(Online) ISSN 2712-0554
Heritage and Sustainable Development *Original Research*
Vol. 8, No. 1, 2026, pp.17-34
https://doi.org/10.37868/hsd.v8i1.1371

Green innovation, company's ability, and corporate social responsibility: Evidence from Indonesia's recycling industry

Eka Ananta Sidharta[1*], Nur Fadjrih Asyik[2], Rusdiyanto[3], Umar Burhan[4], Heryanto Susilo[5]
[1] Department of Accounting, Universitas Negeri Malang, Indonesia
[2] Department of Accounting, Sekolah Tinggi Ilmu Ekonomi Indonesia Surabaya (STIESIA), Indonesia
[3] Department of Accounting, Universitas Gresik, Indonesia
[4] Department of Management, Universitas Gresik, Indonesia
[5] Department of Education, Universitas Negeri Surabaya, Indonesia

*Corresponding author E-mail: eka.ananta.fe@um.ac.id

Received Jun. 6, 2025
Revised Dec. 22, 2025
Accepted Jan. 17, 2026
Online Jan. 20, 2026

Abstract

This study examines the mediating role of company capabilities in the relationship between green innovation and corporate social responsibility (CSR) initiatives in Indonesia's recycling sector. A quantitative approach was employed, using data collected from 129 recycling firms across various regions in Indonesia through a structured online questionnaire. Structural equation modeling–partial least squares (SEM-PLS) was applied using SmartPLS software to test the proposed relationships. The results demonstrate that company capabilities significantly mediate the relationship between green innovation and CSR initiatives, indicating that green innovation alone is insufficient without adequate organizational capabilities. These findings highlight the importance of long-term commitment and strategic coordination in addressing the short-term costs and operational challenges of sustainability implementation in developing industries. This study contributes to the literature by emphasizing the strategic management of natural resources as a key driver of green innovation amid the global climate crisis. By integrating company capabilities, environmental initiatives, and green innovation, the research offers novel insights into sustainability practices in the recycling sector of developing countries. The study provides practical implications for managers and policymakers by underscoring company capabilities as a central mechanism for creating sustainable value, supporting circular economy development, and advancing ESG-oriented strategies.

Keywords: Green innovation, CSR, Indonesia, SEM-PLS, SmartPLS

1. Introduction

In the current era, businesses are required not only to innovate in operations, finance, competitiveness, and products but also to address their environmental impact. Environmental concerns have become a central focus in the global economic discourse on sustainability. The triple bottom line idea emphasizes development that satisfies present needs without jeopardizing the capacity of future generations to fulfill their own demands [1],

[2]. In response, many manufacturing firms have adopted environmentally friendly practices. Individuals' attitudes and knowledge about environmental safety influence their contributions to sustainability [3]. CSR programs reflect companies' commitment to social welfare and sustainable development [4], [5]. Beyond CSR, green innovation is recognized as a strategic capability for achieving long-term sustainability through innovations in products, processes, and management [6], [7]. Recycling plays a vital role in reducing resource consumption and environmental impact [8].

Stakeholder theory posits that corporations are obligated to fulfill the expectations of diverse entities, including consumers, employees, communities, and the environment [9]. In Indonesia's recycling sector, CSR signifies a company's competencies [10]. Integrating sustainability principles and green innovation strengthens stakeholder relations and enhances competitiveness [11], ultimately improving firm performance [12]. At the 40th UNESCO General Conference in 2019, Indonesia reaffirmed its commitment to green innovation. According to the Ministry of Industry and the Indonesian Recycling Association [13], the recycling sector processes 2.54 million tons of waste annually and generates 3 million jobs. Nonetheless, according to the National Waste Management Information System [14], Indonesia produces almost 33 million tons of trash per year, with 40.06% remaining unregulated. This underscores the substantial, persistent obstacles to efficient national waste management and corporate social responsibility implementation.

This study aims to examine the role of CA as a mediator in the interaction between GI and CSR within Indonesia's recycling sector. Eco-friendly business practices have been thoroughly examined across multiple industries, including firms listed on the Pakistan Stock Exchange [15], manufacturing companies in Pakistan [16], [17], manufacturing firms in Ecuador [18], and companies involved in Indonesia's CSR Rating Program listed on the Indonesia Stock Exchange [19]. Additional studies have focused on Indonesian SMEs [20] and service firms in the Maldives and Morocco [21]. However, most of these studies emphasize the impact of eco-friendly practices on the company's ability, CSR, and green innovation, with limited attention to the social dimension. In order to fill the gaps in the literature and provide a more comprehensive analysis of sustainability, this study focuses on Indonesia's recycling sector.

The theoretical foundations and hypothesis development are examined in greater depth in the following section. Thereafter, the procedures for data collection and the research methodology are outlined. The study then presents its key findings along with a comprehensive analysis of the subject. The last section examines the study's limits, explores its theoretical and practical consequences, and delineates avenues for further research.

2. Literature review and hypotheses development

Stakeholder theory posits that businesses are obligated to fulfill the wants and expectations of diverse stakeholders, including customers, employees, communities, and the environment [9]. In the context of this study, CSR represents a tangible expression of a company's accountability to its stakeholders, particularly within Indonesia's recycling industry [10]. By integrating green innovation and sustainability principles, companies not only foster harmonious stakeholder relationships but also strengthen their Company's Ability [11]. Ultimately, this dynamic positively impacts firm performance, as satisfied stakeholders and a well-preserved environment support business continuity and the sustainable, effective attainment of corporate objectives [12]. Companies must take into account the interests of all stakeholders in all decision-making processes, including the application of corporate social responsibility (CSR), according to stakeholder theory. Company competencies are essential in bridging the relationship between CSR and green innovation in the context of the global climate catastrophe. Strong capabilities enable companies to respond more effectively to stakeholder demands, thereby fostering the development of sustainable green innovations and delivering added value to all stakeholders [22], [23].

The ability of a business to incorporate social, economic, and environmental factors into its green innovation assessment is known as "green innovation" [24]. Its key indicators include environmental performance through efforts to minimize resource consumption and maximize renewable resource use [16], [25], economic

performance assessed by profit growth, market share, and customer base expansion [26], [27], and social performance reflecting contributions to community well-being, employee welfare, and safe working conditions [28]. CSR is an ethical commitment to green innovation, environmental sustainability, and social welfare [29], [1], encompassing initiatives focused on eco-friendly practices, social safety, and product safety. CSR involves product and process innovations aimed at energy conservation and eco-friendly design [30]. The ability of the business to attain better performance through initiatives such as cost leadership, differentiation, or market focus is known as the company's ability [31].

According to recent studies, CSR implementation has a positive impact on GI [20], [32]. In addition to supporting long-term economic growth, the adoption of sustainable practices—such as efficient resource management, emission reduction, and waste minimization—is essential to corporate social responsibility [16], [33]. Moreover, firm performance can be further enhanced through the adoption of competitive strategies, including cost leadership, product differentiation, and innovation, which are essential for addressing increasingly complex competitive challenges in dynamic markets [34], [20]. These strategies not only open new market opportunities but also strengthen corporate reputation and brand image [20], [35]. Additionally, they contribute significantly to improving financial outcomes and overall competitiveness in both domestic and global arenas [36], [37]. Therefore, integrating CSR with effective competitive strategies is crucial for companies looking to achieve sustainable growth and keep a competitive advantage in the quickly evolving business climate of today [38], [39].

Green innovation benefits from corporate social responsibility [40], [41]. This is because CSR promotes waste minimization, resource efficiency, and the adoption of environmentally friendly technologies that can reduce operating costs and enhance business performance [42], [43]. However, the direct impact of CSR on green innovation may not reach its full potential without the mediating role of the company's ability [44], [45]. This capability enables firms to leverage the company's ability gained from green innovation into added value within competitive markets [44], [46]. Through this capability, companies can integrate CSR to enhance cost efficiency in order to improve profitability and market share [47], [48]. Therefore, the company's skills moderate the interaction between CSR and green innovation, increasing the efforts' beneficial effects on overall economic performance [49], [42].

The theoretical justification for using stakeholder theory in this mediation model lies in the perspective that companies should consider the interests of various stakeholders in their strategic decision-making. Corporate capabilities act as a mediator in this situation, allowing businesses to better address stakeholder expectations and enhance the connection between innovative success and corporate social responsibility. Thus, corporate capabilities play a crucial role in bridging and enhancing the influence of CSR on organizational outcomes [9], [50]. Based on these insights, this study proposes the following hypothesis:

H1_ CSR has a positive effect on the CA
H2_ The CA has a positive effect on GI.
H3_CSR has a positive effect on GI
H4_ CSR has a positive effect on GI through the CA.

3. Research method

This study uses a quantitative methodology to examine how CA mediates the link between GI and CSR. To support and improve the research findings, two control variables—ESD and SP—are also included. The research framework is depicted in Figure 4.

This study focuses on the recycling industry in Indonesia, specifically targeting companies that manage waste bank systems and process waste materials such as plastic, paper, textiles, and wood into value-added products, including furniture, organic fertilizers, and handicrafts. The selection of this industry is motivated by the limited research available on the recycling sector. Furthermore, this industry actively promotes sustainability and is

increasingly recognized as a viable alternative solution to environmental challenges, demonstrating strong potential for future development in Indonesia [51], with the research data details as follows.

For this study, 241 recycling businesses in different parts of Indonesia were given questionnaires. 53.5% of them were completed, with 129 surveys being returned. A more thorough grasp of the histories of the respondents and the characteristics of the businesses participating in this study was then possible thanks to additional analysis of the data that had been gathered. The corporate characteristics shown in Figure 1, the respondents' regional distribution in Figure 2, and the respondents' demographic characteristics in Figure 3 were taken into consideration while further analysing the gathered data. This analysis offers a more thorough comprehension of the backgrounds of the respondents as well as the characteristics of the participating companies.

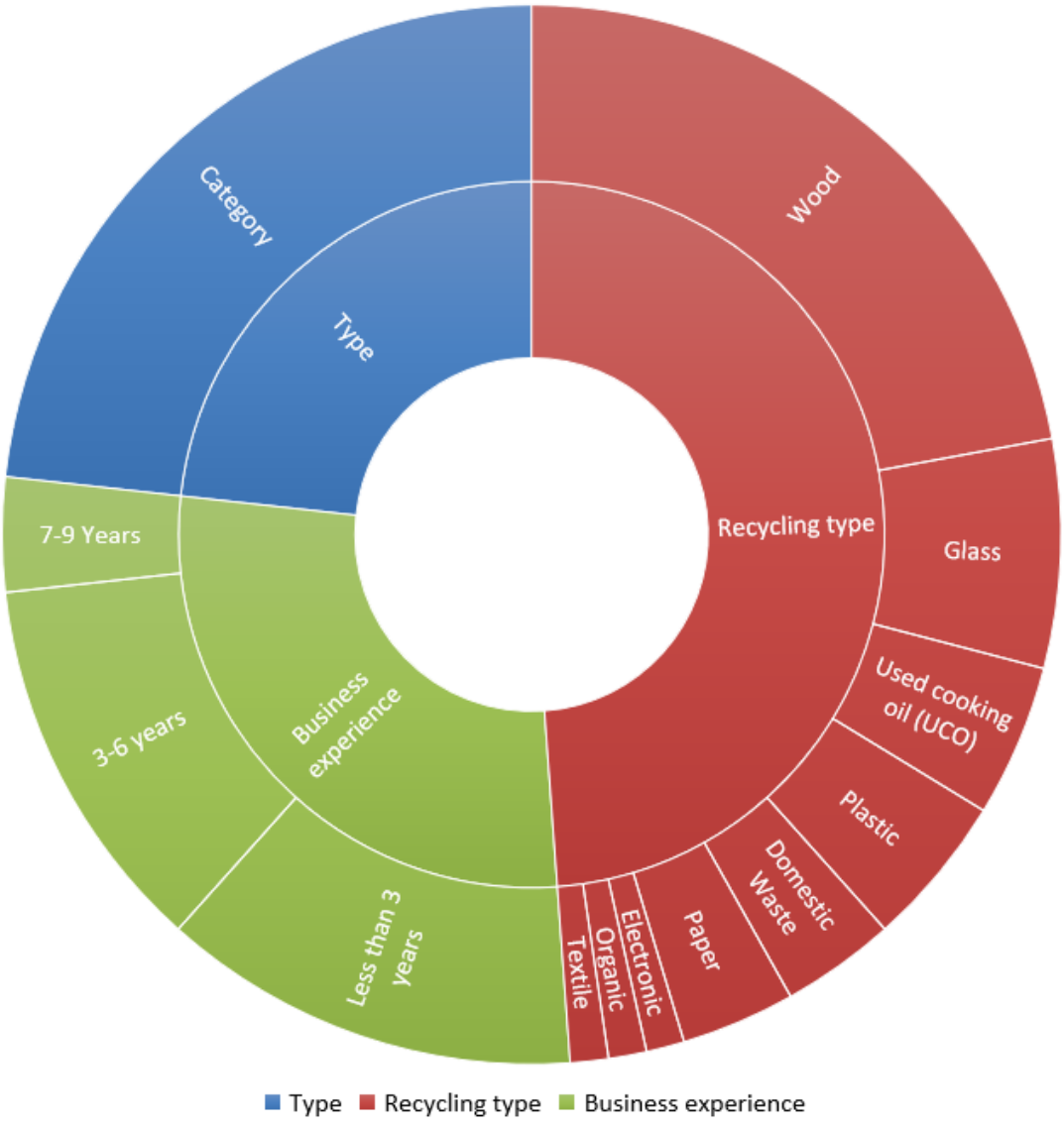

Figure 1. Characteristics of the corporate

Figure 1 presents the types of recycling activities and the business experience of the respondents. Plastic recycling is the most dominant activity, reported by 46.5% of companies, followed by domestic waste (14%), paper and organic waste (each 9.3%), used cooking oil (7%), textiles (7%), and smaller proportions for glass, electronics, and wood (each 2.3%). Regarding business experience, the majority of companies have been operating for less than 3 years (44.2%), followed by those with 3–6 years (25.6%), 7–9 years (23.3%), and more than 10 years (7%).

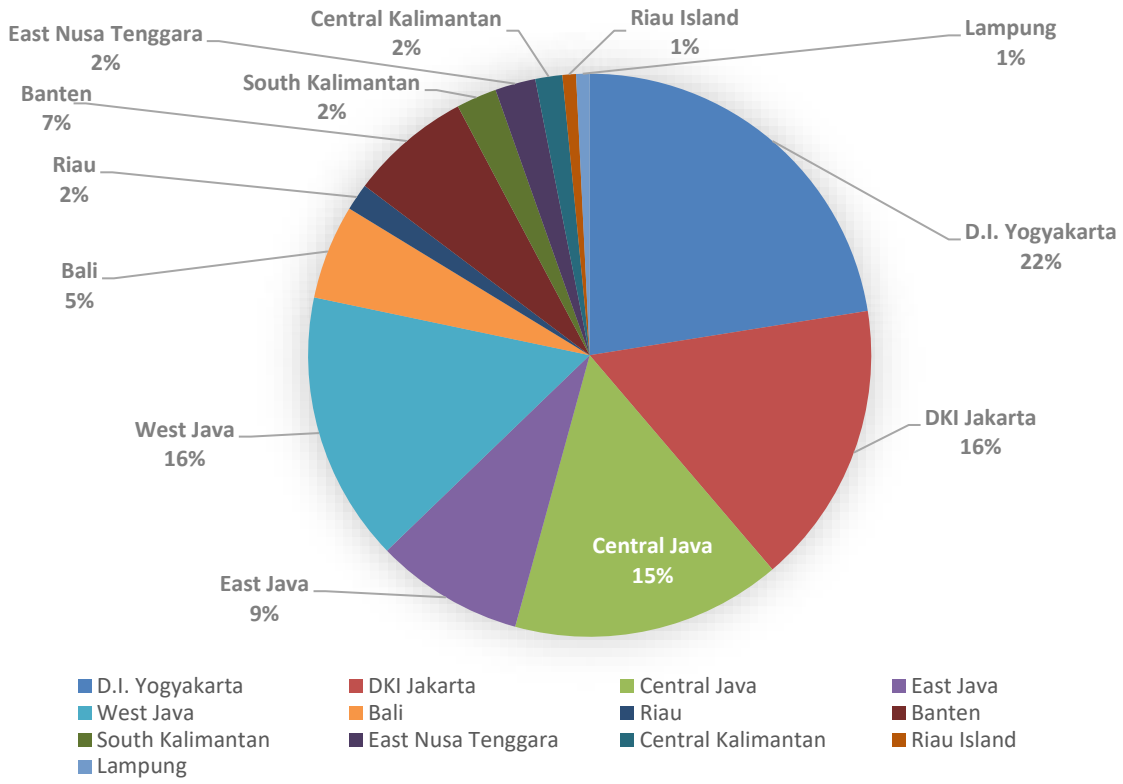

Figure 2. Geographical scope of data distribution

Figure 2 shows that the majority of respondents come from regions with high levels of economic activity and population density, while other areas exhibit a more limited data distribution. The highest number of respondents was from D.I. Yogyakarta, with 29 individuals (22.5%), followed by DKI Jakarta (16.3%), Central Java (15.5%), and West Java.

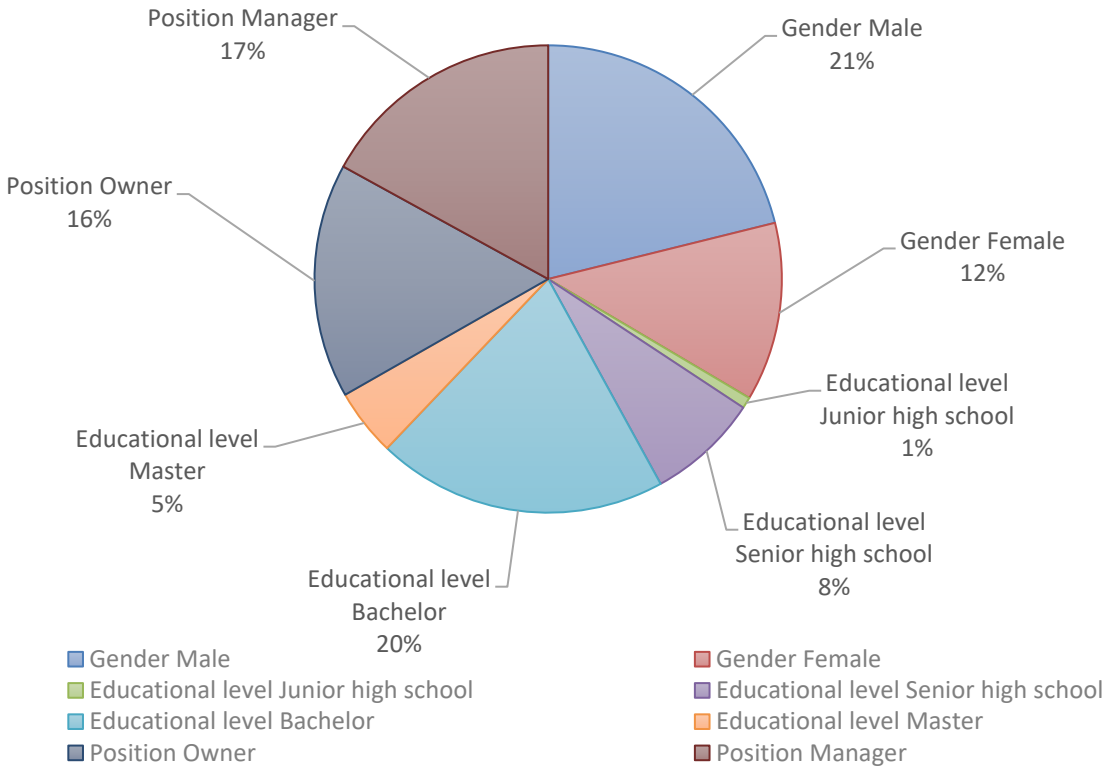

Figure 3. Characteristic of the respondents

Figure 3 shows that of the 129 people who completed the survey, 63 were business owners, while the remaining 66 were managers. The majority of participants were male (62.8% of respondents), while females accounted for 37.2% of respondents. The majority of respondents (60.5%) held a bachelor's degree, followed by high school graduates (23.3%), master's degree holders (14%), and junior high school graduates (2.3%). This suggests that most respondents occupy strategic positions and possess relatively high educational backgrounds, enabling them to actively engage in management and decision-making within their organizations.

An online survey employing a structured electronic questionnaire (Google Form) was used to gather data for this study. Company representatives were contacted using contact details obtained from official websites and social media platforms. A five-point Likert scale was used to measure all variables, aiming to evaluate the relationships among predefined constructs. This study involves independent, dependent, mediating, and control variables. The measurement indicators were carefully refined to ensure reliable responses and minimize bias, with a detailed description provided in Table 1.

Table 1. Definition of variables

Variable Independent	**Indicator**
Corporate social responsibility (CSR) environmental concern reflects a company's strategic commitment and supports the achievement of sustainable performance. [15]	Engagement in environmental preservation efforts
	Allocates investments to benefit future generations
	Implements programs to minimize its negative impact on the natural environment
	Long-term sustainability orientation
	Contributes financially to charities
	Contributes to the well-being of society
	Commits to protecting consumers beyond the minimum legal standards
	Accessible and honest information
	Ensuring customer satisfaction is a top priority.
Variable Mediator	
Company's ability (CA): A company's ability to outperform other companies in the same industry or market. This is achieved by leveraging the company's unique characteristics and resources. [52], [53]–[55]	The resulting value
	Rareness
	Imperfectionally non-imitable
	Product differentiation
	R&D capabilities
	Managerial capabilities
Variable Dependent	
Green innovation (GI) stresses resource efficiency and aims to reduce adverse environmental effects by developing eco-friendly technology, processes, or products. [18], [30]	Recycled materials
	Product recycling
	Use of resources
	Green production system

Variable Independent	Indicator
Variable Control	
Environmental sustainable development (ESD) corporate efforts in managing natural resources responsibly reflect a commitment to environmental stewardship and sustainable development. [17]	Handled or stored toxic waste responsibly.
	Eco-friendly processes and products
	Mitigation of environmental impacts resulting from production processes
Sustainable performance (SP): The level of achievement or outcomes attained, considering economic, social, and environmental aspects in performance evaluation. [20], [28]	ROA
	Profit growth
	Sales growth
	Market share growth
	Improved relationship with the community and stakeholders
	Enhance the living quality of the local community
	Improved work safety
	Improved compliance with environmental standards
	Reducing the amount of hazardous chemicals generated
	Reduction of energy consumption

This study uses descriptive analysis to examine the characteristics of recycling businesses and the profiles of respondents. The collected data were analyzed using the SEM-PLS approach via SmartPLS software to evaluate and interpret the mediating role of the company's ability in the relationship between CSR and GI.

4. Results and discussion

Since SmartPLS is recommended for models with mediating factors, small sample sizes, and multi-component constructs, it is utilized for data analysis. Furthermore, SmartPLS provides validation tests, including discriminant validity and convergence tests that are not available in SPSS [56]. Table 2 displays the descriptive data. Since none of the values fall below the lower bound of 2, the skewness and kurtosis scores suggest that the data have a normal distribution [56].

Table 2. Descriptive statistics

Variable	Obs	Mean	Min	Max	Standard Deviation	Kurtosis	Skewness
CA	129	0.000	-2.142	1.250	1.000	-1.062	-0.250
CSR	129	0.000	-2.734	0.743	1.000	-0.008	-1.148
ESD	129	0.000	-3.198	0.728	1.000	1.862	-1.584
GI	129	0.000	-2.818	0.834	1.000	-0.031	-1.031
SP	129	0.000	-2.903	1.417	1.000	0.368	-0.607

Table 2 presents descriptive statistics for five variables, each with 129 observations. All variables are normalized (mean = 0, standard deviation = 1). Minimum values vary, such as ESD at -3.198 and SP at -2.903, while the highest maximum is found in SP (1.417). All variables show negative skewness, with the lowest in ESD (-1.584). ESD has the highest kurtosis (1.862), while CA has the lowest (-1.062).

The preliminary investigation with SmartPLS applied an algorithmic method to evaluate factor loadings, validity, and reliability, as depicted in Figure 4. All constructs in this investigation met the validity criteria stated by [56], as illustrated in Table 3. All measurement items demonstrated satisfactory factor loadings, with no notable cross-loadings detected. All constructs demonstrated discriminant and convergent validity values surpassing the specified standards, with discriminant validity exceeding 0.70 and convergent validity exceeding 0.50. Moreover, all constructs satisfied the established reliability criteria [56], exhibiting composite reliability ratings over 0.70. Table 3 summarizes the findings of the validity and reliability assessments for each construct.

Figure 4. Algorithm for Structural Model 1

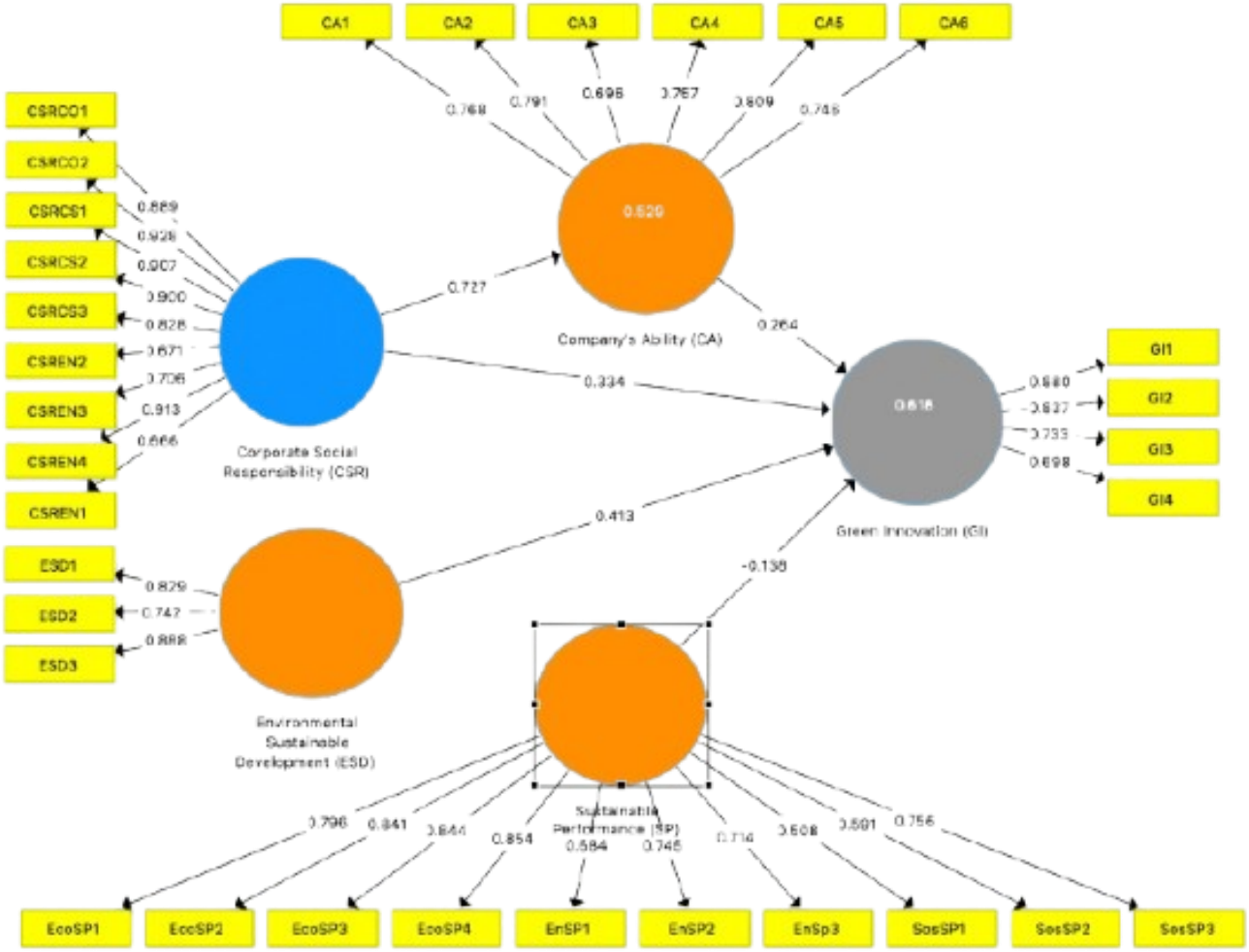

Table 3. Construct reliability and validity

Variable	Cronbach's Alpha	rho_A	Composite reliability	AVE
CA	0.861	0.879	0.893	0.583
CSR	0.942	0.954	0.951	0.688
ESD	0.766	0.821	0.861	0.676
GI	0.797	0.816	0.869	0.625
SP	0.907	0.934	0.923	0.549

According to Table 4, all variables have Cronbach's alpha values over 0.7, signifying strong dependability. The composite reliability ratings are elevated, ranging from 0.861 to 0.951, indicating that the internal consistency of the instruments is preserved. The AVE for all variables is above 0.5, except for sustainable performance (0.549), indicating adequate convergent validity. The rho_A values range from 0.816 to 0.954, further strengthening the construct reliability in this study.

Table 4. R-square

Variable	R-square	R-square adjusted
Company's Ability (CA)	0.529	0.525
Green Innovation (GI)	0.618	0.606

Table 4 shows the R-squared value for CA is 0.529 and for GI is 0.618. This means that 52.9% of the variability in CA and 61.8% in GI can be explained by the research model. The adjusted R-square values are 0.525 for CA and 0.606 for GI, indicating that the model has been adjusted for the number of predictors. These values suggest that the model has a good predictive power for both variables.

Table 5. F-square

Variable	CA	GI
Company's Ability (CA)		0.065
Corporate Social Responsibility (CSR)	1.121	0.105
Environmental Sustainable Development (ESD)		0.212
Sustainable Performance (SP)		0.016

Table 5 shows that CSR has the largest influence on CA, with a value of 1.121, while its effect on GI is 0.105. ESD has an effect of 0.212 on GI, and SP has a very small effect on GI, which is 0.016. Meanwhile, CA itself has an influence of 0.065 on GI. These data indicate that CSR is the main predictor of CA, while ESD is more dominant for GI.

Table 6. Construct cross-validated redundancy

Variable	Q^2
Company's Ability (CA)	0.275
Green Innovation (GI)	0.370

Table 6 shows that the Q^2 value for CA is 0.275 and for GI is 0.370. Q^2 values above 0 indicate that the model has good predictive relevance for these variables. Specifically, the value of 0.275 for CA and 0.370 for GI indicates that the model's predictive quality is in the moderate to strong category, suggesting that the model is suitable for predicting the variables in this study.

Table 7. Model fit

Fit Summary	Saturated Model	Estimated Model
SRMR	0.126	0.132
Chi-Square	3328.394	3363.380

Table 7 shows that the SRMR value for the saturated model is 0.126 and for the estimated model is 0.132. An SRMR value closer to 0 indicates a better model fit, although values above 0.1 can still be acceptable in some studies. The chi-square value is 3328.394 for the saturated model and 3363.380 for the estimated model, where a lower value indicates a better-fitting model. Overall, the model demonstrates an adequate fit.

Table 8. Fornell-Larcker criterion

Variable	CA	CSR	ESD	GI	SP
Company's Ability (CA)	0.764				
Corporate Social Responsibility (CSR)	0.727	0.830			
Environmental Sustainable Development (ESD)	0.603	0.674	0.822		
Green Innovation (GI)	0.651	0.704	0.705	0.791	
Sustainable Performance (SP)	0.766	0.731	0.672	0.587	0.741

Table 8 above presents the correlation values among variables: CA, CSR, ESD, GI, and SP. The highest correlation is between CA and SP at 0.766, indicating a strong relationship. The diagonal values, such as 0.764 (CA), 0.830 (CSR), 0.822 (ESD), 0.791 (GI), and 0.741 (SP), reflect the construct reliability of each variable.

Table 9. Heterotrait-monotrait ratio (HTMT)

Variable	CA	CSR	ESD	GI	SP
Company's Ability (CA)					
Corporate Social Responsibility (CSR)	0.765				
Environmental Sustainable Development (ESD)	0.671	0.744			
Green Innovation (GI)	0.734	0.782	0.859		
Sustainable Performance (SP)	0.834	0.761	0.736	0.623	

Table 9 shows the relationships among the main research variables: CA, CSR, ESD, GI, and SP. The highest correlation is between CA and SP at 0.834, indicating a very strong relationship. The correlation between GI and ESD is also high at 0.859. Meanwhile, CSR has a correlation of 0.765 with CA and 0.744 with ESD, indicating significant interconnections among these variables in supporting SP.

Bootstrapping in the second structural model is used to test the significance and stability of parameter estimates such as path coefficients, outer weights, and R^2 values. This technique involves repeatedly resampling the original data with replacement—typically thousands of times—to calculate confidence intervals and standard errors without assuming normal data distribution [57], [58]. The results of bootstrapping in the second structural model can be seen in Figure 5 and Table 10.

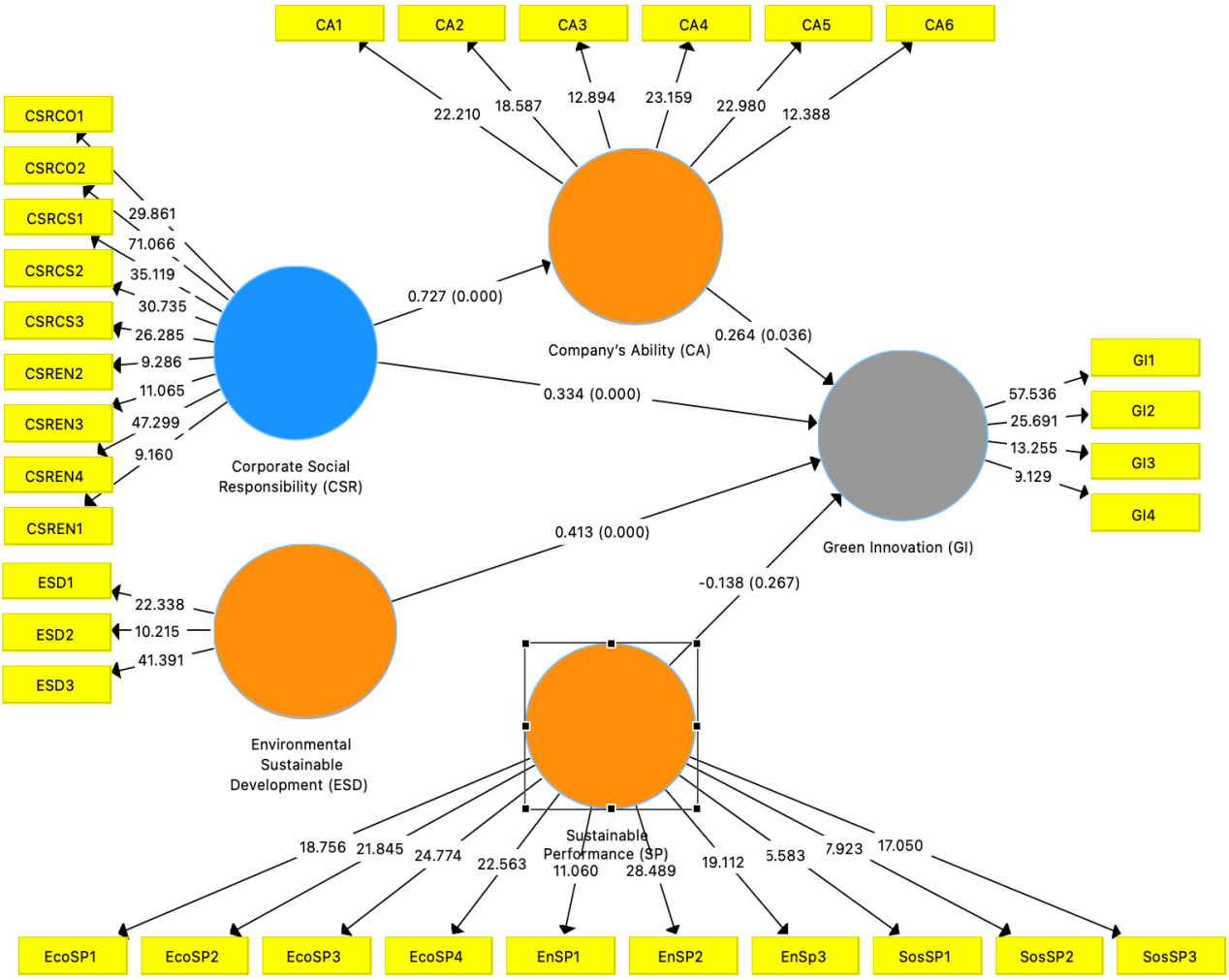

Figure 5. Bootstrapping in the second structural model

Table 10. Direct effects and indirect effects

Direct Effects	Original Sample	T Statistics	P Values	Information
H1_CSR -> CA	0.727	2.421	0.000***	Accepted
H2_CA -> GI	0.264	2.101	0.036**	Accepted
H3_CSR -> GI	0.334	3.642	0.000***	Accepted
Control Variable				
ESD -> GI	0.413	6.160	0.000***	Accepted
SP) -> GI	-0.138	1.111	0.267	Rejected
Indirect Effects				
H4_CSR ->CA -> GI	0.192	2.032	0.043**	Accepted

*Note: ***sig<0,01, **sig<0,05, *sig<0,1*

5. Structural model

This study employed 2,000 resamples and the bootstrapping technique provided by SmartPLS to examine the proposed relationships within the research model. Bootstrapping was chosen because it offers more accurate parameter significance estimates, particularly in path analysis with relatively small sample sizes [59]. This approach is also considered effective for identifying both direct and indirect effects within structural models. The findings support hypothesis H1 by showing that CSR significantly affects CA (coefficient = 0.727, p = 0.000***) (Figure 5 and Table 10). Furthermore, H2 is bolstered by the substantial positive influence of CA on GI (coefficient = 0.264, p = 0.036**). H3 is additionally corroborated by the significant positive impact of CSR on GI (coefficient = 0.334, p = 0.001***). ESD significantly influences GI, whereas SP, a control variable, exerts no significant effect on GI.

Hypothesis H4 is corroborated by the positive and statistically significant impact of CSR on GI (coefficient = 0.727, p = 0.000***). Furthermore, through the CA, CSR indirectly influences GI, as illustrated in Table 10 and Figure 5. Although the direct effect on GI is relatively smaller than the indirect effect, the indirect effect through the CA is significant (coefficient = 0.192, p = 0.043**). This signifies the existence of partial mediation in the association between GI and CSR. These findings underscore the significance of CA in advancing corporate sustainability. A comprehensive summary of these relationships is presented in Table 10.

6. Discussion

This study underscores the intricate challenges encountered by the recycling sector in attaining green innovation, especially within the Indonesian framework [60]. It also investigates the intermediary function of organizational capabilities in the correlation between corporate social responsibility and green innovation [60]. CSR initiatives—whether oriented toward customers, communities, or the environment—tend to have a more pronounced direct impact on green innovation. However, their influence on other CSR dimensions remains limited unless integrated with green innovation [60].

CSR is essential for optimizing the efficient and ethical use of corporate resources, particularly in driving the achievement of more optimal CSR outcomes [61], [62]. The implementation of CSR not only supports ecosystem preservation but also strengthens social relationships with surrounding communities [63], [62]. Furthermore, a company's capability to excel demonstrates a significant positive relationship with CSR implementation and directly contributes to improved green innovation [64], [65]. However, the mediating role of this capability remains limited, indicating that CSR implementation in supporting Green Innovation is still in its early stages [66], [67]. Therefore, better strategic alignment and increased investment are necessary to optimize the long-term benefits of CSR implementation [68], [69].

A company's capability is a vital strategic asset that profoundly influences all facets of GI and serves as an effective intermediary in the connection between GI and CSR [70]. This capability enables companies to

optimally leverage their resources and competencies, thereby creating sustainable added value that distinguishes them from competitors [70]. In the context of the recycling industry, companies that successfully integrate CSR with green process innovation are better positioned to maintain their company's ability [71]. Therefore, it is crucial for recycling companies to translate CSR into unique business strategies that are difficult for competitors to imitate [72], [49]. Strategies such as green innovation, process efficiency, and product differentiation can be key to overcoming market challenges while supporting the company's capability goals [73]. Thus, the company's Ability is not only a source of business strength but also a primary driver in achieving green innovation [70].

Overall, this study emphasizes that sustainability in the recycling industry is not solely driven by corporate social responsibility (CSR), but rather by an integrated approach combining CSR, company capabilities, and Green Innovation [74]. This sustainability also encompasses interconnected aspects of CSR, green innovation, and competitiveness [75], [76]. In the context of Indonesia, although some recycling companies show potential, many remain in the early stages and face economic disparities across regions [77], [78]. Therefore, future research should consider more mature industries and explore how regional disparities influence the adoption and sustainability of CSR practices [79], [80]. Further studies are also expected to identify factors influencing CSR implementation and to examine effective strategies to enhance competitiveness in markets increasingly oriented toward green innovation [81], [82].

7. Conclusions

According to this study, green innovation is significantly and positively influenced by CSR. Moreover, the connection between green innovation and corporate social responsibility is mediated by the company's capabilities. The research underscores that a company's ability is a vital strategic asset that enables firms to utilize their resources and capabilities to foster green innovation. To maintain competitiveness in a progressively dynamic market, recycling firms must adopt strategies that integrate green innovation, operational efficiency, and product differentiation.

This study advocates for future research to investigate the influence of digital technologies and the circular economy on improving sustainable performance. Additionally, further investigation is needed on how to adapt strategies effectively to address climate change and stricter environmental regulations. By doing so, companies can optimally contribute to sustainable development while simultaneously strengthening their competitive position.

The theoretical contribution of this mediation model resides in its elucidation of how corporate capabilities can enhance the relationship between CSR and green innovation, especially in the context of the global climate crisis. This model extends the understanding of stakeholder theory by identifying company capabilities as a significant mediating factor in the process of implementing CSR to drive environmentally friendly innovation. This study presents a novel viewpoint on the significance of cultivating internal organizational capabilities as essential for improving the efficacy of CSR strategies in advancing sustainable green innovation.

Declaration of competing interest

The author declares that this work is free from any conflicts of interest or competing interests.

Funding information

No funding was received from any financial organization to conduct this research.

Acknowledgements

The author expresses profound gratitude to the anonymous reviewers for their astute critiques and invaluable recommendations, which have substantially improved and polished this work.

Author contribution

EAS, NFA, R, UB, and HS collaboratively wrote the manuscript, conducted the study, and performed the editing. They developed the theoretical framework, formulated the study's premise, and supervised the entire research process. Additionally, they oversaw the study's progression and ensured methodological rigor. After a thorough review, EAS, NFA, R, UB, and HS made the necessary revisions and approved the final manuscript for submission.

References

[1] J. Elkington, "The triple bottom line," *Environ. Manag. Readings cases*, vol. 2, pp. 49–66, 1997.

[2] M. Pouresmaieli, M. Ataei, A. Nouri Qarahasanlou, and A. Barabadi, "Corporate social responsibility in complex systems based on sustainable development," *Resour. Policy*, vol. 90, Mar. 2024, https://doi.org/10.1016/j.resourpol.2024.104818

[3] Sabihaini, A. H. Pratomo, H. C. Rustamaji, and Sudaryatie, "Environmental factors affecting traditional fishermen in maintaining the resilience of marine areas in the context of Indonesian State Defense," *Humanit. Soc. Sci. Rev.*, vol. 6, no. 3, pp. 46–54, 2018, https://doi.org/10.18510/hssr.2018.637

[4] W. Long, S. Li, H. Wu, and X. Song, "Corporate social responsibility and financial performance: The roles of government intervention and market competition," *Corp. Soc. Responsib. Environ. Manag.*, vol. 27, no. 2, pp. 525–541, 2020, https://doi.org/10.1002/csr.1817

[5] Y. Hang, M. Sarfraz, R. Khalid, I. Ozturk, and J. Tariq, "Does corporate social responsibility and green product innovation boost organizational performance? a moderated mediation model of competitive advantage and green trust," *Econ. Res. Istraz.* , vol. 35, no. 1, pp. 5379–5399, 2022, https://doi.org/10.1080/1331677X.2022.2026243

[6] D. Zhang, Z. Rong, and Q. Ji, "Green innovation and firm performance: Evidence from listed companies in China," *Resour. Conserv. Recycl.*, vol. 144, pp. 48–55, May 2019, https://doi.org/10.1016/j.resconrec.2019.01.023

[7] N. A. Abu Seman *et al.*, "The mediating effect of green innovation on the relationship between green supply chain management and environmental performance," *J. Clean. Prod.*, vol. 229, pp. 115–127, Aug. 2019, https://doi.org/10.1016/j.jclepro.2019.03.211

[8] X. Wu *et al.*, "Exploring the dynamics of microbial community and metabolic function in food waste composting amended with traditional Chinese medicine residues," *J. Environ. Manage.*, vol. 319, p. 115765, 2022.

[9] R. E. Freeman, J. S. Harrison, A. C. Wicks, B. L. Parmar, and S. De Colle, "Stakeholder theory: The state of the art," 2010.

[10] A. K. Almasyhari, W. S. Rachmadani, and Y. P. Sari, "Strategic decision-making: Linking corporate choices, social responsibility, and environmental accounting in waste management," *Soc. Sci. Humanit. Open*, vol. 11, p. 101404, 2025.

[11] Y. Liu *et al.*, "Patterns of microbial communities and their relationships with water quality in a large-scale water transfer system," *J. Environ. Manage.*, vol. 319, p. 115678, 2022.

[12] W. Ahmed *et al.*, "Analyzing the impact of environmental collaboration among supply chain stakeholders on a firm's sustainable performance," *Oper. Manag. Res.*, vol. 13, pp. 4–21, 2020.

[13] D. Waluyo, "Ekonomi Sirkular Daur Ulang Sampah," *Portal Informasi Indonesia*, 2024.

[14] H. Gutama and F. M. Iresha, "Evaluation of solid waste management effectiveness in Indonesia from 2019-2021: a geographic information system analysis," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2023, p. 12067.

[15] C. Ma, M. F. Chishti, M. K. Durrani, R. Bashir, S. Safdar, and R. T. Hussain, "The Corporate Social

Responsibility and Its Impact on Financial Performance: A Case of Developing Countries," *Sustain.*, vol. 15, no. 4, Feb. 2023, https://doi.org/10.3390/su15043724

[16] M. Sarfraz, I. Ozturk, S. Yoo, M. A. Raza, and H. Han, "Toward a new understanding of environmental and financial performance through corporate social responsibility, green innovation, and sustainable development," *Humanit. Soc. Sci. Commun.*, vol. 10, no. 1, Dec. 2023, https://doi.org/10.1057/s41599-023-01799-4

[17] M. Shahzad, Y. Qu, S. A. Javed, A. U. Zafar, and S. U. Rehman, "Relation of environment sustainability to CSR and green innovation: A case of Pakistani manufacturing industry," *J. Clean. Prod.*, vol. 253, Apr. 2020, https://doi.org/10.1016/j.jclepro.2019.119938

[18] C. P. Padilla-Lozano and P. Collazzo, "Corporate social responsibility, green innovation and competitiveness – causality in manufacturing," *Compet. Rev.*, vol. 32, no. 7, pp. 21–39, Dec. 2022, https://doi.org/10.1108/CR-12-2020-0160

[19] M. Novitasari and D. Agustia, "Competitive advantage as a mediating effect in the impact of green innovation and firm performance," *Bus. Theory Pract.*, vol. 24, no. 1, pp. 216–226, Jan. 2023, https://doi.org/10.3846/btp.2023.15865

[20] Sabihaini, A. Kurniawan, J. Eko Prasetio, and Rusdiyanto, "Environmental analysis and impact on green business strategy and performance in SMEs post the Covid-19 pandemic," *Cogent Econ. Financ.*, vol. 12, no. 1, p. 2330428, Dec. 2024, https://doi.org/10.1080/23322039.2024.2330428

[21] W. Simmou, K. Govindan, I. Sameer, K. Hussainey, and S. Simmou, "Doing good to be green and live clean! - Linking corporate social responsibility strategy, green innovation, and environmental performance: Evidence from Maldivian and Moroccan small and medium-sized enterprises," *J. Clean. Prod.*, vol. 384, Jan. 2023, https://doi.org/10.1016/j.jclepro.2022.135265

[22] B. Yuan and X. Cao, "Do corporate social responsibility practices contribute to green innovation? The mediating role of green dynamic capability," *Technol. Soc.*, vol. 68, p. 101868, 2022.

[23] H. Xiao, A. Al Mamun, M. N. H. Reza, X. Lin, and Q. Yang, "Modeling the significance of corporate social responsibility on green capabilities and sustainability performance," *Heliyon*, vol. 10, no. 19, 2024.

[24] S. Y. Dwikat, D. Arshad, and M. N. Mohd Shariff, "Effect of Competent Human Capital, Strategic Flexibility and Turbulent Environment on Sustainable Performance of SMEs in Manufacturing Industries in Palestine," *Sustain.*, vol. 15, no. 6, 2023, https://doi.org/10.3390/su15064781

[25] M. Kanan *et al.*, "Green Innovation as a Mediator between Green Human Resource Management Practices and Sustainable Performance in Palestinian Manufacturing Industries," *Sustain.*, vol. 15, no. 2, 2023, https://doi.org/10.3390/su15021077

[26] S. A. R. Khan, A. A. Sheikh, and Z. Ahmad, "Developing the interconnection between green employee behavior, tax avoidance, green capability, and sustainable performance of SMEs through corporate social responsibility," *J. Clean. Prod.*, vol. 419, Sep. 2023, https://doi.org/10.1016/j.jclepro.2023.138236

[27] T. Tiep Le, H. Q. Ngo, and L. Aureliano-Silva, "Contribution of corporate social responsibility on SMEs' performance in an emerging market – the mediating roles of brand trust and brand loyalty," *Int. J. Emerg. Mark.*, vol. 18, no. 8, pp. 1868–1891, Aug. 2023, https://doi.org/10.1108/IJOEM-12-2020-1516

[28] I. A. Elshaer, A. M. S. Azazz, and S. Fayyad, "Green Management and Sustainable Performance of Small- and Medium-Sized Hospitality Businesses: Moderating the Role of an Employee's Pro-Environmental Behaviour," *Int. J. Environ. Res. Public Health*, vol. 20, no. 3, Feb. 2023, https://doi.org/10.3390/ijerph20032244

[29] WBCSD, "Corporate Social Responsibility:Meeting Changing Expectations," New York, 1999.

[30] S. K. Singh, M. Del Giudice, R. Chierici, and D. Graziano, "Green innovation and environmental performance: The role of green transformational leadership and green human resource management," *Technol. Forecast. Soc. Change*, vol. 150, Jan. 2020, https://doi.org/10.1016/j.techfore.2019.119762

[31] M. E. Porter, *Competitive advantage: Creating and sustaining superior performance*. simon and schuster, 2008.

[32] A. Dubsok, P. Khamdahsag, and S. Kittipongvises, "Life cycle environmental impact assessment of cyanate removal in mine tailings wastewater by nano-TiO2/FeCl3 photocatalysis," *J. Clean. Prod.*, vol. 366, p. 132928, 2022.

[33] F. M. Hamdi *et al.*, "Hybrid and enhanced electrokinetic system for soil remediation from heavy metals and organic matter," *J. Environ. Sci.*, vol. 147, pp. 424–450, 2025.

[34] C. Zhou, W. Xia, T. Feng, J. Jiang, and Q. He, "How environmental orientation influences firm performance: The missing link of green supply chain integration," *Sustain. Dev.*, vol. 28, no. 4, pp. 685–696, 2020.

[35] M. A. Covaci and L. A. Szolga, "Low-Voltage Plasma Generator Based on Standing Wave Voltage Magnification," *Sustainability*, vol. 14, no. 5, p. 2890, 2022.

[36] H. Goworek, L. Oxborrow, S. Claxton, A. McLaren, T. Cooper, and H. Hill, "Managing sustainability in the fashion business: Challenges in product development for clothing longevity in the UK," *J. Bus. Res.*, vol. 117, pp. 629–641, 2020.

[37] W. Wang, D. Zhang, H. Wang, Q. Zhu, and H. Morabbi Heravi, "How do businesses achieve sustainable success and gain a competitive advantage in the green era?," *Kybernetes*, vol. 52, no. 9, pp. 3241–3260, 2023.

[38] G. M. Silva, P. J. Gomes, H. Carvalho, and V. Geraldes, "Sustainable development in small and medium enterprises: The role of entrepreneurial orientation in supply chain management," *Bus. Strateg. Environ.*, vol. 30, no. 8, pp. 3804–3820, 2021.

[39] C. Cao, X. Tong, Y. Chen, and Y. Zhang, "How top management's environmental awareness affect corporate green competitive advantage: evidence from China," *Kybernetes*, vol. 51, no. 3, pp. 1250–1279, 2022.

[40] S. Galletta and S. Mazzù, "ESG controversies and bank risk taking," *Bus. Strateg. Environ.*, vol. 32, no. 1, pp. 274–288, 2023.

[41] N. Xin and Z. Xie, "Financial inclusion and trade adjusted carbon emissions: Evaluating the role of environment related taxes employing non-parametric panel methods," *Sustain. Dev.*, vol. 31, no. 1, pp. 78–90, 2023.

[42] R. Regmi, Z. Zhang, and H. Zhang, "Entrepreneurship strategy, natural resources management and sustainable performance: A study of an emerging market," *Resour. Policy*, vol. 86, p. 104202, 2023.

[43] M. Saunila, M. Nasiri, J. Ukko, and T. Rantala, "Smart technologies and corporate sustainability: The mediation effect of corporate sustainability strategy," *Comput. Ind.*, vol. 108, pp. 178–185, 2019.

[44] V. Çağlıyan, M. Attar, and A. Abdul-Kareem, "Assessing the mediating effect of sustainable competitive advantage on the relationship between organisational innovativeness and firm performance," *Compet. Rev. An Int. Bus. J.*, vol. 32, no. 4, pp. 618–639, 2022.

[45] D. Asante-Darko and V. Osei, "Sustainable supply chain management practices and firm performance: the mediating effect of firm capabilities," *Manag. Environ. Qual. An Int. J.*, vol. 35, no. 4, pp. 751–779, 2024.

[46] M. AlKhars, M. Masoud, A. AlNasser, and M. Alsubaie, "Sustainable practices and firm competitiveness: An empirical analysis of the Saudi Arabian energy sector," *Discov. Sustain.*, vol. 5, no. 1, p. 146, 2024.

[47] S. Lee and H. Jung, "The effects of corporate social responsibility on profitability: The moderating roles of differentiation and outside investment," *Manag. Decis.*, vol. 54, no. 6, pp. 1383–1406, 2016.

[48] N. Barforoush, A. Etebarian, A. Naghsh, and A. Shahin, "Green innovation a strategic resource to attain competitive advantage," *Int. J. Innov. Sci.*, vol. 13, no. 5, pp. 645–663, 2021.

[49] R. Ullah, H. Ahmad, S. Rizwan, and M. S. Khattak, "Financial resource and green business strategy: the mediating role of competitive business strategy," *J. Sustain. Financ. Invest.*, vol. 14, no. 2, pp. 410–429, 2024.

[50] T. M. Jones, J. S. Harrison, and W. Felps, "How applying instrumental stakeholder theory can provide sustainable competitive advantage," *Acad. Manag. Rev.*, vol. 43, no. 3, pp. 371–391, 2018.

[51] M. C. G. Prayudhia, "Bappenas sebut industri daur ulang miliki potensi ekonomi yang besar," 2024.

[52] M. E. Porter and C. Strategy, "Techniques for analyzing industries and competitors," *Compet. Strateg. New York Free*, vol. 1, 1980.

[53] L. Qiu, X. Jie, Y. Wang, and M. Zhao, "Green product innovation, green dynamic capability, and competitive advantage: Evidence from Chinese manufacturing enterprises," *Corp. Soc. Responsib. Environ. Manag.*, vol. 27, no. 1, pp. 146–165, Jan. 2020, https://doi.org/10.1002/csr.1780

[54] M. Shehadeh, A. Almohtaseb, J. Aldehayyat, and I. A. Abu-AlSondos, "Digital Transformation and Competitive Advantage in the Service Sector: A Moderated-Mediation Model," *Sustain.*, vol. 15, no. 3, Feb. 2023, https://doi.org/10.3390/su15032077

[55] Sabihaini, "COMPETITIVE STRATEGY AND BUSINESS ENVIRONMENT ON SMEs PERFORMANCE IN YOGYAKARTA, INDONESIA," *Int. J. Manag.*, vol. 11, no. 8, pp. 1370–1378, 2020, https://doi.org/10.34218/IJM.11.8.2020.125

[56] N. Laily, N. F. Asyik, D. U. Wahyuni, J. Sari, and R. Rusdiyanto, "The role of Green Business Strategy in mediating the relationship between environmental orientation and SMEs," *South. African J. Entrep. Small Bus. Manag.*, vol. 17, no. 1, p. 13, 2025.

[57] J. F. Hair, *A primer on partial least squares structural equation modeling (PLS-SEM)*. sage, 2022.

[58] C. M. Ringle, S. Wende, and J.-M. Becker, "SmartPLS 3. Bönningstedt: SmartPLS," 2015.

[59] M. Sarstedt, C. M. Ringle, and J. F. Hair, "Partial least squares structural equation modeling," in *Handbook of market research*, Springer, 2021, pp. 587–632.

[60] T.-D. Bui, H. Aminah, C.-H. Wang, M.-L. Tseng, M. Iranmanesh, and M. K. Lim, "Developing a food and beverage corporate sustainability performance structure in Indonesia: Enhancing the leadership role and tenet value from an ethical perspective," *Sustainability*, vol. 14, no. 6, p. 3658, 2022.

[61] N. R. Putra *et al.*, "Advancements and challenges in green extraction techniques for Indonesian natural products: A review," *South African J. Chem. Eng.*, vol. 46, no. 1, pp. 88–98, 2023.

[62] J. Hobeika, I. Khelladi, and M. A. Orhan, "Analyzing the corporate social responsibility perception from customer relationship quality perspective. An application to the retail banking sector," *Corp. Soc. Responsib. Environ. Manag.*, vol. 29, no. 6, pp. 2053–2064, 2022.

[63] N. Lestari and S. Suyanto, "A systematic literature review about local wisdom and sustainability: Contribution and recommendation to science education," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 20, no. 2, p. em2394, 2024.

[64] S. Ma, X. Cui, X. Xiao, and X. Zhao, "The impact of photo verification service on sales performance in the peer-to-peer economy: Moderating role of customer uncertainty," *J. Bus. Res.*, vol. 142, pp. 45–55, 2022.

[65] T. Bassetti, S. Blasi, and S. R. Sedita, "The management of sustainable development: A longitudinal analysis of the effects of environmental performance on economic performance," *Bus. Strateg. Environ.*, vol. 30, no. 1, pp. 21–37, 2021.

[66] B. Peng, "Navigating green horizons: An empirical exploration of business practices aligned with environmental goals in the era of sustainable economy," *Manag. Decis. Econ.*, vol. 45, no. 7, pp. 4732–4752, 2024.

[67] A. Thomas, G. Scandurra, and A. Carfora, "Adoption of green innovations by SMEs: An investigation

about the influence of stakeholders," *Eur. J. Innov. Manag.*, vol. 25, no. 6, pp. 44–63, 2022.

[68] H. M. Nguyen, G. Onofrei, D. Truong, and S. Lockrey, "Customer green orientation and process innovation alignment: A configuration approach in the global manufacturing industry," *Bus. Strateg. Environ.*, vol. 29, no. 6, pp. 2498–2513, 2020.

[69] H. Shao, X. Huang, and H. Wen, "Foreign direct investment, development strategy, and green innovation," *Energy Environ.*, vol. 35, no. 6, pp. 3116–3143, 2024.

[70] N. Ameen, S. Papagiannidis, A. R. S. Hosany, and E. Gentina, "It's part of the 'new normal': Does a global pandemic change employees' perception of teleworking?," *J. Bus. Res.*, vol. 164, p. 113956, 2023.

[71] L. Xu *et al.*, "Sonocatalytic degradation of tetracycline by BiOBr/FeWO4 nanomaterials and enhancement of sonocatalytic effect," *J. Clean. Prod.*, vol. 394, p. 136275, 2023.

[72] C. Mukonza and I. Swarts, "The influence of green marketing strategies on business performance and corporate image in the retail sector," *Bus. Strateg. Environ.*, vol. 29, no. 3, pp. 838–845, 2020.

[73] N. Saqib and M. S. Satar, "Exploring business model innovation for competitive advantage: a lesson from an emerging market," *Int. J. Innov. Sci.*, vol. 13, no. 4, pp. 477–491, 2021.

[74] A. Waheed and Q. Zhang, "Effect of CSR and ethical practices on sustainable competitive performance: A case of emerging markets from stakeholder theory perspective," *J. Bus. Ethics*, vol. 175, no. 4, pp. 837–855, 2022.

[75] M. Dionisio and F. Paula, "A systematic review on the interconnectedness of eco-innovations and digital transformation," *Environ. Qual. Manag.*, vol. 34, no. 1, p. e22212, 2024.

[76] R. R. Jacomossi, P. R. Feldmann, A. Barrichello, and R. S. Morano, "Does ecological sustainability really matter? Evaluation of its mediating role in the relationship between innovation and competitiveness," *BAR-Brazilian Adm. Rev.*, vol. 18, p. e200126, 2021.

[77] W. Wulansari and D. Adhariani, "Corporate waste disclosure, risk-taking and foreign ownership: Evidence from Indonesia," *Bus. Strateg. Dev.*, vol. 6, no. 2, pp. 205–225, 2023.

[78] M. Herrador and M. L. Van, "Circular economy strategies in the ASEAN region: A comparative study," *Sci. Total Environ.*, vol. 908, p. 168280, 2024.

[79] I. Hristov, A. Appolloni, W. Cheng, and M. Venditti, "Enhancing the strategic alignment between environmental drivers of sustainability and the performance management system in Italian manufacturing firms," *Int. J. Product. Perform. Manag.*, vol. 72, no. 10, pp. 2949–2976, 2023.

[80] T. A. Kurniawan *et al.*, "Unlocking synergies between waste management and climate change mitigation to accelerate decarbonization through circular-economy digitalization in Indonesia," *Sustain. Prod. Consum.*, vol. 46, pp. 522–542, 2024.

[81] M. J. Bataineh, P. Sánchez-Sellero, and F. Ayad, "Green is the new black: How research and development and green innovation provide businesses a competitive edge," *Bus. Strateg. Environ.*, vol. 33, no. 2, pp. 1004–1023, 2024.

[82] K. Pitkänen *et al.*, "How to measure the social sustainability of the circular economy? Developing and piloting social circular economy indicators in Finland," *J. Clean. Prod.*, vol. 392, p. 136238, 2023.