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Green Human Capital Development and Organizational Outcomes in the Green Economy: The Mediating Role of Absorptive Capacity in Innovation Performance and Sustainable Performance

Agus Frianto[1], Bima Yatna Anugerah Ramadhani[2*], Muhammad Husain[3], Dyandra Armyta Ramadhan[4], Riedel Paulus Jacobis[5], Khoirur Rozaq[6]

[1-6]Department of Management, Universitas Negeri Surabaya, Indonesia

[*]Email corresponding author: bimaramadhani@unesa.ac.id

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Abstract

This study examines the role of Absorptive Capacity in mediating the relationship between Green Human Capital Development and two organizational outcomes: Innovation Performance and Sustainable Performance. Although organizations increasingly invest in green-oriented training, capacity building, and employee development, such initiatives do not automatically lead to improved organizational outcomes unless the acquired knowledge is effectively absorbed, transformed, and applied. Drawing on a knowledge-based perspective, this study proposes that Absorptive Capacity serves as a key mechanism that converts green-oriented human capital into innovation and sustainability outcomes. A quantitative explanatory design was employed using survey data collected from 380 workers in organizations that had implemented human resource development, innovation programs, sustainability initiatives, or environmentally oriented practices. The data were analyzed using Partial Least Squares Structural Equation Modeling with SmartPLS 4. The findings show that Green Human Capital Development has a positive effect on Absorptive Capacity. Absorptive Capacity also has positive effects on both Innovation Performance and Sustainable Performance. Furthermore, the indirect effect analysis confirms that Absorptive Capacity mediates the relationship between Green Human Capital Development and the two organizational outcomes. These results support the full mediation logic of the study, indicating that green-oriented human capital development contributes to organizational outcomes through knowledge conversion capability. This study contributes to the sustainability-oriented human resource management literature by clarifying how employee development supports innovation and sustainability in the green economy. Practically, the findings suggest that organizations should combine green training with knowledge-sharing systems, learning routines, and managerial support to strengthen innovation and sustainable performance.

Keywords: Green Human Capital Development, Absorptive Capacity, Innovation Performance, Sustainable Performance, Green Economy

INTRODUCTION

The shift to a green economy has emerged as a strategic priority for enterprises. Climate change, regulatory pressures, and stakeholder expectations necessitate that enterprises amalgamate economic success with social and environmental accountability (OECD, 2024; World Economic Forum, 2025). This shift requires assistance through both technical investment and human resources with the knowledge, skills, and capacity to facilitate organisational change towards sustainability (ILO, 2019; World Bank, 2024). Consequently, the advancement of human capital has emerged as a crucial organisational priority, as workers play a pivotal role in converting

sustainability objectives into everyday practices, innovative endeavours, and enduring organisational success (Becker, 1964; Barney, 1991).

The green economy is reshaping organisational job design, competency development, and workforce preparation for future business challenges (World Economic Forum, 2025). The green transition creates new competency requirements related to resource efficiency, environmental accountability, sustainable practices, and innovation (ILO, 2019; World Bank, 2024). Consequently, organisations are increasingly required to enhance training, upskilling, reskilling, and capacity-building. In this context, green human capital development is pertinent as it signifies firms' endeavours to cultivate workers' knowledge, skills, attitudes, and competencies that facilitate sustainability-oriented transformation (Renwick et al., 2013; Kuo et al., 2022).

The development of green human capital is significant; yet, one should not presume a direct or automatic impact on organisational outcomes. Training and capacity building can augment employees' individual knowledge; however, this knowledge may not translate into innovation performance or sustainable performance if the organisation fails to effectively absorb, transform, and utilise it (Cohen & Levinthal, 1990; Zahra & George, 2002). This argument is significant, as it emphasises that organisational results are influenced not only by the existence of human capital, but also by the organisation's capacity to convert employee knowledge into routines, procedures, choices, and innovative practices (Barney, 1991; Zahra & George, 2002).

This research is grounded in the resource-based view, positing that green human capital development is a strategic organisational resource capable of generating value when effectively created and used (Barney, 1991). In this context, workers' knowledge, skills, and competencies are essential assets as they enable firms to adapt to environmental changes and enhance organisational capacities (Barney, 1991; Renwick et al., 2013). Nonetheless, the resource-based view posits that resources alone cannot provide better results unless the organisation has the capability to employ them effectively (Barney, 1991). This research regards green human capital development as a significant input, but not a direct predictor, of innovation performance and sustainable performance.

This research employs the absorptive capacity theory to elucidate the relationship between green human capital development and organisational outcomes. "Absorptive capacity" refers to an organisation's ability to recognise the value of new information, acquire it, digest it, convert it, and use it for organisational objectives (Cohen & Levinthal, 1990; Zahra & George, 2002). This idea is pertinent since green human capital development primarily fosters knowledge and skills, whereas organisational results require the use of knowledge in innovation and sustainability endeavours (Cohen & Levinthal, 1990; Sancho-Zamora et al., 2021). Consequently, absorptive capacity serves as the mediating mechanism that elucidates the transformation of green human capital development into innovative performance and sustainable performance.

The first outcome is innovation performance. Innovation enables firms to respond to shifts in the market, technical advancements, environmental requirements, and stakeholder expectations (Kuo et al., 2022; Sancho-Zamora et al., 2021). Entities with more absorptive ability are more inclined to convert novel information into product, process, service, and management innovations (Cohen & Levinthal, 1990; Sancho-Zamora et al., 2021). Prior research indicates that environmentally focused human resource strategies may enhance innovation-related results when firms facilitate learning, employee engagement, and knowledge use (Kuo et al., 2022; Zihan & Makhbul, 2024).

The second chosen outcome is sustainable performance, since there is a growing expectation for companies to concurrently attain economic, social, and environmental performance (Zihan & Makhbul, 2024; Al Doghan, 2024). "Sustainable performance" refers to an organisation's capacity to improve efficiency, minimise environmental impact, promote social responsibility, and ensure long-term competitiveness (Zihan & Makhbul, 2024; Al Doghan, 2024). Sustainable performance encompasses more than only training personnel. Organisations must effectively convert

information into operational enhancements, strategic choices, and sustainability-focused behaviours (Cohen & Levinthal, 1990; Zahra & George, 2002).

Previous research has investigated the associations between green human resource management and green innovation, environmental performance, and sustainable performance (Kuo et al., 2022; Zihan & Makhbul, 2024; Al Doghan, 2024). Research has demonstrated that green HRM methods positively impact green innovation and environmental performance (Kuo et al., 2022). Zihan and Makhbul (2024) discovered that green HRM enhances sustainable performance via green innovation. Al Doghan (2024) emphasised the significance of green capabilities in elucidating the connection between green HRM practices and green performance. Nonetheless, this research indicates that the connection between environmentally focused human resource practices and organisational results often relies on an internal organisational process, rather than a direct relationship.

This research posits that green human capital development should affect innovation performance and sustainable performance via absorptive capacity, addressing this gap. The theory posits that training, capacity building, and competence development provide knowledge resources, whereas absorptive capacity enables businesses to transform these resources into innovation and sustainability results (Cohen & Levinthal, 1990; Zahra & George, 2002). This research provides a comprehensive mediation model whereby green human capital development does not directly affect innovation performance and sustainable performance but operates via absorptive capacity as the primary mechanism for knowledge translation.

This research aims to investigate the impact of green human capital development on innovation performance and sustainable performance, as mediated by absorptive capacity. This research excludes the direct impact of green human capital development on innovation performance and sustainable performance as the primary theoretical link. The development of human capital necessitates knowledge translation prior to the generation of organisational results (Cohen & Levinthal, 1990; Zahra & George, 2002). This research provides a clearer elucidation of how businesses convert the cultivation of environmentally focused human capital into innovation and sustainable performance.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

Green Human Capital Development

"Green human capital development" represents an organizational effort to develop the knowledge, skills, abilities, awareness, and competencies pertinent to environmental responsibility and the transition towards sustainability (Yafi et al., 2021; Kuo et al., 2022). This framework is closely associated with green training, green skill enhancement, green education, employee engagement, and capacity building, as these practices empower employees to comprehend and implement sustainability principles in their daily tasks (Yafi et al., 2021; Awwad Al-Shammari et al., 2022). This study defines Green Human Capital Development as the initial phase of the model, as it supplies the knowledge resources necessary for organizations to attain innovation and sustainability outcomes (Fang et al., 2022; Zihan & Makhbul, 2024). Green human capital development is crucial, as an organization cannot attain a sustainability transformation solely through technology or policy without employees proficient in implementing sustainability practices (Kuo et al., 2022; Song et al., 2023).

Employees who undergo environmentally focused training and development are more inclined to cultivate environmental awareness, green competencies, and preparedness to participate in sustainability initiatives (Yafi et al., 2021; Yang & Li, 2023). Consequently, Green Human Capital Development integrates the human dimension of sustainability by enhancing employees' capacity to advance environmental objectives, foster innovation, and facilitate organizational transformation (Al-Shammari et al., 2022; Pratiwi et al., 2025). The presence of green

knowledge and skills among employees does not inherently result in organizational outcomes, as individual knowledge must be converted into organizational routines, processes, and practices (Sancho-Zamora et al., 2021; Baeshen et al., 2021).

This distinction is significant as green human capital development primarily focuses on the creation of knowledge resources, whereas innovation performance and sustainable performance pertain to the organization's capacity to effectively absorb, convert, and utilize those resources (Sancho-Zamora et al., 2021; Ni & Abdullah, 2025). Absorptive capacity is the subsequent logical element in the model, elucidating how organizations transform employee knowledge into applicable organizational capabilities (Baeshen et al., 2021; Amaranti et al., 2024) and competencies of employees relevant to environmental responsibility and transformation towards sustainability (Yafi et al., 2021; Kuo et al., 2022). This construct is highly related to green training, green skill development, green learning, employee involvement, and capacity building, as these practices equip employees with the ability to understand and apply sustainability values to their daily work (Yafi et al., 2021; Awwad Al-Shammari et al., 2022). This study conceptualizes green human capital development as the first stage of the model because it provides the knowledge resources for organizations to achieve innovation and sustainability outcomes (Fang et al., 2022; Zihan & Makhbul, 2024).

Green human capital development is important based on this definition, as the organization cannot achieve a sustainability transformation with only technology or policy without employees who know how to implement sustainability practices (Kuo et al., 2022; Song et al., 2023). Employees who receive green-oriented training and development are more likely to develop environmental awareness, green competencies, and readiness to engage in sustainability-oriented initiatives (Yafi et al., 2021; Yang & Li, 2023). Thus, Green Human Capital Development consolidates the human aspect of sustainability by preparing employees' ability to support environmental goals, innovative endeavors, and organizational change (Al-Shammari et al., 2022; Pratiwi et al., 2025).

However, the existence of green knowledge and skills at the employee level does not automatically lead to organizational outcomes, as individual knowledge has to be transformed into organizational routines, processes, and practices (Sancho-Zamora et al., 2021; Baeshen et al., 2021). This distinction is important because green human capital development is mainly about creating knowledge resources, while innovation performance and sustainable performance are about the organization's ability to absorb, convert, and use those resources efficiently (Sancho-Zamora et al., 2021; Ni & Abdullah, 2025). Absorptive capacity is the next logical construct in the model, as it explains how organizations convert employee knowledge into usable organizational capability (Baeshen et al., 2021; Amaranti et al., 2024).

Absorptive Capacity

The absorptive capacity is defined as the ability of an organization to acquire, assimilate, transform, and apply knowledge for organizational purposes (Sancho-Zamora et al., 2021; Ni & Abdullah, 2025). The present model is relevant to this capability, as green human capital development generates knowledge and skills, while absorptive capacity determines if such knowledge can be used in organizational activities (Baeshen et al., 2021; Amaranti et al., 2024). In brief, absorptive capacity is a form of knowledge translation process that connects employee development to results at the organizational level (Sancho-Zamora et al., 2021; Kim et al., 2025).

The role of training and capacity building in strengthening the organization's knowledge base explains the relationship between green human capital development and absorptive capacity (Yafi et al., 2021; Song et al., 2023). Sustainability-oriented training provides employees with new knowledge, which can enrich organizational learning and enhance the organization's capacity to identify useful environmental information (Yafi et al., 2021; Yang & Li, 2023). This process enhances the organization's absorptive and interpretive capacity of knowledge as employees can recognize, disseminate, and utilize sustainability-related knowledge better (Fang et al., 2022; Qiu et al., 2025).

Furthermore, absorptive capacity is enhanced when organizations can integrate the knowledge of their employees into systems, routines, and decision-making processes (Sancho-Zamora et al., 2021; Müller et al., 2021). This integration is important because knowledge that is still segmented at the individual level may not bring innovation or sustainability benefits to the organization (Baeshen et al., 2021; Amaranti et al., 2024). Green human capital development is believed to enhance the quality of knowledge resources that organizations can acquire, assimilate, transform, and apply (Sancho-Zamora et al., 2021; Ni & Abdullah, 2025) and, as a result, enhance absorptive capacity.

H1: Green Human Capital Development has a positive effect on Absorptive Capacity.

Innovation Performance

"Innovation performance" refers to the organization's ability to generate and implement new or improved products, processes, services, and managerial practices (Sancho-Zamora et al., 2021; Ahmed et al., 2023). This outcome is relevant to the green economy context because organizations must continuously adapt their products, processes, and work systems to respond to environmental demands, technological changes, and stakeholder expectations (Kuo et al., 2022; Awwad Al-Shammari et al., 2022). Therefore, innovation performance is not only related to creativity but also to the organization's ability to apply knowledge in ways that create practical improvements (Sancho-Zamora et al., 2021; Amaranti et al., 2024).

The link between absorptive capacity and innovation performance is logical because innovation depends on the organization's ability to recognize valuable knowledge and convert it into new solutions (Sancho-Zamora et al., 2021; Baeshen et al., 2021). Organizations with stronger absorptive capacity are more capable of combining new knowledge with existing resources, which enables them to develop product innovation, process innovation, and managerial innovation (Müller et al., 2021; Amaranti et al., 2024). This argument is supported by recent studies showing that absorptive capacity contributes to innovation capability and green innovation performance because it helps organizations use knowledge more effectively (Sancho-Zamora et al., 2021; Kim et al., 2025).

This relationship also connects directly with green human capital development because training and capacity building create the knowledge foundation that can be transformed into innovation through absorptive capacity (Yafi et al., 2021; Kuo et al., 2022). Green-oriented human resource practices have been shown to encourage green innovation and environmental performance when organizations provide learning support, employee involvement, and knowledge-sharing opportunities (Fang et al., 2022; Song et al., 2023). Therefore, absorptive capacity is expected to improve innovation performance because it enables organizations to transform knowledge from human capital development into innovation-related outcomes (Awwad Al-Shammari et al., 2022; Amaranti et al., 2024).

Innovation Performance denotes an organization's capacity to create and execute novel or enhanced products, processes, services, and management practices (Sancho-Zamora et al., 2021; Ahmed et al., 2023). This result is pertinent to the green economy framework, as organizations must consistently modify their products, processes, and operational systems to address environmental requirements, technological advancements, and stakeholder expectations (Kuo et al., 2022; Awwad Al-Shammari et al., 2022). Consequently, innovation performance pertains not solely to creativity but also to the organization's capacity to utilize knowledge to effectuate tangible enhancements (Sancho-Zamora et al., 2021; Amaranti et al., 2024).

The correlation between absorptive capacity and innovation performance is rational, as innovation relies on an organization's capacity to identify valuable knowledge and transform it into novel solutions (Sancho-Zamora et al., 2021; Baeshen et al., 2021). Organizations possessing enhanced absorptive capacity are more adept at integrating new knowledge with existing resources, facilitating the development of product, process, and managerial innovations (Müller et

al., 2021; Amaranti et al., 2024). Recent studies indicate that absorptive capacity enhances innovation capability and green innovation performance by enabling organizations to utilize knowledge more effectively (Sancho-Zamora et al., 2021; Kim et al., 2025).

This relationship is directly linked to green human capital development, as training and capacity building establish the knowledge base that can be converted into innovation via absorptive capacity (Yafi et al., 2021; Kuo et al., 2022). Eco-centric human resource practices have demonstrated the capacity to foster green innovation and enhance environmental performance when organizations offer learning support, facilitate employee engagement, and promote knowledge-sharing opportunities (Fang et al., 2022; Song et al., 2023). Consequently, absorptive capacity is anticipated to enhance innovation performance by facilitating the conversion of knowledge derived from human capital development into innovation-related results (Awwad Al-Shammari et al., 2022; Amaranti et al., 2024).

H2: Absorptive Capacity has a positive effect on Innovation Performance.

Sustainable Performance

Sustainable Performance is defined as the ability of the organization to achieve economic, social and environmental outcomes in a balanced and long-term manner (Awwad Al-Shammari et al., 2022; Zihan & Makhbul, 2024). This construct is important as organizations are increasingly expected to maintain competitiveness while reducing environmental impact and increasing social responsibility (Kanan et al., 2023; Correia et al., 2024). In this study, Sustainable Performance is considered as the second outcome due to the green economy not only requires firms to create innovation but also to create the long-term sustainability gains (Zihan & Makhbul, 2024; Bindeeba, 2025).

The relationship between Absorptive Capacity and Sustainable Performance is attributed to the fact that sustainability requires knowledge to be applied in practice (Baeshen et al., 2021; Ni & Abdullah, 2025). Organizations that have a high degree of Absorptive Capacity are in a better position to leverage sustainability-related knowledge to improve efficiency, reduce environmental impact, strengthen social responsibility, and secure long-term performance (Correia et al., 2024; Kim et al., 2025). This means that Sustainable Performance does not only depend on the training of employees, but rather on the ability of the organization to translate the knowledge of its employees into operational and strategic sustainability practices (Sancho-Zamora et al., 2021; Zihan & Makhbul, 2024).

This argument is supported by recent studies which found that green-oriented human resource practices can improve sustainable performance through internal mechanisms such as green innovation, green capability, organizational culture, and knowledge-based processes (Kanan et al., 2023; Al Doghan, 2024). Awwad Al-Shammari et al. (2022) found that green HRM practices and green innovation contribute to sustainable performance for small and medium enterprises. Zihan and Makhbul (2024) found that green innovation is a reason behind the link between Green HRM and sustainable performance. In addition, Bindeeba (2025) also confirmed that green innovation is an important mechanism between Green HRM and sustainable business performance by meta-analytic SEM.

Given this evidence, Absorptive Capacity is expected to support Sustainable Performance because it allows organizations to transform knowledge into practices that improve economic, social, and environmental performance (Ni & Abdullah, 2025; Kim et al., 2025). This logic is consistent with the full mediation model because Green Human Capital Development provides knowledge input and Absorptive Capacity explains how that input becomes sustainable organizational action (Sancho-Zamora et al., 2021; Correia et al., 2024). Absorptive Capacity is expected to influence positively on Sustainable Performance (Baeshen et al., 2021; Zihan & Makhbul, 2024).

H3: Absorptive Capacity has a positive effect on Sustainable Performance.

The Mediating Role of Absorptive Capacity

Following the elucidation of the direct correlation between Green Human Capital Development and Absorptive Capacity, as well as between Absorptive Capacity and the two outcomes, the subsequent step is to delineate the mediating function of Absorptive Capacity. This study contends that Green Human Capital Development does not directly yield Innovation Performance, as training and capacity building primarily enhance employee knowledge, whereas innovation necessitates the organizational capacity to assimilate and utilize that knowledge (Sancho-Zamora et al., 2021; Amaranti et al., 2024). Consequently, Absorptive Capacity is anticipated to mediate the relationship between Green Human Capital Development and Innovation Performance, as it transforms employee knowledge into innovation-oriented routines and practices (Baeshen et al., 2021; Kuo et al., 2022).

The identical mediation framework is pertinent to Sustainable Performance, as sustainability results necessitate the conversion of knowledge into actionable organizational practices (Ni & Abdullah, 2025; Kim et al., 2025). The enhancement of Green Human Capital Development can elevate employees' awareness and competencies; however, these resources must be assimilated into organizational processes to enhance efficiency, environmental stewardship, social accountability, and sustained performance (Awwad Al-Shammari et al., 2022; Correia et al., 2024). Consequently, Absorptive Capacity is anticipated to mediate the relationship between Green Human Capital Development and Sustainable Performance, as it elucidates the transformation of knowledge resources into sustainability outcomes (Sancho-Zamora et al., 2021; Zihan & Makhbul, 2024).

This mediated logic aligns with recent empirical research indicating that environmentally-focused human resource practices frequently affect performance outcomes via internal mechanisms rather than solely through direct effects (Fang et al., 2022; Kanan et al., 2023). Fang et al. (2022) demonstrated that green innovation and green culture mediate the association between Green HRM and environmental performance. Kanan et al. (2023) demonstrated that green innovation mediates the association between Green HRM practices and sustainable performance. These findings substantiate the assertion that organizations require a conversion mechanism to translate environmentally-focused human resource practices into innovation and sustainability results (Awwad Al-Shammari et al., 2022; Bindeeba, 2025).

This study identifies Absorptive Capacity as the primary mediating mechanism within the research model. This framework enhances the model's structure by categorizing Green Human Capital Development as an input, Absorptive Capacity as a knowledge conversion process, and Innovation Performance and Sustainable Performance as organizational outcomes (Sancho-Zamora et al., 2021; Hair et al., 2022). This framework mitigates theoretical ambiguity by not presupposing that training and capacity building inherently yield organizational outcomes without a defined internal mechanism (Baeshen et al., 2021; Ni & Abdullah, 2025).

H4: Absorptive Capacity mediates the relationship between Green Human Capital Development and Innovation Performance.

H5: Absorptive Capacity mediates the relationship between Green Human Capital Development and Sustainable Performance.

RESEARCH METHODS

Research Design

This study employed a quantitative research design with an explanatory approach to examine the relationships among Green Human Capital Development, Absorptive Capacity, Innovation Performance, and Sustainable Performance. The explanatory design was selected because this study aimed to test predetermined hypotheses and explain the mediating role of Absorptive Capacity in transforming Green Human Capital Development into organizational outcomes. A cross-

sectional survey was used because the data were collected from respondents at one point in time. The unit of analysis was individual workers, while the analytical focus was placed on workers' perceptions of organizational practices related to human capital development, knowledge absorption, innovation, and sustainability performance. This design was appropriate because the research model involved multiple latent variables, direct relationships, and indirect relationships that required empirical testing using Partial Least Squares Structural Equation Modeling.

Population and Sample

The population of this study consisted of workers employed in formal organizations that had implemented human resource development, training, capacity building, innovation programs, sustainability initiatives, or environmentally oriented organizational practices. The sample consisted of 380 workers selected using purposive sampling because the study required respondents who had sufficient organizational experience and were able to evaluate Green Human Capital Development, Absorptive Capacity, Innovation Performance, and Sustainable Performance in their organizations. The inclusion criteria required respondents to be active workers, at least 18 years old, have a minimum of one year of tenure in their current organization, work in an organization that had introduced human resource development or sustainability-oriented initiatives, and voluntarily complete the questionnaire. Respondents with less than one year of tenure, interns, temporary trainees, incomplete responses, and invalid response patterns were excluded from the final sample. The demographic profile of the respondents is presented in Table 1.

Table 1. Respondent Profile

Characteristic	Category	Frequency	Percentage
Gender	Male	201	52.9%
	Female	179	47.1%
Age	18–25 years	69	18.2%
	26–35 years	153	40.3%
	36–45 years	105	27.6%
	> 45 years	53	13.9%
Tenure in current organization	1–3 years	94	24.7%
	4–6 years	123	32.4%
	7–10 years	90	23.7%
	> 10 years	73	19.2%
Total work experience	1–3 years	72	18.9%
	4–6 years	114	30.0%
	7–10 years	104	27.4%
	> 10 years	90	23.7%
Industry	Manufacturing	98	25.8%
	Services	89	23.4%
	Finance and banking	54	14.2%
	Retail and trade	48	12.6%
	Education	42	11.1%
	Healthcare and hospitality	28	7.4%
	Logistics and transportation	21	5.5%
Job position	Staff or officer	188	49.5%
	Supervisor or coordinator	101	26.6%
	Middle manager	65	17.1%
	Senior manager	26	6.8%

Data Collection and Instrument Development Techniques

Data were collected using a structured questionnaire distributed to workers who met the inclusion criteria, and all items were measured using a five-point Likert scale ranging from 1, indicating strongly disagree, to 5, indicating strongly agree. The questionnaire consisted of demographic questions and measurement items for four constructs: Green Human Capital Development was adapted from green training and green human resource management studies (Yafi et al., 2021; Kuo et al., 2022), Absorptive Capacity was adapted from absorptive capacity and innovation capability research (Sancho-Zamora et al., 2021), Innovation Performance was adapted from studies on innovation capability and green innovation performance (Ahmed et al., 2023; Amaranti et al., 2024), and Sustainable Performance was adapted from studies on sustainable performance in green human resource management and sustainability contexts (Awwad Al-Shammari et al., 2022; Zihan & Makhbul, 2024). The measurement instrument and source references are presented in Table 2.

Table 2. Measurement Instrument and Source References

Variable	Measurement Focus	Example Indicator Direction	Main Reference
Green Human Capital Development	Green training, green skill development, capacity building, and sustainability-oriented learning	The organization provides training and development programs that improve employees' sustainability-related knowledge and skills.	Yafi et al. (2021)
Absorptive Capacity	Knowledge acquisition, assimilation, transformation, and application	The organization is able to acquire, understand, transform, and apply new knowledge for organizational improvement.	Sancho-Zamora et al. (2021)
Innovation Performance	Product innovation, process innovation, service innovation, and managerial innovation	The organization is able to develop and implement new or improved products, processes, services, or managerial practices.	Ahmed et al. (2023)
Sustainable Performance	Economic performance, social performance, and environmental performance	The organization is able to improve economic results, social responsibility, and environmental outcomes in a balanced manner.	Awwad Al-Shammari et al. (2022)

Tool and Material Specifications

The main research material used in this study was a structured questionnaire developed from established measurement indicators in previous international studies. The questionnaire was distributed through an online survey platform and, when necessary, supported by direct distribution to improve response completeness. The main analytical tool used in this study was SmartPLS 4 because this software supports Partial Least Squares Structural Equation Modeling, including measurement model assessment, structural model assessment, mediation testing, reliability testing, validity testing, collinearity assessment, and bootstrapping analysis. Spreadsheet software was also used to organize raw data, code responses, screen missing values, identify incomplete responses, and prepare the dataset before it was imported into SmartPLS 4. This study did not use laboratory equipment or physical experimental materials because the research was based on survey data.

Data Analysis Techniques

The data were analyzed using Partial Least Squares Structural Equation Modeling with SmartPLS 4 because this technique is suitable for analyzing complex models involving latent variables, mediation effects, and prediction-oriented relationships (Hair et al., 2022). The analysis was conducted in two main stages: measurement model assessment and structural model assessment. The measurement model was evaluated using outer loading, Cronbach's alpha, rho_A, composite reliability, Average Variance Extracted, Fornell-Larcker criterion, Heterotrait-Monotrait ratio, and outer Variance Inflation Factor. The structural model was evaluated using path coefficients, t-values, p-values, R-square, f-square, and inner Variance Inflation Factor. The significance of the direct and indirect relationships was tested using a bootstrapping procedure with 5,000 subsamples. The mediation effect of Absorptive Capacity was examined through the specific indirect effect procedure. The direct paths from Green Human Capital Development to Innovation Performance and Sustainable Performance were also assessed to determine whether the empirical results supported a full mediation model.

RESULTS AND DISCUSSION

Result

Evaluation of Measurement Model

The measurement model In Table 3 was evaluated using factor loadings, Cronbach's alpha, composite reliability, and Average Variance Extracted. The results indicate that all constructs achieved satisfactory internal consistency reliability because the Cronbach's alpha values ranged from 0.856 to 0.909, exceeding the recommended threshold of 0.70. In addition, the composite reliability values ranged from 0.897 to 0.923, indicating that all constructs demonstrated strong reliability.

Table 3. Measurement Model Assessment

Items	Loading	Cronbach's Alpha	CR	AVE
Absorptive Capacity		0.856	0.897	0.636
	AC1			
	AC2			
	AC3			
	AC4			
	AC5			
Green Human Capital Development		0.879	0.912	0.674
	GHC1			
	GHC2			
	GHC3			
	GHC4			
	GHC5			
Innovation Performance		0.909	0.923	0.699
	IP1			
	IP2			
	IP3			
	IP4			
	IP5			
	IP6			
	IP7			

	IP8			
	IP9			
	IP10			
	IP11			
	IP12			
		0.902	0.918	0.682
Sustainable Performance	SP1			
	SP2			
	SP3			
	SP4			
	SP5			
	SP6			
	SP7			
	SP8			
	SP9			
	SP10			
	SP11			
	SP12			

Convergent validity was also established because the AVE values for all constructs exceeded the recommended threshold of 0.50. Absorptive Capacity obtained an AVE value of 0.636, Green Human Capital Development obtained 0.674, Innovation Performance obtained 0.699, and Sustainable Performance obtained 0.682. These results indicate that each construct was able to explain more than 50% of the variance of its indicators. Therefore, the constructs used in this study can be considered reliable and valid, and the analysis can proceed to the structural model assessment. However, the loading values for each indicator should be completed before final submission so that indicator reliability can be fully evaluated.

The discriminant validity of the measurement model in Table 4 was assessed using the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio. The Fornell-Larcker results show that Absorptive Capacity and Green Human Capital Development achieved acceptable discriminant validity because the square roots of AVE for these constructs, 0.797 and 0.821, were higher than their correlations with other constructs. However, a potential discriminant validity issue was found between Innovation Performance and Sustainable Performance because their correlation value of 0.873 was higher than the square roots of AVE for Innovation Performance, 0.706, and Sustainable Performance, 0.695. The HTMT results generally supported discriminant validity because most values were below the recommended threshold of 0.85, including the relationships between Green Human Capital Development and Absorptive Capacity, Innovation Performance and Absorptive Capacity, Innovation Performance and Green Human Capital Development, Sustainable Performance and Absorptive Capacity, and Sustainable Performance and Green Human Capital Development. Nevertheless, the HTMT value between Innovation Performance and Sustainable Performance was 0.865, which is slightly above the stricter threshold of 0.85 but still below the more liberal threshold of 0.90. Therefore, the measurement model generally demonstrated acceptable discriminant validity, although the relationship between Innovation Performance and Sustainable Performance should be interpreted carefully because both constructs are theoretically related in explaining organizational outcomes.

Table 4. The discriminant validity of the measurement model

Construct	**Fornell–Larcker Criterion**				**Heterotrait–Monotrait Ratio**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**

Absorptive Capacity	0.797						
Green Human Capital Development	0.787	0.821			0.804		
Innovation Performance	0.618	0.482	0.706		0.701	0.537	
Sustainable Performance	0.64	0.48	0.873	0.695	0.726	0.536	0.865

Structural Model Evaluation

The structural model results show in table 5 that H1 is supported, as Green Human Capital Development has a positive and significant effect on Absorptive Capacity with a path coefficient of 0.787, a t-value of 24.403, and a p-value of 0.000. This indicates that stronger Green Human Capital Development enhances the organization's ability to acquire, assimilate, transform, and apply knowledge. H2 is also supported, as Absorptive Capacity has a positive and significant effect on Innovation Performance with a path coefficient of 0.629, a t-value of 7.274, and a p-value of 0.000. This means that organizations with stronger Absorptive Capacity are more likely to improve their innovation outcomes. Furthermore, H3 is supported, as Absorptive Capacity has a positive and significant effect on Sustainable Performance with a path coefficient of 0.692, a t-value of 7.688, and a p-value of 0.000. This finding indicates that Absorptive Capacity plays an important role in improving organizational sustainability outcomes. Overall, these results confirm that Absorptive Capacity is a key mechanism linking Green Human Capital Development with Innovation Performance and Sustainable Performance.

Table 5. The Direct Effect of Hypothesis Testing

Direct Effect	Path Coefficient	SE	t-value	p-value	Decision
H1: Green Human Capital Development → Absorptive Capacity	0.787	0.032	24.403	0	Supported
H2: Absorptive Capacity → Innovation Performance	0.629	0.086	7.274	0	Supported
H3: Absorptive Capacity → Sustainable Performance	0.692	0.09	7.688	0	Supported

The indirect effect results in Table 6 indicate that Absorptive Capacity significantly mediates the relationship between Green Human Capital Development and both organizational outcomes. The indirect path of Green Human Capital Development → Absorptive Capacity → Innovation Performance has a positive path coefficient of 0.495, a standard error of 0.074, a t-value of 6.716, and a p-value of 0.000, indicating that H4 is supported. Similarly, the indirect path of Green Human Capital Development → Absorptive Capacity → Sustainable Performance shows a positive path coefficient of 0.545, a standard error of 0.079, a t-value of 6.900, and a p-value of 0.000, indicating that H5 is supported. These findings demonstrate that Green Human Capital Development improves Innovation Performance and Sustainable Performance through the organization's ability to acquire, assimilate, transform, and apply knowledge, confirming that Absorptive Capacity serves as a significant mediating mechanism in the proposed model.

Table 6. The Indirect Effect of Hypothesis Testing

Indirect Effect	Path Coefficient	SE	t-value	p-value	Decision
H4: Green Human Capital Development → Absorptive Capacity → Innovation Performance	0.495	0.074	6.716	0	Supported

H5: Green Human Capital Development → Absorptive Capacity → Sustainable Performance	0.545	0.079	6.9	0	Supported

Following the significant direct and indirect effects, the explanatory power of the model was evaluated using R-square and adjusted R-square values. The results show that the model explains 61.99% of the variance in Absorptive Capacity, with an R-square value of 0.620 and an adjusted R-square value of 0.619. In addition, the model explains 38.25% of the variance in Innovation Performance, with an R-square value of 0.382 and an adjusted R-square value of 0.379. The model also explains 41.18% of the variance in Sustainable Performance, with an R-square value of 0.412 and an adjusted R-square value of 0.409. These results indicate that the model has strong explanatory power for Absorptive Capacity and moderate explanatory power for Innovation Performance and Sustainable Performance. The small differences between the R-square and adjusted R-square values also suggest that the model remains stable after accounting for the number of predictors included in the structural model.

DISCUSSION

The findings of this study provide a coherent explanation of how Green Human Capital Development contributes to organizational outcomes through a knowledge-based mechanism. The positive relationship between Green Human Capital Development and Absorptive Capacity indicates that green-oriented training, capacity building, and employee development strengthen the organization's ability to acquire, assimilate, transform, and apply knowledge. This result suggests that human capital development does not only improve individual competence, but also enriches the organizational knowledge base needed to respond to sustainability-related challenges. Employees who receive sustainability-oriented development are more likely to understand environmental priorities, share relevant knowledge, and participate in organizational learning processes that support long-term transformation. This finding is consistent with previous studies showing that green training and green human resource practices enhance environmental knowledge, employee capability, and learning-oriented behavior within organizations (Yafi et al., 2021; Kuo et al., 2022; Song et al., 2023).

Extending this argument, the study demonstrates that Absorptive Capacity plays an important role in improving Innovation Performance. This finding highlights that innovation is not merely the result of possessing knowledge, but depends on how effectively organizations absorb and transform knowledge into new products, processes, services, or managerial practices. Organizations with stronger Absorptive Capacity are better positioned to combine newly acquired knowledge with existing resources, enabling them to develop more adaptive and innovative responses to environmental and market changes. In the context of green economy transformation, this capability becomes particularly important because organizations must continuously convert sustainability-related knowledge into practical improvements. This result supports prior research indicating that absorptive capacity enhances innovation capability and green innovation performance by enabling organizations to recognize, integrate, and exploit knowledge more effectively (Sancho-Zamora et al., 2021; Baeshen et al., 2021; Amaranti et al., 2024).

The findings also show that Absorptive Capacity contributes to Sustainable Performance. This result indicates that sustainability outcomes require more than awareness, training, or formal environmental commitment; they require the organizational capability to translate knowledge into operational and strategic practices. Organizations that can absorb and apply sustainability-related knowledge are more likely to improve efficiency, strengthen environmental responsibility, support social responsibility, and maintain long-term organizational performance. This finding reinforces the view that sustainability performance is produced through internal organizational mechanisms that connect knowledge, capability, and action. It is also in line with previous studies showing that

green-oriented human resource practices and sustainability initiatives can improve sustainable performance when supported by innovation, organizational capability, and knowledge-based processes (Awwad Al-Shammari et al., 2022; Kanan et al., 2023; Correia et al., 2024; Zihan & Makhbul, 2024).

A more important contribution of this study lies in the mediating role of Absorptive Capacity in linking Green Human Capital Development with Innovation Performance. The results indicate that green-oriented human capital development becomes more meaningful for innovation when organizations are able to convert employee knowledge into organizational routines and innovation practices. This finding implies that training and capacity building alone are not sufficient to produce innovation unless the organization has the capability to absorb, interpret, and apply the knowledge generated from those development activities. In this regard, Absorptive Capacity functions as a bridge between employee-level knowledge and organization-level innovation outcomes. This finding is consistent with previous studies showing that the influence of green human resource practices on innovation-related outcomes often occurs through internal mechanisms such as green innovation, green culture, learning capability, and knowledge application (Fang et al., 2022; Kuo et al., 2022; Sancho-Zamora et al., 2021).

The mediating role of Absorptive Capacity is also evident in the relationship between Green Human Capital Development and Sustainable Performance. This result suggests that sustainability-oriented employee development contributes to sustainable performance when the organization is capable of transforming employee knowledge and competence into concrete sustainability practices. In practical terms, organizations may invest in green training and capacity building, but the benefits of these investments will remain limited if knowledge is not embedded into work systems, operational improvements, environmental initiatives, and strategic decision-making. Absorptive Capacity therefore explains how human capital development can move beyond individual learning and become an organizational capability that supports economic, social, and environmental outcomes. This finding is consistent with previous research showing that green human resource practices improve sustainable performance through mediating mechanisms such as green innovation, green capability, and sustainability-oriented organizational processes (Awwad Al-Shammari et al., 2022; Kanan et al., 2023; Bindeeba, 2025).

Taken together, the findings strengthen the full mediation logic proposed in this study. Green Human Capital Development serves as an important source of sustainability-related knowledge and competence, but its contribution to organizational outcomes depends on the presence of Absorptive Capacity as a knowledge conversion mechanism. This means that organizations should not treat green training and capacity building as isolated human resource programs, but as part of a broader organizational learning system that connects employee development with innovation and sustainability strategies. Theoretically, this study contributes to the sustainability-oriented human resource literature by clarifying the process through which green-oriented human capital is transformed into organizational outcomes. Practically, the findings suggest that organizations seeking to improve Innovation Performance and Sustainable Performance should strengthen not only employee competencies, but also organizational systems that support knowledge acquisition, knowledge sharing, knowledge transformation, and knowledge application.

CONCLUSION

This study concludes that Green Human Capital Development plays an important role in strengthening Absorptive Capacity, which subsequently contributes to Innovation Performance and Sustainable Performance. The findings show that green-oriented training, capacity building, and employee development do not automatically generate organizational outcomes, but must first be converted into organizational capability through knowledge acquisition, assimilation, transformation, and application. In this regard, Absorptive Capacity becomes the central mechanism that enables organizations to transform employee knowledge and sustainability-

related competencies into innovation outcomes and long-term sustainable performance. This conclusion reinforces the idea that organizations should not treat Green Human Capital Development as an isolated human resource activity, but as part of a broader organizational learning and capability-building system.

The study also confirms that Absorptive Capacity fully mediates the relationship between Green Human Capital Development and both Innovation Performance and Sustainable Performance. This means that the value of green-oriented human capital development depends on the organization's ability to absorb and apply knowledge effectively. Theoretically, this study contributes to the sustainability-oriented human resource literature by clarifying the process through which employee development supports organizational outcomes in the green economy.

Practically, the findings suggest that organizations should strengthen not only green training and capacity-building programs, but also knowledge-sharing systems, learning routines, cross-functional collaboration, and managerial support that enable knowledge to be transformed into innovation and sustainability practices.

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