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When Sustainability Meets Emissions: Factors Shaping ESG Performance in Indonesian Manufacturing Firms

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Abstract

Main Purpose - This study investigates the effects of R&D expenditure, green innovation, and Corporate Social Responsibility on Environmental, Social, and Governance (ESG) performance, while examining the moderating role of carbon emissions in Indonesian manufacturing firms.

Method - A quantitative explanatory approach was employed using panel data from 23 manufacturing firms listed on the Indonesia Stock Exchange during 2019–2023, selected through purposive sampling. Data were analyzed using panel regression and moderated regression analysis with STATA.

Main Findings - The results indicate that ESG performance is strengthened by integrated strategies combining innovation, CSR, and emissions management. Carbon emissions significantly moderate the relationship between innovation variables and ESG outcomes.

Theory and Practical Implications - The findings support stakeholder and sustainability theories by highlighting the importance of aligning environmental innovation and emission control with ESG frameworks. Policymakers and industry leaders should promote regulations that encourage green R&D and responsible emission management to enhance long-term competitiveness.

Novelty - This study positions ESG performance as the dependent variable and introduces carbon emissions as a moderating factor, providing new empirical evidence from an emerging market context.

Keywords: ESG Performance, Green Innovation, Corporate Social Responsibility, Carbon Emissions, Manufacturing Companies.

Abstrak

***Tujuan Utama** - Penelitian ini menganalisis pengaruh R&D, inovasi hijau, dan Corporate Social Responsibility (CSR) terhadap kinerja Environmental, Social, and Governance (ESG), serta menguji peran moderasi emisi karbon pada perusahaan manufaktur di Indonesia.*

***Metode** - Pendekatan kuantitatif eksplanatori digunakan dengan data panel 23 perusahaan manufaktur yang terdaftar di Bursa Efek Indonesia periode 2019–2023. Sampel dipilih secara purposive. Analisis dilakukan menggunakan regresi data panel dan moderated regression analysis dengan STATA.*

***Temuan Utama** - Kinerja ESG dipengaruhi oleh strategi terintegrasi yang mengombinasikan inovasi, CSR, dan pengelolaan emisi. Emisi karbon terbukti memoderasi hubungan antara inovasi dan kinerja ESG.*

***Implikasi Teori dan Kebijakan** - Hasil penelitian mendukung teori keberlanjutan dan stakeholder, serta menegaskan pentingnya integrasi inovasi lingkungan dan pengendalian emisi dalam kerangka ESG. Regulasi perlu mendorong penerapan R&D hijau dan manajemen emisi.*

***Kebaruan Penelitian** - Penelitian ini menempatkan ESG sebagai variabel dependen dan memperkenalkan emisi karbon sebagai variabel moderasi dalam konteks Indonesia.*

***Kata Kunci:** Kinerja ESG, Inovasi Hijau, Tanggung Jawab Sosial Perusahaan, Emisi Karbon, Perusahaan Manufaktur*

INTRODUCTION

The integration of ESG has become a global necessity in insuring the legitimacy of business operations and ensuring long-term value creation, especially for carbon-intensive industries such as manufacturing. The take up of ESG has accelerated rapidly around the world thanks to investor pressure, international climate treaties and ESG metrics incorporated into capital markets. But when it comes to applying ESG, a new study shows global progress is mixed. For example, in industries where carbon emissions are high (Martiny et al., 2024), firms are paying more attention to governance openness and social disclosure than the act of making a real difference on environment. This discrepancy shows just how much simpler it is to meet the standards that define governance and social reporting than it is to reduce emissions, or to innovate with new green technologies — both of which are more expensive and complex.

This gap is even wider in Asia. While some developed economies in Asia have been stepping up ESG rules and environmental laws, in many emerging Asian economies, much of the ESG standards have so far been centered around compliance and transparency. The Asian manufacturing stand: Studies have exposed that organisations in Asian manufacture industry are more successful at CSR practices and governance structure suggests there is a transparency gap between stakeholder perception concerning environmental performance, in particular carbon emission reduction such as poor regulatory enforcement; 'business-as-usual' attitudes towards the environment; lack of incentives to support green innovation.(A. Ramadhan & Widiastuty, 2023; Xie et al., 2024). As a result, ESG ratings in the sector are frequently more about social license and less about impact.

This is particularly the case in Indonesia where ESG adoption patterns have not yet matured. Even as regulation has driven data disclosure about sustainability, the ranking of ESG implementation often puts social and governance issues like community development and company transparency — ahead of actual progress on environmental problems such as controlling emissions. D) Manufacturing companies tend to be one of the biggest contributors to carbon emissions, but they typically only perform small or symbolic gestures to reduce their negative environmental impacts that don't improve their environmental ESG ratings. Therefore, there is a large gap between ESG disclosure and the actual environmental performance. This suggests that we must consider the primary determinants of total ESG performance in the manufacturing sector of Indonesia. This multi-level global–regional–national dynamics provides strong evidence for explaining the ESG variables in an emerging-market context marked by major but poorly managed environmental problems.

Previous studies have largely considered ESG as an antecedent of financial performance. While R&D and green innovation are expected to enhance ESG performance, the results were mixed based on empirical evidence in emerging markets like Indonesia which highlights regulatory and institutional barriers. CSR on the other hand has a stronger, consistent and positive association with ESG performance, as CSR activities are directly related to social and governance components from ESG evaluation perspective. CSRs such as community development programs, employee welfare, ethical business practices and transparent governance policies are more visible and readily captured by the ESG rating agencies, thus having a greater immediate and measurable influence on the ESG scores than long-term environmental innovation effects. There is also consistent evidence from emerging economies that firms with greater CSR involvement have better ESG activities as being engaged in CSR can improve corporate legitimacy and stakeholder relationships (Cuandra & Lie, 2023; Lew et al., 2024).

Under the Indonesian's environment, CSR is heavily act as a determining factor in influencing ESG performance such that regulatory aspiration and stakeholder pressure are focusing more on social responsibility and governance adherence rather than genuine environmental leverage (Maria Kristari & Yusram Teruna, 2023). Furthermore, Darsono et al., (2024)show that CSR disclosure is a crucial channel through which firms enhance ESG ratings, when there is only modest environmental

performance enhancements. Our results show that CSR is a more institutionalized and stable driver of ESG performance, structurally grounded between firms, when compared with the weak nature of environmental regulation and innovative incentives in developing countries. Of note, the effect of carbon emissions on this contextual moderating variance in the associations is underread and unclear (Maria Kristari & Yusram Teruna, 2023; Xie et al., 2024).

Nonetheless, research in emerging economies continues to generate conflicting results as to the relationship between ESG performance and carbon emissions. Nor can we say with any certainty whether there is an overall positive correlation between ESG performance, carbon emissions or sustainability at large. For instance, a new panel-data analysis of 55 countries shows that corporate greenhouse gas emissions have widely different impacts on economic returns depending on industry and level of national development. In the context of developing countries, high-emission industries often find it difficult to reduce GHG emissions and corporate performance is influenced by them instead. It is suggested that not all increased environmental performance brings an economically advantageous result for enterprises in such areas.

More significantly, ESG studies in emerging markets have found that in certain institutions or under certain circumstances comprehensive ESG disclosures might be associated with more rather than fewer carbon emissions. This is quite the reverse of using ESG reports to improve company performance; it is in fact "carbon-washing." On the other hand, a Southeast Asian study indicates that ESG ratings might have a beneficial impact on a company's economic success-especially for companies with less intensive carbon emissions. But the breakdown of environmental impacts on ESG outcomes will provide varying degrees of results. These findings from diffuse emerging markets reveal the diversity and complexity of ESG dynamics beyond developed countries and indicate a need to examine conditional mechanisms such as environmental pressure (e.g., carbon emissions) in analyzing how sustainability drivers influence ESG performance.

In countries like Indonesia, future research shows that although investment in reveasearch and development (R&D) as well as green innovation must necessarily lead to a heightened level of ESG performance, poor regulatory enforcement, inadequate green incentives, and also difficulties in rating environmental (as opposed to social) impact make such results so far largely inconclusive (A. Ramadhan & Widiastuty, 2023; M. A. Ramadhan et al., 2023). In contrast, Corporate Social Responsibility consistently shows a marked advantageous relationship with ESG performance as CSR practices have become more widespread, more noticeable and more in line with stakeholder demands. In addition, Corporate Social Responsibility has a stronger positive relationship with ESG performance, as it not only conforms to social norms but may also provoke wider sustainability practices like green technological innovation (Haryanto et al., 2025).

This was based upon both theoretical reasoning and practical importance among Indonesia's developing country institutions: if carbon emissions had not been viewed as a moderating variable, then some managers and enterprises might have assumed its a generated variable from within their organization which they can eat away at later. As a result, emissions whether up or down alter for the better or worse context sustainability drivers such as R&D investment, green innovation and CSR are seen, assessed and turned into ESG performance. Rather than being an instantaneous reason that these drivers emerge If carbon emissions were not included as a moderator, then the study of necessity would assume that the impacts of R&D, green innovation and CSR on ESG performance are the same for every company, no matter how much pollution it causes In ESG research this kind of simplification is particularly harmful Or stepping up from a thousand wakes of pollution and you see is not just land but residential estates cancel your environmental off-site inputs In other words, from an ESG perspective (and legal viewpoint) companies which have a higher level of emissions will inevitably find it harder to demonstrate their legitimacy and suffer more third-party criticism.

This could mean sustainability investments getting better returns from improved ESG performance, or the reverse. Therefore moderation is needed to capture this conditionality or else it would be obscured in a model where only the direct effects take place. Carbon emissions are always conceptually inadequate, mediating variable in this research environment. Mediation means a causal chain, the sustainability drivers bring about emissions changes, and these in turn greatly affect ESG performance. This kind of strategy is fine in places with many rules and high carbon prices. But in developing countries like Indonesia, it just doesn't go well, and emissions have not yet been linked to innovation or CSR. Equally in practice, many businesses do CSR or green innovation to look good or comply with the rules, but they still won't reduce emissions either because technology limits it, no one is enforcing, or else just for the appearance that only extends as far as it is being done.

In addition, putting carbon emissions between the two would create a low-institution reality with not much chance for sustainability measures True to form, whatever sustainability measures there are would then seem much more successful at cutting emissions than they really are. From another angle, using carbon emissions as a moderator allows us to ask does environmental pressure influence sustainability methods or not, for I am not presupposing that these strategies are always correspondingly effective yet force the company to shut down when operating costs become too high.This approach is in keeping with current ESG research in developing countries, for example studies that show company emissions often do not result from corporate sustainability measures themselves but rather serve as environmental pressures (Maria Kristari & Yusram Teruna, 2023).

Inversely, this research uses a moderator method to provide innovative empirical insights as to why sustainability drivers in fact sometimes do not increase ESG performance, especially in areas where the coordination of carbon legislation is not yet in place and ESG framework is still taking shape. This research has three solid exports. The first is that it takes ESG performance as the dependent variable, a departure from research that looks at its consequences instead and fills a gap left by Martinegro et al. in 2022.Reasonably, carbon emission is theoretically valid as a moderating variable because it appears as a verifier of the environmental pressures on enterprises and can be measured directly. This seems especially true in pollution-intensive industries like construction. For example according to Legitimacy and Piaget Theory, companies that produce more carbon will have more attention paid to them from investors, the regulators and society.

This in turn makes it more important for their strategy to focus on sustainability. Therefore, R & D, green innovation, and investments in CSR are likely to provide superior ESG performances. For they are all systemic advances and expressive of environmental concern and legitimacy rebuilding. In summary, carbon emissions affects not only ESG performance per se but also issues of how sustainability drivers are identified in ESG. This is what makes emissions more than just a simple cause, but rather an effective moderator. In an Indonesian perspective, it would be highly correspondent but empirically not deeply explored." Indonesia is still behind in ESG adoption, but the carbon emissions disclosure has increased with so many regulation including OJK Regulation No. 51/POJK. 03/2017 and the progressive convergence towards international sustainability standards.

But emission disclosures are spotty and mostly voluntary, with the vast bulk of them coming from larger, higher-profile industrial concerns. Such partial and selective disclosure effects lead to very dramatic differences in emission intensity levels across firms, which are important for moderation analysis. Weak carbon pricing and compliance mechanisms CO/CO pressure may or might not be enough. trigger strategic behaviour. This makes Indonesia an excellent setting for testing empirically whether carbon emissions strengthen or weaken the relationship between sustainability efforts and ESG performance. As such, by theorizing carbon emissions as a conditioning variable the study can make explicit an intermediate perspective on the conditional effect of environmental pressure in emerging-market ESG considerations—a significant void in previous research where pollution is often assumed away as something to be controlled but not leveraged or even used to predict variance.

Industry is an important part to study in ESG, it requires quite a lot of resource and has quite an impact on the environment versus other industries. Manufacturing and part of the industrial processes overall are one of the biggest sources of greenhouse gas emissions (GHG), and therefore there is a large energy consumption around the world. This means that we must take a closer look at green performance, green innovation and sustainable behavior. For example, the manufacturing sector accounts for nearly 22% of global direct greenhouse gas emissions. This figure goes to nearly 31% once indirect emissions from power consumption is included. And manufacturing's greenhouse gas emissions in Indonesia, for instance, reached some 154.3 million tCO_2e in 2023 or about 34% of the country's industrial emissions.

That number could swell dramatically if nothing is done. These environmental challenges mean the industry is a good place to examine ESG factors, as environmental standards are typically the hardest part of ESG performance to meet in an industrial setting. Manufacturers are also dealing with weighty environmental issues, from cutting emissions and recycling waste to adding transparency along the supply chain. They also have to address social issues such as workplace safety and fair labor standards. Emphasising the manufacturer has implications for both the context of ESG research and its policy messages: performance improvements at manufacturers may have big environmental impacts but also spillover to industry-wide norms.

Manufacturers are also under more pressure from regulators and shareholders to demonstrate their environmental bona fides, face imperatives for coming up with ideas that work in the green sector and are obligated to be transparent about how they conduct business. It's a good example of how ESG practices are unearthed and adopted — particularly in emerging markets like Indonesia, where embracing ESG is in an early state. This study aims to analyze the influences of R&D, eco-friendly innovation and CSR on ESG perfomance by moderating role of carbon emission on these relationships in manufacturing companies listed in IDX. The findings will contribute to the ESG literature but also provide practical recommendations for improving sustainability management in comparable institutional settings.

LITERATURE REVIEW

Stakeholder Theory

This is a core tenet of Stakeholder Theory, which proposes that the long-term viability and continuing success of an organization hinges on its skill to manage relationships with different stakeholders such as shareholders, employees, customers, suppliers, regulators and community at large, as well as natural environment —as distinct from concentrating solely on the maximization of shareholder wealth (Freeman & McVea, 2005). The theory places an imperativeness on the fact that, organizations must conform their strategic initiatives to stakeholders' expectations in order to guarantee their legitimacy, trust and organizational effectiveness. From the viewpoint of Environmental, Social and Governance (ESG), Stakeholder Theory is a sound basis for explaining why companies focus on sustainability.

The ESG performance measures the degree to which firms assume the stakeholder expectations concerning ethical behavior, environmental concern, social responsibility and transparent governance (Wang, 2024). Such a shift has been proposed to be motivated by stakeholders´ intention to assess firms not only in terms of their financial performance but also the way they handle social and environmental externalities, particularly when those are situated in pollution-sensitive industry contexts (Martiny et al., 2024). Firms in manufacturing (particularly of carbon-heavy products) attract very close attention from regulators, investors and civil society owing to the heavy environmental and social influence that they exert.

In the case of emerging markets like Indonesia, stakeholder pressure on EMA (environmental degradation and emission of carbons), as well as social responsibility has been increasing albeit not consistent in its execution (Maria Kristari & Yusram Teruna, 2023). Hence, firms are forced to pursue sustainability-focused tactics to ensure their social legitimacy and access to important stakeholder resources. Organisational responses The firm level strategies such as R&D investment, green innovation and CSR are the organisational responses to these pressures from stakeholders. R&D as well as green innovation would be relied to solve environmental problems by means of decreasing resources using and exhausting emissions, and CSR programs assist companies in developing social legitimacy and governance credibility (Haryanto et al., 2025).

The literature suggests that such practices are frequently used not just for efficiency but to signal environmental/societal responsibility in line with stakeholders' expectations expressed in ESG schemes (Cuandra & Lie, 2023). Stakeholder Theory thus elucidates the mechanisms through which and why firms adopt sustainability related practices as part of their business strategy, with effects on ESG performance. This theory is employed in this study to provide rationale for the choice of R&D investment, green innovation and CSR as CODs of ESG performance and elaborate on stakeholder pressure in influencing corporate sustainability behavior within Indonesian manufacturing context.

Hypotheses Development

Relationship Between R&D Investment and ESG Performance

R&D investment constitutes a strategic commitment to innovative capability and future competitiveness. As per the stakeholder theory, organizations must respond to changing expectations of stakeholders which involve environmental compliance and sustainable ways of producing goods (Freeman & McVea, 2005). R&D provides firms with opportunities to create environmentally friendly technologies, decrease resource usage and ensure product safety—factors that directly relate to ESG aspects.

Yet in emerging markets, the effect of R&D on improving ESG performance is contingent. In some of Indonesian firms, due to the weak regulatory enforcement and insufficient incentive for green innovation in Indonesia, these may lead the sustainable deviated on Corporate R&D activities (A. Ramadhan & Widiastuty, 2023). Nonetheless, companies with a higher level of R&D intensity are still better at creating eco-innovation and enhancing governance disclosure for innovation processes (Ding et al., 2024). Hence, R&D expenditure is likely to promote ESG performance by increasing environmental capacity and indicating long-term commitment towards sustainability.

H1: Investment in R&D positively influences ESG performance.

Relationship Between Green Innovation and ESG Performance

Environmental innovation means developing products, processes, and technologies that are environmentally friendly and cost-effective as well as help to reduce the amount of waste produced and the consumption of resources. The Natural Resource-Based View indicates that environmental capabilities can serve as a source of competitive and sustainability advantages. There is evidence from developing countries with mixed results. The more green innovation affects ESG performance in a positive way, the higher is that influence (the moderation effect) but it also depends on the level of disclosure and institutional support. Firms producing in Indonesia are expected using green technology to cut down the carbon intensity and attain a better environmental rating. Green innovation also has positive spillover in governance and social dimension, since it contributes to transparency, systems of the compliance and reputation corporate (Haryanto et al., 2025).

H2: Green innovation affect ESG performance is positive.

Relationship Corporate Social Responsibility and ESG Performance

Corporate Social Responsibility is the reflection of corporate ethical behaviours, community development and social responsible governance. CSR activities are the ones that directly penetrate into social and governance aspects of ESG. Empirical evidence from the Indonesian context has consistently revealed that CSR disclosure makes a significant contribution to ESG ratings (Cuandra & Lie, 2023; Maria Kristari & Yusram Teruna, 2023). CSR projects are more public, formalized and conformed to stakeholder expectations than long-term environmental innovation projects. ESG rating agencies also have strong dependence on public disclosure of social and governance indicators, therefore, CSR is a quantifiable and institutionally enforced ESG performance driver (Darsono et al., 2024). Therefore, CSR acts as a key tool for firms to increase their legitimacy and stakeholder trust in emerging markets.

H3: There is a positive relationship between Corporate Social Responsibility and ESG performance.

Relationship between R&D Investment and ESG Performance with Carbon Emissions as a Moderator

Concerns regarding carbon emissions that poses environmental pressure and legitimacy risk are more serious, especially for pollution-intensive sectors like manufacturing. Companies with higher emissions receive greater attention from regulators, investors and society, which could affect how they evaluate sustainability investments (Xie et al., 2024). High polluting firms feel more intense pressure on investment in R&D and are more likely to spend resources on the development of low carbon technology. R&D does more to enhance ESG performance in such a scenario, as it specifically targets environmental risks and legitimacy concerns. In low-emission firms, R&D might be less strategically associated to environmental performance.

H4: Carbon emissions act as a moderator of the association between R&D investment and ESG performance.

Relationship between Green Innovation and ESG Performance with Carbon Emissions as a Moderator

Green technology in high-polluting firms has stronger signaling effects, because it refers to the fundamental environmental risks. Signaling theory would suggest that sustainability programs are more credible when they directly address material environmental issues. Nevertheless, in developing nations where emission levels are high, a functional-centric view becomes questionable which can result in challenging the credibility of ESG where improvements on environmental aspect is low; thus despiteable to weaken the phenomenon of carbon washing (Maria Kristari & Yusram Teruna, 2023).

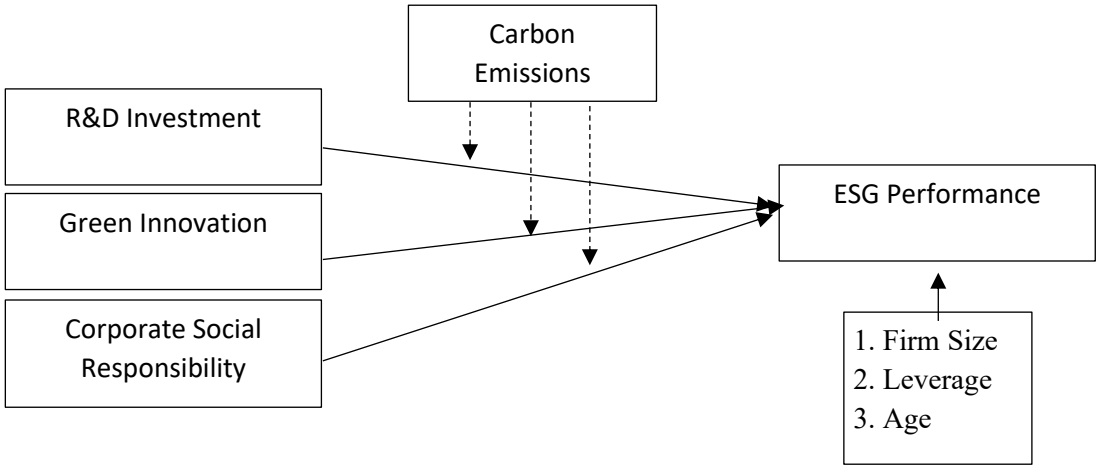
H5: Carbon emissions moderate the relationship between green innovation and ESG performance.

Relationship between CSR and ESG Performance with Carbon Emissions as a Moderator

The impact of Corporate Social Responsibility on ESG performance is suggested to depend on the company's environmental performance, particularly its carbon emissions level. A company that generates significant carbon emissions encounters a serious contradiction between its social programs and its ecological footprint, potentially damaging the trust and authenticity of its CSR initiatives. Stakeholder Theory suggests that stakeholders assess a company in its entirety. When elevated emissions conflict with social assertions, it generates a credibility gap that reduces the beneficial impact of CSR on stakeholder perceptions overall and, in turn, on ESG ratings. In contrast, companies with minimal carbon emissions have their CSR efforts seen as aligned with and supported by their solid environmental track record, amplifying the positive influence of CSR on ESG performance and enhancing its credibility. Consequently, carbon emissions are anticipated to adversely influence this relationship.

H6: Carbon moderate the relationship between CSR and ESG performance

Figure 1. Research Framework



RESEARCH METHOD

Using a quantitative research method within an explanatory–causal framework, and panel data analysis, the study tests empirically the causal relationships of hypotheses in the research model. The population in this research is all manufacturing companies listed on the Indonesia Stock Exchange (IDX) from 2021 to 2024. A purposive sampling method was employed to achieve data relevance and sufficiency. A company belonged to the sample if it issued complete annual and sustainability reports continuously over the research period and its data were fully available for all of the variables in our study - R&D investment, green innovation, CSR (both direct related and environmental), carbon emissions, and ESG performance. In general, despite the limited sample size of 23 manufacturing firms for three years (for a total of 69 firm-year observations) investigated in this study, its results should be treated significant and meaningful due to the analytical instead adopted by the research.

This study is not suggesting that the findings can be generalized to all companies or industries but rather that it intends to examine how R&D investment, green innovation, CSR performance, carbon emissions and ESG performance are theoretically linked in a country-specific institutional setting such as Indonesia manufacturing firms. The data's panel structure enhances the analysis by capturing cross-sectional and time-series differences,su(ch that it can control for firm-specific heterogeneity which is not identifiable in purely cross-sectional studies. Further, ESG-related variables are less universally reported in emerging markets (e.g., they do not have carbon emissions and green innovation disclosure) so purposive sampling is an appropriate methodology to achieve strong data quality for comparability reasons. Previous ESG studies on emerging markets also depend on the small but high-quality sample from disclosure barriers, and have shown that smaller-sized, focused samples can provide robust insights as well being theory-consistent.

Consequently, the generalization of findings in this study applies at theoretical and contextual levels (i.e., to manufacturing firms operating in developing countries with similar regulatory settings and ESG disclosure practices), but not at the populational inference level. Data The study uses secondary data sources, which are based on corporate financial reports and sustainability reports that are published by Indonesia Stock Exchange's (IDX) official website, in addition to the ESG rating data from International reputable rating agencies. All variables are measured as: ESG is for environmental, social and governance value; RDI represents research development investment; GI refers to green innovation, CSR is corporate social responsibility activities and CE reflects carbon emission. Nonetheless, three control variables, i.e., size of firm, leverage, and firm age are included to control for possible biases due to the peculiarities of the firms and influences outside the firm(Nurlaila & Mutmainah, 2025).

This article does not present a thorough robustness check. The lack of a robustness check is more due to data and contextual limitations than methodological negligence. More precisely, the analysis relies on a relatively small panel data set of 23 manufacturing firms observed over a 3-year period or overall sample count of N=23*3=69 (firm-years). Given the short time dimension of our dataset and limited number of cross-sectional units, application of standard robustness checks (e.g., alternative variable proxies) or methods for dealing with endogeneity that may be more appropriate to other datasets (e.g., drop observations, dynamic panel estimators such as GMM or instrumental variables estimation) is likely to result in lower statistical power and possibly biased unstable estimates.

Further, ESG-related variables (including green innovation and carbon emissions) are sourced from sustainability reports as well as recognized ESG rating agencies using standardized disclosure-based indicators. This means alternate operationalizations or proxy replacements are not available without threatening indicator measurement validity and consistency. Given these constraints, this study emphasizes model parsimony and internal validity by adopting panel regression of firm-level control variables and interaction terms for unobserved heterogeneity as well as moderating hypothesis testing. However, in order to increase the credibility of the empirical results, our study includes several indirect robustness-strengthening strategies (panel data techniques, theoretically justified choice of model specification and of control variables commonly used in ESG-related literature). We encourage future research to subject the findings (from a longer period of observation and more extensive data sets) to formal robustness tests, such as alternative ESG measures, lagged independent variables or dynamic panel models.

In order to improve the reliability and validity of composite indexes such as CSR, ESG, and green innovation utilised in this work is ESG ratings from established agencies like MSCI, Refinitiv and Bloomberg proving to be under strict verification/auditing conditions in their evaluation process. For those with self-reporting or disclosure-based scoring methodologies, internal consistency and measurement reliability are evaluated using Cronbach's Alpha. In sum, this research design aims to offer empirical evidence on the effects of R&D investment, green innovation and CSR in ESG performance, in addition a moderation effect approach by carbon dioxide emission level can be tested with regard to Indonesia manufacturing firms. Empirical analysis is carried out applying panel data regression models and moderated regression analysis (MRA) with the STATA 17 software. The method to analyze data includes the classical assumption testing, baseline regression analysis (for direct effects), and interaction term test in order to detect and interpret the moderating effect of carbon emissions on the relationships. The following regression model was obtained:

Model 1:

$$ESG = \beta_o + \beta_1 RDI + \beta_2 GI + \beta_3 CSR + \beta_4 CE + \beta_5 (RDI*CE) + \beta_6 (GI*CE) + \beta_7 (CSR*CE) + \beta_8 Size + \beta_9 Leverage + \beta_{10} Age + \varepsilon$$

Model 2:

$$ESGit = \beta_0 + \beta_1 RDI_{it} + \beta_2 GI_{it} + \beta_3 CSR_{it} + \beta_4 CE_{it} + \beta_5 Size_{it} + \beta_6 Leverage_{it} + \beta_7 Age_{it} + \varepsilon_{it}$$

Control variables included firm size, leverage, and age. The credibility and dependability of the measurement metrics are reinforced by utilizing audited ESG ratings from reputable organizations.

Table 1. Operational Variable

Variable	Indicator	Source	Reference
ESG Performance	ESG score index reflecting environmental, social, and governance dimensions	ESG rating agencies (e.g., MSCI, Refinitiv, Bloomberg); sustainability reports	(Naziyatul Ulfa & Rahman, 2024)

R&D Investment	Ratio of R&D expenditure to total assets	Annual reports; financial statements	(Ding et al., 2024)
Green Innovation	Number of green patents and/or proportion of R&D expenditure allocated to environmentally friendly products and processes	Annual reports; sustainability reports; patent databases	(Haryanto et al., 2025)
Corporate Social Responsibility (CSR)	CSR disclosure index based on GRI Standards (economic, environmental, and social indicators)	Sustainability reports; GRI-based content analysis	(Haryanto et al., 2025)
Carbon Emissions	Total carbon emissions measured in tons of CO_2 equivalent (CO_2e) per year	Sustainability reports; carbon emission disclosures	(Zaikin & Nagu, 2024)
Firm Size	Natural logarithm of total assets	Annual reports	(Haryanto et al., 2025)
Leverage	Total liabilities divided by total assets	Annual reports	(Haryanto et al., 2025)
Firm Age	Number of years since company establishment	Company profile; annual reports	(Haryanto et al., 2025)

Source: Compiled by the authors (2025).

RESULTS

Table 2. Descriptive Statistics

Variabel	N	Mean	Std. Dev.	Min	Max
ESG Performance	115	16.01	25.62	-0.83	86.91
R&D Investment	115	0.003	0.00001	0.001	0.0001
Green Innovation	115	0.65	0.18	0.25	1.00
CSR Score	115	0.61	0.33	0.04	1.00
Firm Size	115	27.12	4.56	15.39	32.68
Leverage	115	0.94	5.42	0.00	57.20
Firm Age	115	19.71	11.19	-1.83	34.92

Source: Processed data (2025)

A pre-statistical summary of the data quality is given in table I and is a first step to understand some relevant basic characteristics of the data that are useful before hypothesis testing. The results in Table 6 show that the average size of ESG Performance is 16.01, and it has a large dispersion with standard deviation as high as 25.61 with values from – 0.83 to 86.91 on the whole. Such wide dispersion reflects significant variation in the level of ESG commitment and practice among manufacturing companies in Indonesia, thus indicating an uneven development of sustainability maturity of firms. Both R&D Investment and Green Innovation have mean values of 0.003 and 0.65 on a scale of 0–1, with moderate dispersion around these means. Hence, these evidences suggest that the extent of the corporate investment in R&D and environmentally friendly innovation are still low and uneven across firms.

These patterns suggest that green technology is at an early stage and only a few firms engage in it. In contrast, the CSR factor shows a higher and constant average value of 0.61, indicating that CSR actions are more grounded and generally accepted than environmental strategies based on innovation. This could indicate companies' propensity to favour CSR practices as those that are more visual, standardized and less structural and capital-intensive with respect to R&D-based green innovation. By contrast, the Carbon Emissions variable has significant variation across observations which reflects large variations in emission intensity and carbon governance by manufacturing firms. This difference between firms highlights the different levels of success of emissions control policies, and indicates that the companies experience varying regulations and have workload management capabilities not to mention technological constraints in controlling their environmental impact.

Table 3. Hypotheses Testing

Variable	Coefficient	Std. err.	P>|t|	Description
R&D Investment	718532.4	1370041	0.601	No Significant
Green Innovation	1.58542	11.2561	0.888	No Significant
CSR	39.155	8.275	0.000	Significant
Firm Size	-0.052	0.463	0.910	No Significant
Leverage	-0.147	0.36	0.683	No Significant
Firm Age	0.467	0.241	0.056	No Significant
R&D × Emissions	-10.262	20.542	0.622	No Significant
Green Innovation × Emissions	8.43e-07	1.70e-06	0.629	No Significant
CSR × Emissions	-1.87e-06	1.59e-06	0.241	No Significant
Constant	-15.046	15.400	0.331	
R squared	0.4144			
F Statistic	0.0000			

Source: Compiled by the authors (2025).

DISCUSSION

Research & Development investment does not significantly affect ESG performance

The empirical results indicate that R&D investment is not a significantly associated factor on ESG performance, which implies that sustainability practices have not been fully embedded into the innovation strategy of enterprises. This triviality also constructs the interpretation that, in many of Indonesian manufacturing companies' innovation occurs categorically irrespective of ESG aspect. Hence, this finding paves way for an important benchmark in the development of fiscal tools and sustainability-attentive incentive-based study to reconnect innovation endeavors with overall ESG goals. The weak trees of R&D investment and ESG performance relation is very important, as it provides useful insight facts with regard to the structural lag between innovation strategies on one hand and sustainability accounting agendas in the Indonesian case of manufacturing industry.

Mostly R&D isn't a lever for environmental or social change so much as escalation of technique to improve process and lower the cost. This all has a great deal to do with the institutional and market structure. First, the Indonesian green innovation policy environment is not yet conducive. The country does not have a coherent "carrot-and-stick" policy mix (ie efficient carbon pricing tools or large tax incentives for business to engage in sustainability-motivated R&D) that could help to bring corporate innovation strategies into line with national sustainability goals (A. Ramadhan & Widiastuty, 2023). Hence, R&D departments have little incentive to invest in projects whose outcome will lead to ESG related externalities.

Second, there is an imbalance in investor and stakeholder pressures in Indonesia more towards social and governance aspects of ESG at present. Tangible CSR performance played a more direct role in stakeholders, such as local communities and regulators Acandidates or even investors.behavior, as compare to long-term and uncertain R&D expenses (Wang, 2024). This creates a strategic arithmetic for business directors : sink capital into conspicuous social schemes and get returned your badge of legitimacy quicker than a splurge on high-risk green technology. Consistent with Agbakwuru et al. (2024) explains that in these cost-restricted environments, R&D represents a high-cost investment with uncertain ESG benelits. Hence, the non-empirical result is not merely peculiar but a structural mismatch of RDI venture and worthwhile activity.

Theoretically, DCT suggests that R&D would improve firm's ability to sense, seize and reconfigure resources for sustainability challenges (Liang et al., 2022). In spite of gains made in these fields, our findings would seem to indicate that the Indonesian manufacturing sector is not equipped with sensing capabilities necessary to identify ESG-led innovation opportunities, or indeed any kind of organisational capacity to effectively dedicate resources to them. This limit restricts the ability of R&D to transform ESG performance. And most importantly, these results highlight a real policy window. For R&D to become a significant ESG performance driver, targeted policy interventions are needed. Such interventions could involve green R&D tax super-deductions, preferential funding for sustainable patents and the incorporation of ESG-output indicators in publicly-sponsored innovation investment programs. If not supported by the institutions, R&D investment will continue to be a marginal feature of Indonesia's corporate sustainability story, despite the proven theoretical role it can play in fostering a long-term sustainable change.

Green Innovation has no significant impact on ESG performance

Accordingly, numerous types of green innovation, especially incremental innovations, process-related and context-specific ones are not adequately reflected in ordinary ESG metrics. "Most existing indicators in ESG frameworks can't measure small environmental gains that tend to be common in emerging-market manufacturing settings, and this has led to the systematic underreporting of companies' real environmental performance levels (A. Ramadhan & Widiastuty, 2023; Tyas Handayani & Regina Jansen Arsjah, 2024).

Thus, the trivial statistical result does not mean that green innovation is irrelevant; instead it suggests that currently used ESG measurement designs are limited in capturing its localized expressions. This result also indicates that green innovation in Indonesia has not been sufficiently mainstreamed as a part of standardised ESG reporting system, and this complicates its quantitative assessment. Green innovation is viewed as a tangential goal for many companies rather than a core part of their sustainable business model. Policy-wise, this result highlights how important it is to come up with more specific and context-aware ESG metrics which specifically account for the value of green innovation. Such indicators might range from, for instance, so-called ecoinnovation patents and energy efficiency improvements to cleaner (production) technologies and emission reductions through technological innovation. Higher reporting standards would make ESG assessments more accurate, and it would provide companies with a clearer incentive to embed environmental innovation further into their company and sustainability strategies.

The moderating interaction variable of carbon emissions is not significant to ESG performance

The findings of this study are in line such that green innovation has no significant impact on ESG performance. This indicates that eco-friendly innovation among Indonesian manufacturing firms have not sufficiently been incorporated in the ESG assessment and reporting systems. In practice, business greening innovations are small scale, largely based on operational improvements, and rarely covered in ESG reporting — leading to a lack of an uplift in overall environmental ratings. That indicates green innovation methods and ESG analysis models don't come together. ESG ratings assign much more importance to governance and social transparency than to technological environmental impacts.

This is aligned with other findings in the literature on emerging markets that show green innovation is often underrepresented in ESG scores because of weak reporting standards, low regulatory push and little market push for innovation-based environmental performance (A. Ramadhan & Widiastuty, 2023; M. A. Ramadhan et al., 2023). Furthermore, green innovation in developing countries is less likely to be taken on a larger scale and visibility as the main drivers for sustainability performance (Tyas Handayani & Arsjah, 2024). A study by Maria Kristari and Yusram Teruna (2023) found that the environmental factor, green innovation and carbon emission failed to significantly affect ESG performance in the Indonesian context of contrast with CSR.

Accordingly, this research reaffirms that the absence of a significant influence of green innovation does not mean that there is no relationship of interest at all but underscores limitations whether institutional or methodological in quantitatively establishing such association between EI and ESG performance (Martiny et al., 2024; Nurfatimah et al., 2024). This constitutes a challenge for quantitatively assessing the contribution of green innovation and is indicative of how many firms view environmentally oriented innovation as something to do when one has time, rather than an integral part of their sustainability strategy. From a policy perspective, this highlights the need to further perfect more detailed and "innovation-oriented" ESG indicators that capture environmental patents, energy efficiency innovations, or emission savings generated as a result of technological advancements.

Improved transparency and standardization of ESG reporting would permit a more accurate assessment, and incentivize companies to incorporate green innovation at an even deeper level into their business and sustainability strategies. Such findings suggest that CSR is the only variable that has a statistically significant (positive) impact on ESG performance, indicating that social and governance aspects are still the main determinants of ESG scores in Indonesia. This indicates that strategic CSR not only meets regulatory and normative requirements, but also delivers long-term value for and legitimation by stakeholders.

On the other hand, the insignificant interaction between R&D investment, green innovation and carbon emissions points to an institutional failure in firm level sustainability plans in terms of integrating innovation activities with strategy decisions on allocating research resources while considering carbon discharges as a material concern for corporate sustainability. Overall, these results further confirm that Indonesia's ESG system is still socially and institutionally based with ongoing implementation and measurement obstacles for environmental dimensions. From a policy perspective, we suggest our findings to reinforce the need for harmonising innovation policy and regulatory frameworks with sustainability reporting systems in order to strengthen the attention towards environmental performance within ESG practices.

Through sounder regulation, targeted financial stimuli and clearer disclosure requirements more of the industry can be enabled to move from compliance-driven CSR toward a real green innovation form which is a key driver for industry sustainability in the long run. Finally, the study reveals that carbon emissions do not considerably moderate the interactions between R&D, green innovation, CSR and ESG performance. This finding is the core of research interest and it gives important indication to the situation around the issue of sustainability in relation to Indonesian manufacturing sector. High as well as Low emission intensity doesn't seem to motivate firms towards redirecting R&D in favor of ESG focused proceeds. Instead R&D continues to focus overwhelmingly on efficiency and cost reducing rather than decarbonizing aims.

Lax regulatory enforcement, the lack of robust carbon pricing schemes and low levels of investor scrutiny lead to firms not using emission intensity as a strategic driver for innovation choices. According to Legitimacy Theory, companies are more likely to react to environmental pressures when societal and regulatory expectations cross a certain threshold—a concept that has not been well developed in the Indonesian setting (Xie et al., 2024). In addition, the findings indicate that high-emission firms do not improve ESG scores despite their green innovation. This result is due to two contextual factors. First, green innovations in Indonesia tend to be incremental, symbolic or poorly articulated, making them not effective for compensating negative environmental perceptions derived from the high emissions. Second, the current systems of measure for ESG lack tools to properly validate and value these innovations' potential in terms of greenhouse gas reduction.

This finding is in line with the study by Nurfatimah and et al. (2024), who argue green initiatives in emerging markets often lack high visibility and level of credibility, which is required to make the emissions an effective moderating variable. Finally, it is crucial that the positive effect of CSR on ESG performance are not dependent upon the emission intensity; showing us that stakeholders and ESG rating agencies still analyze social legitimacy (i.e., relative to society's expectation) and environmental performance with partly different lenses. The ESG benefits from CSR (i.e., the combined E+S+G score) are not lower or higher for high very environmentally dirty firms, suggesting that legitimacy obtained through social actions is independent of environmental performance proxy. This finding is supportive of some existing studies that in emerging markets, CSR has a significant influence on sustainability legitimacy compared to the effects of environmental performance measures (Lew et al., 2024).

In sum, the continuing absence of moderation effects supports that carbon emissions have yet to manifest as a salient contingency factor in Indonesia ESG mode. This is indicative of a wider systemic weakness: an insufficient carbon rule, increasingly clear stakeholder awareness of risk to climate change and ESG rating methodologies that do not integrate carbon performance well. In addition, to make carbon emissio n a significant strategic driver, there needs to be stronger regulatory messages from Government as well as market-based incentives and transparent audited emission reporting systems.

CONCLUSION

This paper explores the influence of R&D investment, green innovation and Corporate Social Responsibility (CSR) on ESG performance in manufacturing companies in Indonesia with carbon emissions as a moderating variable. The results suggest that ESG performance in the Indonesian manufacturing sector is mostly influenced by CSR activities, with R&D investment and green innovation have yet to show evidence of being integrated properly into measurable ESG enhancements. Additionally, carbon emission does not constitute a significant moderator in the relationship observed.

These findings indicate that ESG implementation in Indonesia is still socially and institutionally oriented, not outcome-based for the environment. Companies are eager to focus on CSR initiatives that look good, gain a lot of legitimacy and stakeholder support quickly due to their visibility but environmental innovations and emission reduction efforts are not yet below the surface where they are part of corporate sustainability strategies or ESG assessment criteria. The lack of moderating effects also implies that carbon emissions have not yet emerged as an important strategic issue in contemporary ESG valuation.

Overall, this paper adds to the ESG literature by identifying a structural decoupling of environmental innovation efforts and ESG performance in EMs. [1] [1]Allyn recently argued that ESG scores in the Indonesian manufacturing context represent social legitimacy and governance disclosure rather than actual environmental change.

SUGGESTION or RECOMMENDATION

Practical Recommendations

For producers, the findings also suggest the need to refocus sustainability strategies that have been geared towards CSR as a compliance tool into more results-oriented environmental activities. Enterprises are encouraged to include in their R&D programmes environmental targets, in particular for low-carbon technologies, energy efficiency improvements and reduction of emissions. A deeper inclusion of innovation aspects in ESG reporting would also make corporate sustainability more robust and effective over time.

For regulators and policy makers, the findings suggest a need for better environmental governance. The absence of a significant effect of CARBON EMISSIONS as an influence on control, indicates that the policy drivers in place are insufficient. More broad-based, transparent carbon pricing for example, tightened emission discosure rules, or targeted fiscal incentivites for R&D on sustainability related investments could be introduced by policymakers to make environmental performance a material part of assessing ESG.

The findings also imply that investors and ESG rating agencies should enhance their assessment of the quality of ESG. Current frameworks may exaggerate the importance of social disclosure with respect to the actual environmental impact. Inclusion of such ESG factors at a more granular, lower level related to emission intensity, green innovation outputs and verified environmental performance would enhance the relevance and accuracy of the ESG scores in emerging markets.

Theoritical Recommendations

In theory, the present study dismantles Stakeholder Theory by providing explanation that stakeholder pressure in an emerging market is not homogenously related to three ESG dimensions. The note that CSR is observed to overwhelm in terms of environmental innovation should increase awareness on heterogeneity and contingency of stakeholder pressures, positing ESG as a product of path-dependent regulatory development rather than an ideal reference point.

Therefore, future research may intend to investigate of any other potential contingent that could create a circumstance for innovation and information about environmental performance in which ESG being able to influence through notably regulatory quality, institutional ownership or governace effectiveness. And if period of observation was extended, and comparison between emerging countries were made, we would not only provide a generalizability of empirical evidence but also enrich ESG theory within domestic context.

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