International Journal of Research Studies in Management
2025 Volume 13 Number 3, 141-152

ESG practices, challenges and opportunities among carbon intensive industry: Basis for green corporate image framework

Zeng, Fanlong ✉
Graduate School, Lyceum of the Philippines University - Batangas, Philippines

ISSN: 2243-7770
Online ISSN: 2243-7789

Received: 13 March 2025 **Revised**: 20 April 2025 **Accepted**: 23 April 2025 OPEN ACCESS
Available Online: 25 April 2025 **DOI**: 10.5861/ijrsm.2025.25047

Abstract

This research examines the ESG Practices, Challenges, and Opportunities within carbon-intensive industries—including steel, energy, and chemicals—in Shanghai, China. The study seeks to evaluate the hurdles these companies face when adopting ESG strategies, particularly concerning stakeholder engagement, product lifecycle management, and data standardization issues. Additionally, it aims to outline the specific ESG practices of carbon-intensive industry firms and analyze the relationship between these practices, the challenges they may encounter, and future development opportunities. Lastly, it focuses on the framework for the green image of carbon-intensive enterprises. The insight of this research work is that if an enterprise highly depends on carbon emissions, there are internal correlations between its three major ESG pillars and multiple core aspects, such as the quality of operational efficiency, the pace of technological progress, and the supervision mechanism for various stakeholders. In the process of improving the ESG performance of such companies, on the one hand is the degree of perfection of their internal control systems, and on the other hand depends on the specific level of the enterprise's own data management. The research used a descriptive method; 407 responses were collected. Finding, outlines several key paths for sustainable growth of carbon-intensive enterprises. It is urgent for enterprises to invest in the skill improvement of their workforce, and special training programs are important means to achieve this goal. They also need to work on unblocking information channels, such as measures like improving communication systems and regularly conducting internal control audits. Implementing sound data governance norms and implementing standardized operating procedures in possible areas are also crucial for the steady development of enterprises. Embracing digital solutions to simplify operations and reinforcing corporate governance structures are equally crucial. Finally, this study develops a comprehensive green corporate image framework for carbon-intensive industry firms.

Keywords: ESG practices, carbon-intensive industries, internal control, sustainable growth, green corporate image framework

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1. Introduction

In the context of growing global environmental challenges and the increasing importance of corporate social responsibility, Environmental, Social, and Governance (ESG) practices have become a critical standard for assessing the sustainability performance of carbon-intensive industries such as steel manufacturing, power generation, chemical production, glass manufacturing, and energy resource management. Carbon-intensive enterprises not only exhibit high carbon emissions but are also often associated with higher risks of water pollution, air pollution, and soil contamination, making them more susceptible to environmental challenges. Research has shown that ESG plays an "accelerator" role in promoting the green transformation of carbon-intensive industry enterprises (Wang et al., 2024). This study aims to explore the ESG practices, challenges, and opportunities among carbon-intensive enterprises, providing a foundation for developing a green corporate image framework to guide sustainable development.

ESG originates from the principles of responsible investing (Gasperini, 2020). Specifically, ESG practices refer to a set of standards used to assess corporate behavior, with socially responsible investors using these criteria to screen potential investment targets. The environmental criteria focus on a company's performance in managing natural resources, while the social criteria evaluate how the company manages its relationships with employees, suppliers, customers, and the communities in which it operates. Governance criteria address aspects such as corporate leadership, executive compensation, auditing, internal controls, and shareholder rights. Numerous ESG assessment systems have been developed to evaluate these standards, including MSCI, Vigeo Eris, Refinitiv, Sustainalytics, ISS, Oekom, Robeco Sam, ECPI, Bloomberg, FTSE Russell, and Reprisk (Becchetti et al., 2022). In summary, the ESG concept emphasizes that companies should focus on ecological environmental protection, fulfill social responsibilities, and improve governance standards. These practices are increasingly viewed as key to achieving long-term sustainability and success. However, the implementation of ESG practices in carbon-intensive industries faces significant challenges, particularly in areas such as stakeholder engagement, product and service life-cycle management, and data management and standardization (Yu et al., 2024).

Recent research has highlighted the various challenges industries face in implementing ESG practices. For example, Toma et al. (2024) argue that data management and standardization are major obstacles due to the lack of unified reporting standards across industries. This is particularly pronounced in the agricultural sector, where the absence of a consistent ESG disclosure framework leads to difficulties in data collection and usage. Judijanto et al. (2024) emphasize the challenges of stakeholder engagement, particularly in coordinating the interests of different groups. The study points out that the diversity of stakeholders and conflicting goals significantly increase the complexity of interest coordination. Additionally, as highlighted by Shaheen et al. (2024), managing the life-cycle of products and services presents significant challenges due to the complexity of supply chains and the need for comprehensive environmental assessments, which further hinder the implementation of ESG practices.

Despite these challenges, carbon-intensive industries still possess numerous innovative opportunities to enhance their ESG performance. For example, Jia et al. (2024) explore how innovation, driven by internal and external incentives such as government subsidies and equity-based incentives for key technical personnel, can significantly improve corporate ESG performance. Their study indicates that innovation is particularly effective in the context of external incentives like government subsidies and equity incentives for core technical staff. Similarly, Huang et al. (2023) highlight how digital innovation not only improves corporate performance and attracts analysts' attention but also positively impacts ESG performance. Furthermore, Zheng et al. (2022) found that green innovation significantly enhances the ESG scores of companies listed on China's Growth Enterprise Market (GEM) and, through indirect mediation, contributes to the financial performance of these companies. Additionally, there is an increasing recognition of the importance of integrating ESG practices into business strategies to gain a competitive advantage. Effective ESG practices can lead to better financial performance by enhancing corporate reputation and building stakeholder trust (Quintiliani, 2024). For example, Similarly, Yavuz et al. (2025) demonstrate that strong ESG performance is associated with lower capital costs and better overall financial performance.

Given the increasing urgency of global environmental challenges and the critical role of corporate social responsibility, the researcher believes it is essential in addressing the ESG practices of carbon-intensive industries. These industries, which contribute significantly to carbon emissions and environmental degradation, face mounting pressure to transition toward sustainable operations. However, despite the recognized importance of ESG frameworks, their implementation remains complex due to challenges in stakeholder engagement, data standardization, and lifecycle management. By examining these challenges and identifying opportunities for improvement, this study seeks to contribute to the development of a green corporate image framework that can guide carbon-intensive enterprises in enhancing their sustainability performance. The findings will not only aid in refining ESG strategies within these industries but also provide empirical insights for policymakers, investors, and corporate leaders striving to balance economic growth with environmental responsibility.

Objectives of the Study - The study aims to explore the ESG practices, challenges and opportunities among carbon intensive industry that will be the basis in developing a green corporate image framework. Specifically, the study aims to determine the Environment, Social, and Governance practices; assess the challenges in terms of stakeholder engagement, product and service life-cycle management, and data management and standardization; describe the opportunities in technology and project development, business model innovation, and collaboration and advocacy; test the significant relationship between ESG practices, challenges, and opportunities; and develop a green corporate image framework for carbon-intensive industries.

2. Methods

Research Design - This study used a descriptive research design combining quantitative to explore the ESG practices, challenges, and opportunities among carbon-intensive industries in Shanghai, China. Quantitative data were collected through questionnaires designed to capture information on various ESG indicators, and were analyzed using SPSS software for descriptive analysis, correlation analysis, and regression analysis.

Participants of the Study - A total of 407 participants were involved in this study, representing carbon-intensive industries in Shanghai, China, including executives, managers, and key personnel engaged in ESG activities. The study aimed to obtain a representative sample of participants from various departments within these industries to gain comprehensive insights. The sample size was determined using Raosoft analysis, ensuring a 95% confidence level and a 5% margin of error.

Data Gathering Instrument - The research tool for this study is a self-structured questionnaire composed of closed questions. The questionnaire was designed according to the research objectives, ensuring that all variables related to ESG practices, challenges, and opportunities were adequately reflected. Before distribution, a pre-test was conducted to refine the questionnaire and ensure its clarity and effectiveness. The final version of the questionnaire was designed to be completed within 15 minutes to enhance response rates and ensure the validity and reliability of the data collected. The results will be interpreted using the four Likert scale below:

Likert Scale Measurement Interpretation

Measurement	Interpretation		
	ESG Practices	Opportunity	Challenges
4 Strongly Agree	Highly Practiced	Strong Opportunity	Highly Observed
3 Agree	Moderately Practiced	Moderate Opportunity	Moderately observed
2 Disagree	Slightly Practiced	Limited Opportunity	Slightly observed
1 Strongly Disagree	Not practiced	No Opportunity	Not observed

A pilot test was undertaken to determine the survey questionnaire's efficacy. 30 samples were subjected to a reliability test using Cronbach's alpha via SPSS 28. Table 1 below shows the reliability test result for each of the variables used in this research.

Table 1

Reliability Test Result using Cronbach Alpha and its Interpretation

Indicators	No. of Items	Cronbach Alpha	Remarks
Environment Practices	5	0.928	Excellent
Social Practices	5	0.934	Excellent
Governance practices	5	0.938	Excellent
Stakeholders Engagement	5	0.924	Excellent
Product/Service Life Cycle	5	0.943	Excellent
Data Management and Standardization	5	0.930	Excellent
Technology and Project Development	5	0.927	Excellent
Business Model Innovation	5	0.933	Excellent
Collaboration and Advocacy	5	0.926	Excellent

Data Gathering Procedure - The data collection process involved distributing questionnaires to participants from selected carbon-intensive industries in Shanghai. Questionnaires were distributed via email, online platforms such as WeChat, and in person, primarily through the WeChat "WenJuanxing" app. The questionnaires targeted executives, managers, and key personnel involved in ESG activities. Additionally, interviews were conducted with a sample of these stakeholders to gain deeper insights. Participants were requested to complete the questionnaire within a specific time frame, and follow-up reminders were sent to non-respondents to ensure a high response rate. This meticulous approach to data collection was inspired by the effective methodologies employed in logistics and supply chain management, ensuring thorough engagement and comprehensive data gathering.

Ethical Considerations - During the research process, ethical issues will be considered to ensure that any information obtained is used only for research purposes, maintaining the quality and integrity of the research. The researchers asked each respondent for information before filling in the questionnaire, and completed the questionnaire after confirmation to ensure that the interviewees were willing to fill in the survey according to their wishes, so as to obtain real and effective data. The researchers did not ask the respondents' names when filling out the questionnaires, thereby protecting their privacy and identity.

Data Analysis - Weighted and rank were used to assess knowledge sharing practices in terms of diversity of knowledge sources, transfer of knowledge and integration of knowledge; to determine change management practices in terms of individual, team and organizational; and to determine learning culture in terms of adaptability, organizational structure and support for learning. The result of Shapiro-Wilk Test showed that p-values of all variables were less than 0.05 which means that the data set is not normally distributed. Therefore, Spearman rho was used to test the significant relationship as part of the non-parametric tests. All analyzes were performed using SPSS version 28.

3. Results and discussions

Table 2

Summary Table on ESG Practices

Key Result Areas	Composite Mean	VI	Rank
Environment Practices	2.59	Agree	1
Social Practices	2.58	Agree	2
Governance Practices	2.48	Disagree	3
Grand Composite Mean	2.55	Agree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 2 presented the carbon-intensive companies involved in this study face a series of challenges in stakeholder engagement. Overall, while the companies have made some progress in certain areas, there remain many aspects that require improvement, particularly in identifying potentially affected groups and effectively balancing the needs of different stakeholders.

Firstly, regarding whether "the company identifies all groups that may be affected by or affect its ESG performance," the score was 2.36, ranking fifth. This indicates that the companies performed poorly in this area, suggesting that they have shortcomings in comprehensively identifying and understanding all relevant stakeholders. Effective stakeholder identification is fundamental to formulating a practical ESG strategy (Khamisu et al., 2024). If companies fail to accurately identify and understand the needs and expectations of their stakeholders, they may face significant challenges in implementing ESG objectives, potentially leading to strained relationships with key stakeholders, negatively impacting the company's social responsibility and reputation.

In the area of "balancing often competing priorities between different stakeholders (investors, employees, communities)," the score was 2.44, ranking third, indicating that companies face considerable difficulties in balancing the interests of various stakeholders. In carbon-intensive industries, stakeholder demands often conflict, particularly between short-term financial returns and long-term sustainability. The diversity of stakeholders and goal conflicts are major barriers to the implementation of ESG strategies, especially in industries facing high competition and complex environments (Parameswar et al., 2024).

The score for the item "Does the company have sufficient communication tools and platforms to effectively engage with stakeholders?" was 2.40, ranking fourth. This indicates that companies still have significant gaps in building effective communication tools and platforms. Effective communication is key to ensuring stakeholder engagement, and a lack of communication tools can lead to information asymmetry and reduced participation (Bonetti et al., 2023). Without proper communication tools, it is difficult for companies to establish cooperative relationships with multiple stakeholders, thus affecting their ESG performance.

In contrast, the score for "Does the company demonstrate the actual impact or effect of stakeholder engagement on its ESG efforts?" was 2.79, ranking first. This indicates that companies have made some progress in this area and are, to some extent, able to demonstrate the specific outcomes of stakeholder engagement in their ESG strategy implementation. Effective stakeholder engagement not only helps companies better understand the needs of various parties but also enhances their social reputation and brand image (Martin-de Castro, 2021). Additionally, the score for "Does the company consider logistical and cultural differences when engaging with stakeholders across regions?" was 2.68, ranking second. This suggests that companies are gradually improving their ability to manage cross-cultural and cross-regional stakeholders in a globalized context, although further improvements are still needed.

In conclusion, the carbon-intensive companies involved in this study face multiple challenges in stakeholder engagement, particularly in stakeholder identification, balancing competing demands, and effective communication. These companies need to invest more in stakeholder management and communication channels, as well as enhance their cultural sensitivity and communication skills in the context of globalization. By optimizing these aspects, companies can better advance their ESG objectives and enhance their sustainability capacity in the context of globalization and diversification.

Table 3

Summary Table on Challenges

Key Result Areas	Composite Mean	VI	Rank
Stakeholder Engagement	2.53	Agree	2
Product and Service Lifecycle Management	2.61	Agree	1
Data Management and Standardization	2.33	Disagree	3
Grand Composite Mean	2.49	Disagree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

According to the data presented in Table 3, carbon-intensive companies show generally positive performance in terms of opportunities in technology and project development, although there are still areas for improvement. The overall score is 2.50, which falls within the "Agree" range (2.50 to 3.49), indicating that while companies have opportunities to leverage technology and project development to achieve ESG goals, certain areas have yet to be fully explored.

Firstly, regarding whether the company utilizes digital platforms to facilitate communication and interaction with stakeholders on ESG issues, the score was 2.60, ranking jointly first. This indicates that companies have made progress in promoting information transparency and stakeholder engagement, particularly in the area of digital transformation. With technological advancements, an increasing number of companies have enhanced their interaction efficiency with stakeholders through digital platforms, which has strengthened the implementation of their ESG strategies. The application of digital technology not only helps improve operational efficiency but also increases transparency, thereby attracting external stakeholders and providing strong support for the company's long-term sustainability goals (Dwivedi et al., 2022). Secondly, the score for "Whether the company evaluates the use of technological strategies to support long-term ESG goals" was also 2.60, ranking jointly first. This suggests that companies are beginning to prioritize the use of technology at a strategic level to drive the achievement of sustainable development goals. By strategically allocating resources towards technological investments, companies can make progress in areas such as clean technologies and green innovations, reducing their negative environmental impact. Strategic decisions regarding technology investments are crucial for achieving ESG goals, especially in terms of energy efficiency and pollution reduction, where technological innovation plays a significant role (Yu et al., 2024).

However, in the area of "Whether the company strategically allocates resources for technological investments that support long-term ESG goals," the score was 2.44, ranking fourth. This indicates that companies' resource allocation in this domain is still insufficient. Although companies are conscious of investing some resources in technological development, these investments are still not enough in relation to actual needs. Therefore, companies should increase their financial and resource investments in technology research and development, particularly in green and sustainability technologies, to ensure the smooth implementation of long-term ESG strategies (Yang et al., 2024).

In conclusion, while companies have made certain progress in the use of digital platforms and technology strategies, they still face challenges in terms of the depth of technology investment and optimization of resource allocation. In the future, companies should focus more on the strategic allocation of technological investments, especially in clean and innovative technologies that support long-term ESG goals, in order to effectively drive sustainable development.

Table 4

Summary Table on Opportunities

Key Result Areas	Composite Mean	VI	Rank
Technology and Project Development	2.50	Agree	3
Business Model Innovation	2.67	Agree	1
Collaboration and Advocacy	2.59	Agree	2
Grand Composite Mean	2.59	Agree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Based on the Table 4, carbon-intensive companies have generally shown a positive performance in terms of opportunities, with an overall score of 2.59, which falls within the "Agree" range (2.50 to 3.49). Among the opportunities, business model innovation (score 2.67) ranks first, indicating significant progress in this area; collaboration and advocacy (score 2.59) ranks second, showing that companies have established good relationships with external stakeholders in driving ESG goals; while technology and project development (score 2.50) ranks third, suggesting that opportunities in this area still need further exploration.

In the realm of business model innovation, the average score of 2.67 indicates firms are proactively embedding ESG principles into their fundamental value chains while addressing growing consumer preferences for eco-conscious offerings. As Zhang et al. (2025) observed, such strategic innovation serves a dual purpose: boosting competitive advantage while future-proofing operations. Moreover, this sustainability-focused approach enables organizations to cultivate environmentally responsible brand identities, which increasingly resonate with both ethically-minded consumers and impact-driven investors (Alam et al., 2021). Secondly, in collaboration and advocacy, the score is 2.59, indicating that companies have shown strengths in collaborating with NGOs, experts, and other stakeholders. The collaboration between enterprises and external organizations often injects innovative ideas and technical assistance into them, and this interaction promotes the effective implementation of their ESG strategies (Liao et al., 2023). If enterprises can actively cooperate with industry partners and share best practices, the pace of improving their ESG performance can also be accelerated accordingly. Of course, there is still room for improvement in specific areas such as building stakeholder networks. Despite these improvement points, we believe that the overall performance of enterprises in such collaborative interactions is remarkable.

In the tech and project development sectors, the score clocks in at a meager 2.50. Despite acknowledging the critical role tech innovation plays in propelling environmental, social, and governance (ESG) objectives, companies haven't quite hit the mark when it comes to tech investment and project advancement. Jumping on the digital and clean tech bandwagon is a must for firms looking to beef up environmental stewardship and resource efficiency (Zhao et al., 2024; Shaheen et al., 2022). Companies should increase their investment in technology R&D in the future to better address environmental challenges and promote green transformation.

Table 5

Relationship Between ESG Practices and Challenges

Variables	rho	p-value	Interpretation
Environment Practices			
Stakeholder Engagement	0.716**	<.001	Highly Significant
Product and Service Lifecycle Management	0.721**	<.001	Highly Significant
Data Management and Standardization	0.766**	<.001	Highly Significant
Social Practices			
Stakeholder Engagement	0.746**	<.001	Highly Significant
Product and Service Lifecycle Management	0.740**	<.001	Highly Significant
Data Management and Standardization	0.759**	<.001	Highly Significant
Governance Practices			
Stakeholder Engagement	0.739**	<.001	Highly Significant
Product and Service Lifecycle Management	0.725**	<.001	Highly Significant
Data Management and Standardization	0.762**	<.001	Highly Significant

***. Correlation is significant at the 0.01 level*

Table 5 illustrates how ESG practices relate to stakeholder engagement hurdles, life-cycle management of products and services, and data governance challenges. When it comes to environmental initiatives, research reveals a particularly strong link to three key areas: stakeholder involvement (ρ=0.716), life-cycle management of products and services (ρ=0.721), and data handling and standardization (ρ=0.766). Each of these correlations is highly statistically significant ($p<0.001$), with data management emerging as the most strongly associated factor. These findings indicate that companies enhancing their environmental strategies tend to experience notable improvements across these domains, especially in data-related practices (Blak et al., 2023). Similarly, social practices are also strongly linked to positive outcomes in these challenges, with stakeholder engagement (ρ=0.746), product and service life-cycle management (ρ=0.740), and data management and standardization (ρ=0.759) all showing highly significant positive correlations. These efforts demonstrate how corporate social responsibility projects enhance stakeholder interactions, product environmental durability, and data management practices (Wang et al., 2020).

Finally, governance practices exhibit a similarly strong connection to these challenges, with correlations of 0.739, 0.725, and 0.762 for stakeholder engagement, product and service life-cycle management, and data management and standardization, respectively. Significant correlations exist across all ESG dimensions, indicating that these practices help address various challenges that organizations may face (Meiden et al., 2023). Improvements in governance, social, and environmental strategies are associated with better outcomes in managing stakeholder relationships, optimizing product life-cycles, and standardizing data processes, with the greatest impact seen in data management and standardization.

Table 6

Relationship Between ESG Practices and Opportunities

Variables	rho	p-value	Interpretation
Environment Practices			
Technology and Project Development	0.752**	<.001	Highly Significant
Business Model Innovation	0.713**	<.001	Highly Significant
Collaboration and Advocacy	0.724**	<.001	Highly Significant
Social Practices			
Technology and Project Development	0.712**	<.001	Highly Significant
Business Model Innovation	0.726**	<.001	Highly Significant
Collaboration and Advocacy	0.751**	<.001	Highly Significant
Governance Practices			
Technology and Project Development	0.754**	<.001	Highly Significant
Business Model Innovation	0.717**	<.001	Highly Significant
Collaboration and Advocacy	0.735**	<.001	Highly Significant

***. Correlation is significant at the 0.01 level*

Table 6 shows ESG Practices' link to key opportunities. When it comes to green initiatives, there's a robust connection between tech advances and project building (ρ=0.752), business innovation (ρ=0.713), and teamwork with advocacy (ρ=0.724) that's not just strong but also super significant ($p<0.001$). This means that nailing down environmental improvements opens up huge chances for companies to kick their tech projects into high gear, shake things up with new business strategies, and step up their game in the realm of collaboration and public support (Pedersen et al., 2021). In the case of social practices, similar strong correlations are observed. Technology and project development (ρ = 0.712), business model innovation (ρ = 0.726), and collaboration and advocacy (ρ = 0.751) all show highly significant relationships with social practices. This indicates that socially responsible actions create important opportunities for technological advancement, the development of innovative business models, and stronger collaboration and advocacy initiatives (Scherer et al., 2020). Finally, technology and project development (ρ=0.754), business model innovation (ρ=0.717), and collaboration and advocacy (ρ=0.735) are all significantly related to governance practices. This suggests that good governance practices increase opportunities for innovation and collaboration. According to the research findings, companies that prioritize the implementation of ESG practices are better positioned to seize opportunities for business development brought about by technological advancements, business innovations, and collaboration (Barguilla et al., 2025).

Table 7

Relationship Between Challenges and Opportunities

Variables	Rho	p-value	Interpretation
Stakeholder Engagement			
Technology and Project Development	0.744**	<.001	Highly Significant
Business Model Innovation	0.708**	<.001	Highly Significant
Collaboration and Advocacy	0.746**	<.001	Highly Significant
Product and Service Lifecycle Management			
Technology and Project Development	0.730**	<.001	Highly Significant
Business Model Innovation	0.723**	<.001	Highly Significant
Collaboration and Advocacy	0.736**	<.001	Highly Significant
Data Management and Standardization			
Technology and Project Development	0.753**	<.001	Highly Significant
Business Model Innovation	0.743**	<.001	Highly Significant
Collaboration and Advocacy	0.739**	<.001	Highly Significant

***. Correlation is significant at the 0.01 level*

Table 7 shows how organizational challenges link to key opportunities. The interactive participation practice of stakeholders verifies the existence of an inherent high degree of relevance between its evolution with the technical system and project engineering ($\rho = 0.744$), the innovation of the business operation paradigm ($\rho = 0.708$), and the collaboration of multiple subjects and the advocacy of concepts ($\rho = 0.746$). We are convinced that effectively addressing various challenges emerging in this process will surely bring more historical opportunities for the breakthrough of frontier technologies, the creation of business models, and even the strengthening of cooperation networks (Leonidou et al., 2020).

The situation of product and service life cycle management shows a similar picture. There are quite close and very significant internal connections between it and technology and project R&D (ρ=0.730), the innovative ideas of business models (ρ=0.723), and even collaborative relationships and advocacy activities (ρ=0.736). If an organization is committed to improving its control level over the entire life course of its product service, we observe that this will help them successfully capture important development opportunities in the above-mentioned key areas (Bianchi et al., 2022).

For data management and standardization, the correlations with technology and project development ($\rho = 0.753$), business model innovation ($\rho = 0.743$), and collaboration and advocacy ($\rho = 0.739$) are the strongest among the three challenge areas. This suggests that carbon-intensive companies have significant potential in addressing data management and standardization challenges, which will provide opportunities for technology and project development, business model innovation, and collaboration and advocacy (Raptis et al., 2019). Enterprises will encounter many problems on their business paths. We must look far ahead, formulate and implement effective strategies to deal with them. These measures aim to stimulate innovation vitality and promote partnership collaboration, and it also lays a solid foundation for achieving long-term sustainable development (Mariani et al., 2022).

Research Output

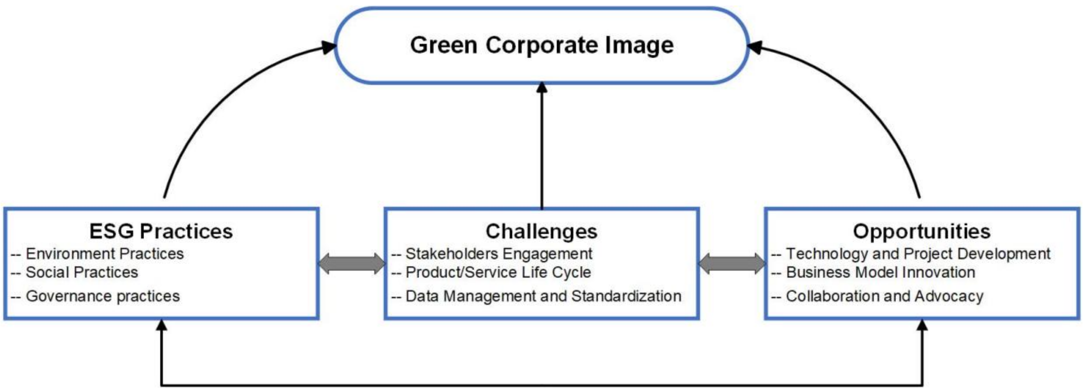

Figure 1. Green Corporate Image Framework for Carbon-Intensive Industry

Overall, understanding the relationship between ESG practices and organizational challenges and opportunities is crucial for companies to achieve sustainable development in today's complex and competitive business environment. By actively strengthening environmental, social, and governance (ESG) practices, companies can not only effectively address a variety of challenges, but also seize key opportunities in areas such as technological innovation, business model transformation, and cross-industry collaboration, thus enhancing their overall performance.

Through the analysis of the relationship between ESG practices and challenges in stakeholder engagement, product lifecycle management, and data management, we can conclude that strengthening ESG practices can significantly improve companies' management effectiveness in these areas. Especially in data management and standardization, improving the accuracy and transparency of data handling will have a profound impact on long-term development. Similarly, good social responsibility practices and governance structures also help improve interactions with stakeholders, optimize the full lifecycle management of products and services, and create greater value for the company.

In terms of opportunities, by reinforcing ESG practices, companies can not only optimize existing technological projects but also gain significant opportunities in business model innovation and industry collaboration. Specifically, strong positive correlations are evident across environmental, social, and governance aspects. If companies can increase investments in these areas, they will be better positioned to leverage technological advancements, promote sustainable development, and strengthen their competitiveness in the market.

In conclusion, a positive feedback loop is formed between ESG practices, organizational challenges, and potential opportunities (as shown in Figure 1). Carbon-intensive industries, by strengthening various ESG practices, can effectively respond to both internal and external challenges, and uncover more opportunities in technology, business model innovation, and cross-industry collaboration. This process not only helps companies achieve better performance in social responsibility but also ensures steady progress along the path of sustainable development while enhancing overall competitiveness.

4. Conclusions and recommendations

Based on the findings of the study, the following conclusions are drawn: The respondents agreed that ESG practices, with environmental and social practices are moderately practiced by their company while governance was practiced slightly only. The respondents indicated that the challenges in stakeholder engagement, product and service lifecycle management were moderately observed. while data management and standardization was observed slightly. The respondents generally agreed that opportunities in technology and project development, business model innovation, and collaboration and advocacy are present at a moderate level. Highly significant relationship exist between ESG practices, challenges, and opportunities. Green corporate image framework for carbon intensive enterprises was developed.

The carbon-intensive enterprises management may enhance governance practices in ESG in balancing competing priorities, recognizing all affected groups, strengthening engagement strategies, and enhancing communication tools to foster inclusivity and trust. Carbon-intensive enterprises may improve data management and standardization through establishment of a centralized and integrated system for ESG data, enhance data accuracy and verification processes, and ensure consistency in data collection and measurement across all departments. Carbon-intensive enterprises may prioritize strengthening technology and project development by investing in innovative tools, capacity-building initiatives, and fostering collaboration to drive sustainable advancements. The developed framework may be recommended for adoption of carbon intensive enterprises to enhance ESG governance, with proper implementation strategies that include stakeholder training, continuous assessment, and integration into corporate policies. Future research may refine the applicability of the developed framework by conducting empirical validation across various contexts, industries, and organizational settings.

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