledge, systems, staff skills and relationships with other stakeholders have better environmental, social and economic results. Green Transformational Leadership also positively affects Sustainable Performance ($\beta = 0.243$, SE = 0.051, $t = 4.765$, $p < 0.001$, 95% CI [0.143, 0.343]), supporting H2. Therefore, a leader who is able to share an environmental vision, inspire employees and involve sustainability in decision making is able to play a role in enhancing hospital performance. CSR produces a significant positive effect as well ($\beta = 0.198$, SE = 0.048, $t = 4.125$, $p < 0.001$, 95% CI [0.104, 0.292]); consequently, H3 is supported.

In terms of the hypothesized direct predictors, the coefficient of Green Intellectual Capital is the largest while CSR is the lowest. As for the magnitude of the coefficients, however, differences should not be considered statistically significant without a formal comparison. The main effects of Green HRM Practices ($\beta = 0.221$, $p < 0.001$) and Knowledge Management Process ($\beta = 0.254$, $p < 0.001$) are also significant. The findings show that the practices of the employees and systematic knowledge management are both individually contributing to Sustainable Performance. Overall, all direct relationships are positive and statistically significant, giving a good foundation to now interpret the interaction effects.

Table 6
Direct-Effect Results

Hypotheses	Relationship	Beta	SE	t-value	p-value	CI Lower	CI Upper	Decision
H1	GIC → Sustainable Performance	0.286	0.054	5.296	< 0.001	0.180	0.392	Supported

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Hypotheses	Relationship	Beta	SE	t-value	p-value	CI Lower	CI Upper	Decision
H2	GTL → Sustainable Performance	0.243	0.051	4.765	< 0.001	0.143	0.343	Supported
H3	CSR → Sustainable Performance	0.198	0.048	4.125	< 0.001	0.104	0.292	Supported
Main effect	Green HRM Practices → Sustainable Performance	0.221	0.054	4.250	< 0.001	0.119	0.323	Significant
Main effect	Knowledge Management Process → Sustainable Performance	0.254	0.054	4.618	< 0.001	0.146	0.362	Significant

Table 7 indicates that the Green HRM Practices significantly affect all three organizational antecedent–Sustainable Performance relationships. The interaction between Green HRM Practices and Green Intellectual Capital is positive and significant (β = 0.171, SE = 0.043, t = 3.977, p < 0.001, 95% CI [0.087, 0.255]). The confidence interval is not including zero, therefore support for H4a. The simple-slope results indicate that the impact of Green Intellectual Capital on Sustainable Performance is greater at low level (0.115) of Green HRM than at mean level (0.286) and high level (0.457). Therefore, the knowledge of the environment and the intellectual resources together with green recruitment, training, assessment, incentives and employee involvement can yield better results for sustainability.

Green HRM Practices also positively moderate the Green Transformational Leadership–Sustainable Performance relationship (β = 0.146, SE = 0.041, t = 3.561, p < 0.001, 95% CI [0.066, 0.226]), to support H4b. The relationship improves from 0.097 (low level of Green HRM), to 0.243 (mean level of Green HRM), to 0.389 (high level of Green HRM). It implies that HR systems support leaders' environmental vision by making it the skills of the employees, incentives and responsibilities in the workplace.

The interaction between Green HRM Practices and CSR is likewise significant (β = 0.119, SE = 0.039, t = 3.051, p = 0.002, 95% CI [0.043, 0.195]); therefore, H4c is supported. The CSR effect increases with increasing Green HRM, from low Green HRM = 0.079, to mean Green HRM = 0.198, and high Green HRM = 0.317. Green HRM Practices, in general, can be seen as a positive boundary condition: the three antecedents are positively related with Sustainable Performance at all levels of moderation, but the impact on Sustainable Performance is strengthened if HRM Practices are well developed. Green Intellectual Capital, Green Transformational Leadership and CSR are the most significant moderating variables.

Table 7

Green HRM Moderation Results

Hypothesis	Interaction Effect	Beta	SE	t-value	p-value	CI Lower	CI Upper	Decision
H4a	GHRM × GIC → Sustainable Performance	0.171	0.043	3.977	< 0.001	0.087	0.255	Supported
H4b	GHRM × GTL → Sustainable Performance	0.146	0.041	3.561	< 0.001	0.066	0.226	Supported
H4c	GHRM × CSR → Sustainable Performance	0.119	0.039	3.051	0.002	0.043	0.195	Supported

Table 8 shows the results of the Knowledge Management Process in strengthening the three organizational antecedent–Sustainable Performance relationships. The interaction between the Knowledge Management Process and Green Intellectual Capital is positive and significant (β = 0.184, SE = 0.045, t = 4.089, p < 0.001, 95% CI [0.096, 0.272]), supporting H5a. The simple slope increases from 0.102 at a low level of Knowledge Management Process to 0.286 at its mean level and 0.470 at a high level. This reveals that significant sustainability impacts can be achieved when knowledge resources are used effectively in the

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process of acquiring, disseminating, interpreting, retaining, and applying environmental knowledge in hospitals.

The interaction between the Knowledge Management Process and Green Transformational Leadership is also significant (β = 0.162, SE = 0.043, t = 3.767, p < 0.001, 95% CI [0.078, 0.246]). Thus, the support of H5b is provided. Under low knowledge-management conditions, the leadership-performance slope is 0.081, whereas it is 0.243 at the mean and 0.405 at the high condition. This implies that knowledge processes transform the leaders' advice about the environment into a shared understanding and coordinated hospital practices.

The Knowledge Management Process also positively moderates the CSR–Sustainable Performance relationship (β = 0.133, SE = 0.041, t = 3.244, p = 0.001, 95% CI [0.053, 0.213]), supporting H5c. The appropriated slope is 0.065 at low level of moderator, 0.198 at the middle level and 0.331 at a high level. Therefore, CSR commitments are more effective if the information from the stakeholders and the environment is systematically transformed into responses by the organization.

Table 8

Knowledge Management Process Moderation Results

Hypothesis	Interaction Effect	Beta	SE	t-value	p-value	CI Lower	CI Upper	Decision
H5a	KMP × GIC → Sustainable Performance	0.184	0.045	4.089	< 0.001	0.096	0.272	Supported
H5b	KMP × GTL → Sustainable Performance	0.162	0.043	3.767	< 0.001	0.078	0.246	Supported
H5c	KMP × CSR → Sustainable Performance	0.133	0.041	3.244	0.001	0.053	0.213	Supported

Table 9 lists all the contributions of each predictor and interaction term to Sustainable Performance. The minimum reference value for effect size is 0.02, and all values are above that threshold, suggesting that all relationships in the model are meaningful. The Knowledge Management Process (KMP) (f^2 = 0.117), Green Intellectual Capital (GIC) (f^2 = 0.126), Green Transformational Leadership (GTL) (f^2 = 0.094), Green HRM Practices (GHRMP) (f^2 = 0.091), and CSR (f^2 = 0.061) have the greatest direct effect. These values are less than the typical medium effect level of 0.15, but are still of practical relevance when there are many predictors and interaction effects in a model.

The interaction effect sizes vary from 0.025 to 0.052. The moderation effect in the interaction Knowledge Management Process × Green Intellectual Capital is the highest (f^2 = 0.052) followed by the interaction Green HRM × Green Intellectual Capital (f^2 = 0.045) and the interaction Knowledge Management Process × Green Transformational Leadership (f^2 = 0.041). All other interaction effects are not significant, but are larger than 0.02. In general, both moderators have the highest effect on the Green Intellectual Capital–performance relationship.

Table 9

Effect Sizes and PLS-Predict Assessment

Relationship/Outcome	f^2	Q^2-predict	RMSE	MAE	Interpretation
GIC → Sustainable Performance	0.126				Small
GTL → Sustainable Performance	0.094				Small
CSR → Sustainable Performance	0.061				Small
Green HRM Practices → Sustainable Performance	0.091				Small
Knowledge Management Process → Sustainable Performance	0.117				Small
GHRM × GIC	0.045				Small interaction
GHRM × GTL	0.034				Small interaction

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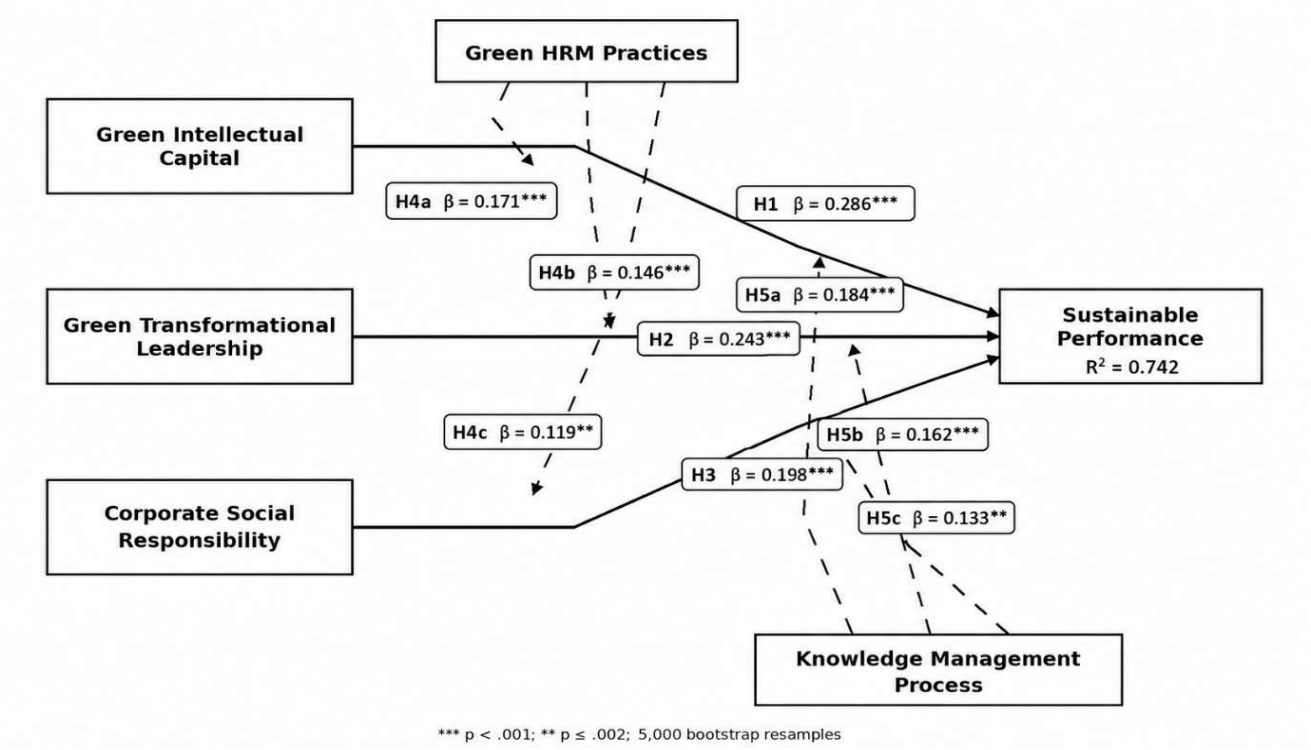
Relationship/Outcome	f^2	Q^2-predict	RMSE	MAE	Interpretation
GHRM × CSR	0.025				Small interaction
KMP × GIC	0.052				Small interaction
KMP × GTL	0.041				Small interaction
KMP × CSR	0.029				Small interaction
Sustainable Performance		0.536	0.548	0.416	Strong predictive relevance

The effects of the model are summarized in Figure 2. The Green Intellectual Capital (β = 0.286), Green Transformational Leadership (β = 0.243), and Corporate Social Responsibility (β = 0.198) have significant positive effects on Sustainable Performance, which supports H1, H2, and H3. In addition to the moderators and interaction terms, the model accounts for 74.2% of the variance in Sustainable Performance (R^2 = 0.742), as it shows strong explanatory power.

Green HRM Practices have a significant impact on Green Intellectual Capital (β = 0.171), Green Transformational Leadership (β = 0.146), and CSR (β = 0.119) on Sustainable Performance, which helps support H4a–H4c. The Knowledge Management Process also plays a supporting role in the impact of Green Intellectual Capital (β = 0.184), Green Transformational Leadership (β = 0.162) and CSR (β = 0.133) to support H5a–H5c. The greatest direct effect is that of Green Intellectual Capital, and the strongest interaction is that of Knowledge Management Process × Green Intellectual Capital. In general, the nine hypotheses are supported.

Figure 2

Graphical Presentation of Results



Note. Figure content as supplied in the source file.

5. Discussion and Findings

The findings reveal that Green Intellectual Capital, Green Transformational Leadership and Corporate Social Responsibility have positive relationship with Sustainable Performance in Pakistan's Healthcare Industry. The model accounts for 74.2% of the variance in Sustainable Performance, demonstrating that the

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organizational resources, supporting systems and interaction effects selected can explain a significant amount of variance. This adjusted R^2 value is still quite similar to the R^2 value of 0.771 obtained in the original model, indicating that this is not mostly due to the addition of unnecessary predictors. The Q^2-predict value of 0.536 further proves the predictive usefulness, although the final judgement of the predictiveness is to be made on the basis of comparisons of the PLS-SEM prediction errors with the errors of a linear-model benchmark.

The three organizational antecedents had positive effects on GIC and the largest direct effect was found for Green Intellectual Capital with $\beta = 0.286$, $p < 0.001$, as confirmed by H1. It indicates that hospitals have better environmental, social and economic outcomes when they have trained staff, an environmental process, efficient information systems, and collaborative relationships with stakeholders. Green human capital is about the ability to identify sustainability challenges among healthcare employees, and green structural capital is about the ability to keep sustainability knowledge in policies, databases, technologies and operation routines. Green relational capital enables to involve suppliers, regulators, patients, communities, and professional networks. It is consistent with Tram and Ngoc (2024) which revealed that Green Intellectual Capital is correlated with environmental enhancement through three aspects: waste reduction, use of renewable resources, and employees' environmental behaviour. It is also aligned with the finding of Zahid et al. (2024) that the Green Intellectual Capital plays a vital role between organizational responsibility, green innovation and Sustainable Performance.

Likewise, Green Transformational Leadership had a significant positive impact on Sustainable Performance ($\beta = 0.243$, $p < 0.001$), which was in favor of H2. This suggests that leaders can enhance the sustainability of the hospital by communicating a clear environmental vision, by becoming responsible role models, by raising awareness of inefficient routines among employees, and by accepting supportive decisions which move towards environmentally oriented solutions. The outcome is of particular significance for healthcare, as hospitals need to implement improvements in the environment without disrupting patient safety and continuity of care. The discovery aligns with Saleem et al. (2025), who found evidence from hospitals that green leadership positively affects environmental outcomes through the enhancement of employees' green attitudes, empowerment and self-efficacy. It is also similar to Huynh et al. (2024), who discovered that Green Transformational Leadership and knowledge management assist green innovation and Sustainable Performance in a developing-economy setting.

Sustainable Performance was significantly and positively affected by CSR ($\beta = 0.198$, $p < 0.001$) which confirmed H3. The coefficient was smaller than the other two components of the model, namely Green Intellectual Capital and Green Transformational Leadership, but statistically and practically significant. This finding means that the economic, legal, ethical, environmental, workplace and patient/community obligations of the hospital can impact their performance over time. The CSR can help to build trust, adherence to regulations, improved employee well-being, responsible disposal practices, and organizational legitimacy. Zahid et al. (2024) also found significant relationship between CSR and Sustainable Performance, specifically, when there were responsible commitments that facilitated the development of environmental knowledge and innovation. The present results further corroborate this argument by demonstrating that CSR can have a positive impact on social and economic outcomes of hospital performance as well as environmental outcomes.

The main effect of Green HRM Practices was significant for Sustainable Performance ($\beta = 0.221$, $p < 0.001$) and the relationships among the antecedents and Sustainable Performance were positive and significant, being moderated by Green HRM Practices. The most significant relationship was with Green Intellectual Capital ($\beta = 0.171$), Green Transformational Leadership ($\beta = 0.146$) and CSR ($\beta = 0.119$). So, H4a, H4b and H4c were supported. Thus, it can be inferred from the results that green resources yield more successful outcomes when hospitals hire green staff, train them to be green, assess environmental performance, reward green actions in a meaningful way, and engage staff in sustainable decision making.

These moderation results are consistent with the Ability-Motivation-Opportunity explanation. Green HRM shapes employees' environmental skills by hiring and training, motivates employees by appraising and rewarding, and opens opportunities for them by participating and empowering. The findings are similar to

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that of Zhao et al. (2024) which revealed that Green HRM positively affects Sustainable Development performance, and that the impact of Green HRM is contingent on adequate organizational conditions. Moreover, they align with the multilevel results of Gupta and Kaur (2024) who demonstrated that the Green HRM fosters a positive psychological setting and encourages Green employee behaviour. In the present study, the investigators confirm that the effect of Green HRM is not limited to its own performance, but it also enhances the value of the performance of intellectual resources, leadership and CSR.

The examination of the main effect of the Knowledge Management Process indicated that it has a significant positive effect on Sustainable Performance ($\beta = 0.254$, $p < 0.001$) and enhanced all three antecedent–performance relationships. The strongest interaction with KMP was with the GIC ($\beta = 0.184$), the KMP × GTL ($\beta = 0.162$), and the KMP × CSR ($\beta = 0.133$). The findings agree with H5a–H5c. The effects of GIC, GTL and CSR increased to 0.470, 0.405 and 0.331 at a high level of KMP respectively. These patterns illustrate the importance of systematic knowledge acquisition, dissemination, interpretation, retention, and application within environmental resources to drive productivity.

It is similar to the findings of Khan et al. (2024) which indicated that green knowledge management is linked to green intellectual capital, sustainable performance, and

6. Theory and Practice Implications

The results confirm and extend the Resource Based View, as the possession of the green resources is not enough to ensure Sustainable Performance. Green Intellectual Capital, Green Transformational Leadership and Corporate Social Responsibility directly influenced the environmental, social and economic outcomes of hospitals, and their combined influence was amplified by the presence of Green HRM Practices and the Knowledge Management Process. The study thus extends the focus on resource possession to offer insights into how complementary organizational systems enable the dynamic use of green resources in hospitals.

The moderating effects of Knowledge Management Process support the Organizational Learning Theory. Knowledge about the environment cannot add value unless the knowledge is gained, shared by departments, understood as a group, used for decisions and stored within organizational memory. There was a strong relationship between Knowledge Management Process and Green Intellectual Capital, which showed that the value of sharing and application of knowledge in hospitals yields the greatest benefits by environmental systems and expertise.

The results of the Green HRM moderation further validate the Ability-Motivation-Opportunity approach. Environmental ability can be developed through green recruitment and training, the motivation can be achieved through appraisal and rewards, and the opportunities for green action can be provided through employee participation and empowerment. Green HRM thus supports the leaders' sustainability message, supports the use of intellectual resources and turns implementation of CSR commitments into real employee action.

The environmental responsibilities need to be incorporated into recruitment, induction, training, appraisal, promotion and reward systems for hospital managers. Medical-waste segregation, energy and water conservation, responsible use of materials, sustainable procurement, and environmental reporting are areas that should be trained. Workable green improvements should be rewarded for by staff, either financially or non-financially. Also, hospitals should establish sustainability committees with participation of clinical, technical, administration, procurement and HR staff.

Environmental policies, audit results, operating procedures, regulatory updates and successful environmental sustainability projects should be stored in a formal knowledge repository. Knowledge and performance can be shared across departments in cross departmental meetings. Environmental measures including energy, water, waste and emissions, should be included alongside social and economic metrics such as employee wellbeing, patient safety, community giving, operational efficiency and cost reduction in sustainability reporting. These indicators can be integrated into hospital accreditation and environmental inspection systems.

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7. Novelty of the Study

The originality of this study is trying to explain how and when green organizational resources generate Sustainable Performance. The model does not consider Green HRM and knowledge management as just direct predictors or mediators, instead they are seen as two separate moderators. Thus, Green HRM can be said to be a people-management system which nurtures the capability, motivation and opportunity of the employees while the Knowledge Management Process is a knowledge utilization system that can be said to acquire, disseminate, interpret, remember, and utilize information related to the environment.

The effects of Green Intellectual Capital, Green Transformational Leadership and CSR were reinforced by both moderators. The Knowledge Management Process yielded higher interaction coefficients in all three relationships, but formal coefficient-difference testing would be needed to determine if any differences are statistically significant.

8. Conclusion, Limitations, and Future Research

The study findings have concluded that Green Intellectual Capital, Green Transformational Leadership and CSR have a significant positive effect on Sustainable Performance. Green Intellectual Capital had the highest direct coefficient followed by Green Transformational Leadership and CSR. Three antecedent–performance relationships were enhanced by the main effects of Green HRM Practices and the Knowledge Management Process. Therefore, the following amendments were supported: H1–H3, H4a–H4c, and H5a–H5c. The model accounted for 74.2% of the variation in Sustainable Performance, and had significant predictive relevance. This finding is consistent with previous results, which indicated that hospitals do better when their environmental resources are backed by systems in place to coordinate employees and to utilize knowledge.

Some limitations should be taken into account when interpreting the findings. Causal inferences are limited by the cross-sectional design and social-desirability and common-method biases may be present with the self-reported measures. The analysis is restricted to a particular set of Pakistani cities, thus precluding generalization to other healthcare systems. Multi-source analysis further relies on the accuracy of the hospital or department identifiers and the consistency of the responses from any group before the employees' responses are combined and compared with management responses. Other factors like hospital funding, regulatory pressure, infrastructure, and managerial quality may induce endogeneity concerns.

Longitudinal and matched employee–manager designs and more hospitals and objective sustainability indicators are recommended for future research. Multigroup comparisons can be done between public and private hospitals, size of organizations, cities and provinces, etc. In the future, the subsequent models may also provide answers to whether Green HRM and Knowledge Management Process interact together in three-way interaction or whether they reinforce the mediation through the Green Passion, green commitment, employee engagement, or green innovation.

Author's Contributions

All authors participated in ideation, development, and writing the manuscript. All authors read and approved the final manuscript.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this article.

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Informed Consent

Informed consent was obtained from all participants prior to data collection. Participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without any consequences. The confidentiality and anonymity of respondents were guaranteed throughout the research process.

Data Availability

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The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request. The authors are committed to transparency and will provide detailed methodological information and analysis protocols upon request.

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