Title:

Assessing Carbon Accounting, Green Supply Chain Management, Environmental Costs, and Sustainable Value Added in Shaping Sustainable Financial Performance in the Indonesian Chemical Industry

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Abstract

This study examines carbon accounting's impact on Green Supply Chain Management (GSCM), environmental costs, sustainable value added (SVA), and sustainable financial performance in the Indonesian chemical industry. It employs a quantitative approach, collecting data through a comprehensive industry survey. Structural equation modeling shows that carbon accounting strongly influences GSCM adoption, with GSCM and SVA mediating the link between carbon accounting and sustainable financial performance. Organizations implementing carbon accounting practices enhance environmental responsibility, leading to improved financial performance. The study emphasizes the significance of eco-friendly supply chain integration for better financial results.

Keywords: *Carbon accounting, GSCM, environmental costs, sustainable value-added, sustainable financial performance*

Introduction

The chemical industry is vital to the Indonesian economy, contributing to industries as diverse as manufacturing, agriculture, pharmaceuticals, and consumer goods (Farjana et al., 2018). However, the industry also confronts substantial environmental challenges because of its resource-intensive nature and the potential for pollution and emissions (D. Zhang et al., 2023). In this scenario, incorporating Green Supply Chain Management (GSCM) principles becomes critical to reducing environmental effects, complying with regulations, and promoting sustainability in Indonesia's chemical industry (Shekarian et al., 2022). Environmental costs in the Indonesian chemical industry include spending on environmentally friendly procedures across the supply chain (Wu et al., 2017). These expenditures may include investments in greener industrial technology, waste management systems, emission control measures, and adherence to Indonesian government environmental rules (Fatimah et al., 2020). Chemical businesses may examine the financial impact of their sustainability activities and make educated resource allocation decisions by correctly accounting for environmental expenses (Rezaee, 2016).

Carbon accounting is especially important in Indonesia's chemical industry, considering the sector's large contribution to greenhouse gas emissions (Crippa et al., 2021; Faisal et al., 2018). Chemical businesses can identify emission hotspots, evaluate their carbon footprint, and adopt targeted initiatives to minimize and minimize emissions by precisely measuring, monitoring, and reporting carbon emissions influences to their operations (Demeter et al., 2022). Carbon accounting is consistent with GSCM principles, allowing chemical businesses to successfully manage their environmental impact and contribute to Indonesia's climate change mitigation goals (Bhubalan et al., 2022; Krevor et al., 2023). Sustainable value-added methods in Indonesia's chemical sector can take several forms (Agustiany et al., 2022). Cost savings can be achieved through resource optimization, which includes energy and raw material usage, waste reduction, and recycling activities (J. Li et al., 2022; Smol et al., 2020). Implementing environmentally friendly manufacturing techniques, such as green chemistry principles, can help improve

the industry's reputation and attract environmentally concerned clients nationally and internationally (Chen et al., 2020; Moshood et al., 2022). Furthermore, chemical businesses can meet sustainability criteria, participate in eco-certifications, and enter new markets that value ecologically friendly goods and supply chains (Jia et al., 2020).

It is critical to understand the links between environmental costs, carbon accounting, and sustainable value-added, as well as their consequences for long-term financial performance in Indonesia's chemical industry. The significance of this comprehension becomes evident when considering the potential negative consequences of its absence. The importance of this understanding is often left unexplained, leaving us to wonder why it matters. This understanding is pivotal for several reasons. Firstly, it enables companies to identify opportunities and risks associated with sustainable practices in an industry increasingly attuned to environmental concerns. Secondly, a lack of understanding can lead to missed business prospects, potential legal and regulatory violations, damage to a company's reputation, and a decline in financial performance. Companies may incur unforeseen additional costs or experience reduced operational efficiency without a solid grasp of these relationships. Understanding these dynamics allows companies to optimize their sustainable practices, mitigate risks, enhance efficiency, and capitalize on sustainability-influences business opportunities. By successfully managing environmental expenses, chemical firms can enhance their financial performance by decreasing waste, improving resource utilization, and lowering regulatory and legal risks (S. A. R. Khan et al., 2023). Robust carbon accounting methods allow businesses to track and manage their carbon emissions, contribute to Indonesia's emission reduction goals, and improve their environmental management practices (Tao et al., 2021). Furthermore, sustainable value-added processes in the supply chain can help chemical businesses position themselves as responsible corporate citizens, improving their market competitiveness and long-term sustainability (Kotsantonis et al., 2016). Environmental costs, carbon accounting, and sustainable value-added are critical variables within GSCM in the context of Indonesia's chemical sector. Chemical firms prioritizing these characteristics can reduce their environmental impact, improve financial performance, meet regulatory requirements, and gain a competitive advantage in home and international markets (Barforoush et al., 2021; Khalil & Nimmanunta, 2023; Singjai et al., 2018). Adopting GSCM principles helps to build a more sustainable and resilient chemical sector, which coincides with Indonesia's environmental goals and promotes a greener future for the country (Ascione et al., 2022).

Despite the growing importance of GSCM in the Indonesian chemical industry, a research gap must be filled. Existing studies frequently concentrate on basic GSCM practices or specific features of GSCM in various sectors. Nonetheless, little research has been explicitly investigating the implementation and ramifications of GSCM in the context of the Indonesian chemical sector. This research gap provides an opportunity to delve deeper into the difficulties, possibilities, and best practices of GSCM in the unique context of Indonesia's chemical sector. The presence of the chemical industry near densely populated areas is a unique characteristic of the chemical industry in Indonesia. Several factors contribute to this phenomenon. Firstly, Indonesia's industrial zones are often situated on islands with limited available land, necessitating chemical facilities being established close to residential areas. Additionally, the need for swift and efficient access to consumer markets plays a role in this placement, facilitating the distribution of

chemical products, especially those used in everyday life, to consumers. Furthermore, the availability of a readily accessible workforce from nearby residential communities is a significant consideration for chemical companies. While there are advantages to having chemical industries near residential areas, it also presents significant challenges, primarily influences to environmental and public health impacts. Exposure to air pollution and wastewater discharge from chemical facilities can pose severe health and environmental risks to the local population. Strict regulations, safe waste management practices, and adopting clean technologies are imperative to address these challenges. Collaborative efforts involving the chemical industry, government authorities, and local communities are crucial for mitigating potential negative consequences and ensuring the chemical industry's sustainability in densely populated areas. The proposed research would add to the current body of knowledge by investigating the application and consequences of GSCM in the Indonesian chemical sector. It aims to provide fresh perspectives on the difficulties, solutions, and consequences of implementing GSCM practices in this business. This study can identify significant characteristics that influence the effective deployment of GSCM in the chemical industry environment in Indonesia by performing empirical research and evaluating data. The findings will help to generate industry-specific guidelines and recommendations for chemical businesses to successfully incorporate GSCM processes and achieve long-term financial and environmental performance.

Furthermore, this research can thoroughly grasp the environmental costs, carbon accounting, and sustainable value-added techniques in Indonesia's chemical industry. The study can provide a holistic perspective on GSCM and shed light on their unique implications for sustainable financial performance in the chemical industry by investigating these factors' interconnections and consequences. The uniqueness of this study rests in its focus on the chemical industry in Indonesia, which has distinct characteristics and issues compared to other industries. This study can provide industry-specific insights and practical consequences for chemical companies wishing to implement GSCM techniques by reducing the research scope and studying the chemical industry's setting. The study's findings can help close a research gap, broaden understanding of GSCM in Indonesia's chemical industry, and provide helpful guidance for academics and industry practitioners.

The motivation behind this research stems from the need to comprehend the impacts of carbon emissions measurement and reporting on business practices and financial performance within the context of the Indonesian chemical industry. With the increasing awareness of environmental issues and sustainability concerns, coupled with the demand to mitigate adverse environmental impacts, companies are becoming more inclined to adopt carbon emissions measurement and reporting practices. However, a need remains to identify how these practices influence aspects such as GSCM practices, environmental costs, Sustainable Value Added (SVA), and sustainable financial performance.

The primary objective of this study is to analyze the relationships between carbon emissions measurement and reporting and GSCM practices, environmental costs, SVA, and sustainable financial performance in the Indonesian chemical industry. This research aims to understand whether adopting carbon emissions measurement practices significantly affects the implementation of GSCM, environmental cost implications, the

creation of SVA, and sustainable financial outcomes. Therefore, this study seeks to provide a deeper understanding of how carbon emissions measurement practices can impact various business aspects and company performance within the context of the chemical industry in Indonesia. The findings are expected to offer practical insights for companies in developing ecologically and financially sustainable strategies while contributing to the literature on the linkages between carbon measurement and sustainable business performance.

Literature review and development hypothesis

Carbon accounting

Carbon accounting is a systematic process of measuring, quantifying, and tracking greenhouse gas emissions, especially carbon dioxide (CO2), produced directly or indirectly by an organization's activities (Alromaizan et al., 2023). Luo et al. (2021) assert that involves calculating and reporting the total amount of carbon emissions released during the entire lifecycle of a product, service, or business operation. According to Ebrahimi & Koh (2021), carbon accounting helps organizations understand their environmental impact and provides valuable data to set emission reduction targets, assess sustainability efforts, comply with regulatory requirements, and support decision-making for more environmentally responsible practices. By combining GSCM and carbon accounting, companies can effectively identify areas for improvement, optimize resource usage, and reduce their carbon footprint (Shen et al., 2023). This integration leads to cost savings and regulatory compliance and enhances the company's reputation, fostering a more sustainable and responsible brand image (Dangelico & Vocalelli, 2017). By implementing carbon accounting practices, companies can gain insights into their carbon footprint and identify areas for emission reduction, leading to more efficient and sustainable operations (Fang et al., 2022). As carbon emissions are often a significant contributor to environmental costs, reducing these emissions through carbon accounting can help minimize environmental expenses and achieve long-term cost savings (Kelly et al., 2019). Velvizhi et al. (2022) assert that by integrating carbon accounting into the assessment of Sustainable Value added (SVA), companies can recognize the environmental value they create or diminish Tracking carbon emissions and striving to reduce them directly contribute to a positive SVA by showcasing a company's commitment to environmental responsibility. As companies focus on reducing their carbon footprint, it enhances their economic performance and elevates their social and environmental contributions (Danish et al., 2020). Integrating carbon accounting into sustainable finance allows investors to assess a company's environmental performance, including its carbon footprint and commitment to emission reduction (Popescu et al., 2021). Companies with robust carbon accounting practices are more likely to attract sustainable investments as they demonstrate a proactive approach toward environmental stewardship (He et al., 2022). Based on the description from previous research, the hypothesis we propose is as follows:

H1: Carbon accounting influences on GSCM
H2: Carbon accounting influences on environmental costs
H3: Carbon accounting influences on SVA
H4: Carbon accounting influences on sustainable financial performance

Green supply chain management

Balon (2020) holds the view that GSCM is a business strategy integrating environmental considerations into the supply chain process. It involves managing and optimizing the flow of goods, services, and information, from sourcing raw materials to the final delivery of products to customers, to reduce the environmental impact. GSCM aims to minimize the use of natural resources, reduce waste, and mitigate greenhouse gas emissions throughout the supply chain (Rupa & Saif, 2021). GSCM promotes using renewable resources and recycling, which can significantly decrease waste disposal costs and the ecological burden of non-renewable resources (Shao et al., 2021). By considering environmental factors in decision-making and implementing sustainable practices, GSCM reduces environmental costs for businesses while fostering a more responsible and environmentally conscious approach to supply chain management (Agrawal et al., 2023). Through GSCM, companies enhance their financial performance and align their operations with social and environmental goals, creating meaningful and enduring sustainable value for all stakeholders involved (Hui Li et al., 2023). Through GSCM, companies enhance their financial performance and align their operations with social and environmental goals, creating meaningful and enduring sustainable value for all stakeholders involved (Knoppen & Knight, 2022). Emphasizing GSCM and SVA fosters a more holistic and responsible business approach, ensuring businesses thrive in an environmentally conscious and socially responsible manner while positively impacting society and the planet (Q. Zhang et al., 2022). Implementing GSCM practices can lead to operational efficiencies, cost savings, and improved financial performance, all of which align with sustainable finance principles (Wong et al., 2020). Laari et al. (2018) and Jazairy & von Haartman (2020) are the opinion that investors are increasingly seeking companies that demonstrate proactive environmental responsibility, and GSCM provides a tangible way for companies to align their environmental goals with financial objectives. Drawing from the overview of prior research, the hypothesis we put forth is outlined as follows:

H5: GSCM influences on environmental costs

H6: GSCM influences on SVA

H7: GSCM influences on sustainable financial

Environmental costs

Harper & Snowden (2017) asses that environmental costs refer to the expenses and negative impacts incurred by businesses and society due to the degradation or depletion of natural resources, pollution, and environmental damage caused by human activities. These costs encompass a wide range of consequences, such as expenses for waste management, pollution control, environmental restoration, health care for those affected by pollution, and ecological damage repair. Additionally, Dreoni et al. (2022) believe that environmental costs can include intangible expenses, such as loss of biodiversity, ecosystem services, and adverse effects on human health and well-being. Environmental costs highlight the economic and social implications of unsustainable practices, emphasizing the need for businesses and society to adopt more environmentally responsible approaches to mitigate and minimize their negative environmental impact and move towards a more sustainable future (de Mello et al., 2020). By addressing and reducing environmental costs, companies can improve their SVA. Sustainable practices

that lead to reduced resource consumption, waste generation, and emissions can decrease environmental costs and increase efficiency, ultimately contributing to a more positive SVA (Niinimäki et al., 2020). Sustainable business practices can also improve a company's reputation, enhance stakeholder trust, and attract responsible investors who prioritize environmental performance (Khan et al., 2021). Addressing environmental costs through sustainable practices positively impacts sustainable finance, leading to cost savings, improved financial efficiency, and attracting responsible investors (Maltais & Nykvist, 2020). On the other hand, high environmental costs and negative impacts can result in financial risks and reduced investment attractiveness (Broughel & Wüstenhagen, 2022). By factoring in environmental considerations, investors and financial institutions can better assess a company's sustainability performance and financial viability (Rajesh & Rajendran, 2020). Embracing sustainable practices enhances alignment with sustainable finance principles, contributing to a more sustainable and resilient global economy (Akomea-Frimpong et al., 2022). Referring to the account provided by preceding research, we posit the following hypothesis:

H8: Environmental costs influence on SVA

H9: Environmental costs influence on sustainable financial performance

Sustainable value added

SVA measures the value created by a company beyond economic gains, considering its contributions to environmental and social well-being (Shad et al., 2019). Sustainable finance, on the other hand, involves incorporating environmental, social, and governance (ESG) criteria into investment decisions and financial practices (Gregory et al., 2021). According to Popescu et al. (2021), the concept of SVA aligns with sustainable finance principles by encouraging investors to consider a company's broader impact on society and the environment. By valuing sustainable practices and responsible corporate behavior, investors can identify companies that create positive social and environmental value and financial profits (Chang et al., 2022). Sustainable finance emphasizes investing in companies demonstrating environmental stewardship, social responsibility, and good governance practices (Drempetic et al., 2020). Companies with strong SVA, which positively contribute to the environment and society, are more likely to attract sustainable investments from socially conscious investors (Kölbel et al., 2020). Conversely, companies that neglect their environmental and social responsibilities may face reputational risks and negative financial consequences (D. Li et al., 2017). Sustainable finance incentivizes companies to adopt sustainable practices, reduce environmental impacts, and enhance their overall social and environmental contributions, ultimately improving their SVA (Hepei Li et al., 2023). Thus, the information and findings from previous researchers serve as the foundation for the hypothesis we put forward as follows:

H10: SVA influences on sustainable financial performance

The mediation effects

The study examines the interplay between various factors in the context of sustainable financial. Specifically, it investigates the potential mediation roles of GSCM, Environmental Cost, and SVA in the relationship between Carbon Accounting practices

and a company's financial sustainability. GSCM entails incorporating environmentally conscious practices within supply chain processes, while Environmental Cost encompasses expenses influences to environmental impact mitigation. SVA likely involves quantifying sustainability-driven value creation. By delving into these mediators, the research aims to shed light on how Carbon Accounting practices influences to and impact a company's overall financial sustainability. Therefore, the hypothesis we propose is as follows:

H11: GSCM mediates the relationship between carbon accounting and sustainable financial performance

H12: Environmental costs mediate the relationship between carbon accounting and sustainable financial performance

H13: SVA mediates the relationship between carbon accounting and sustainable financial performance

Based on the literature review and hypothesis development, the authors provide a holistic representation of the hypothesis in a unified framework, as illustrated in Figure 1.

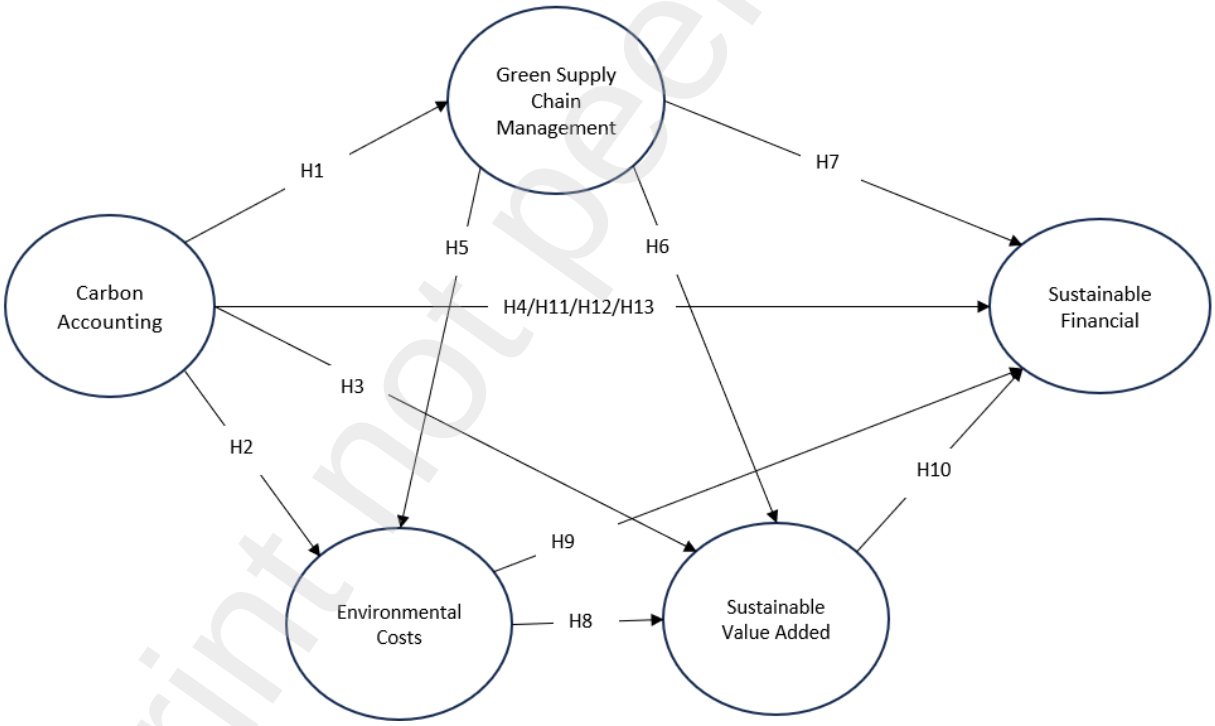

Fig. 1. Research Framework

Methodology

Research design and data collection

The research design adopts a quantitative approach to explore the relationship between sustainability practices, specifically carbon accounting, GSCM, environmental costs, SVA, and sustainable financial performance within the Indonesian chemical industry. This study focuses on a single point in time, collecting data from a diverse group of 154 companies operating in various sub-industries of the chemical sector.

Measurement Instruments

Quantitative measurement instruments are employed to capture relevant variables. GSCM practices are assessed through a validated questionnaire designed to gauge the extent to which companies implement environmentally conscious supply chain strategies adopted by (Rupa & Saif, 2021; Q. Zhang et al., 2022). Environmental costs adopted by (Luo et al., 2021). SVA adopted by (Agustiany et al., 2022). Carbon accounting practices are evaluated using structured surveys to quantify carbon emissions measurement and reporting adopted by (Alromaizan et al., 2023; He et al., 2022). Sustainable financial metrics are derived from (Chang et al., 2022; Khalil & Nimmanunta, 2023).

Sample selection and data analysis

A systematic sample selection process ensures representation from multiple sub-industries within the Indonesian chemical sector. Data were collected from 154 companies through surveys and financial reports, with the sample distribution encompassing various sub-industries in the chemical sector: petrochemicals (31 companies or 20%), pharmaceuticals and chemical materials (23 companies or 15%), agrochemicals (18 companies or 12%), consumer chemicals (15 companies or 10%), industrial chemicals (28 companies or 18%), renewable energy (15 companies or 10%), research and development (15 companies or 10%), and others (8 companies or 5%).. Quantitative data from the surveys and financial reports undergo rigorous statistical analysis using the sophisticated Structural Equation Modeling (SEM) technique. SEM's path analysis quantitatively examines the intricate relationships between GSCM, carbon accounting practices, environmental costs, SVA, and sustainable financial performance. This approach enhances our understanding of the quantitative interactions between sustainability practices and financial performance in the Indonesian chemical industry.

Results and finding

Validity and reliability

We evaluated the credibility of the indicator by utilizing the convergent method, which resulted in the external loading factor. The acceptable range for the loading factor in preliminary studies, which constitutes the initial phases of constructing a measurement scale, lies between 0.50 and 0.70. In our particular investigation, all indicators displayed an outer loading value surpassing 0.70, satisfying the convergent validity criteria (refer to Table 1). Subsequently, we compared the square root coefficient of variance (AVE) extracted from each latent factor with the correlation coefficient among the other elements within the model. This analysis aimed to ascertain discriminant validity in the variables, indicating their capability to distinguish between distinct categories. The AVE values notably exceeded 0.5, as shown in Table 1. Consequently, all constructs under scrutiny in this study exhibited discriminant validity higher than 0.50, aligning with the standards set by Fornell & Larcker (1981). In the final phase of the procedure, we employed composite reliability to assess the robustness of the variable indicators. The composite reliability and Cronbach's alpha exceeded 0.70, confirming the credibility of the outcomes (Chin, 2010).

Table 1. Confirmatory factor analysis

Construct	Items	Outer Loading	Cronbach's Alpha	rho_A	CR	AVE

Carbon Accounting	CAC1=Measurement of Carbon Emissions	0.723	0.952	0.954	0.962	0.783
	CAC2=Tracking of Emissions Sources	0.949				
	CAC3=Carbon Emissions Reporting	0.828				
	CAC4=Integration of Carbon Accounting in Decision-Making	0.952				
	CAC5=Identification of Emission Reduction Opportunities	0.949				
	CAC6=Collaboration for Carbon Reduction	0.811				
	CAC7=Investment in Carbon Offset Initiatives	0.954				
Green Supply Chain Management	GSCM1=Adoption of Environmentally Friendly Packaging Materials	0.836	0.938	0.944	0.951	0.766
	GSCM2=Use of Energy-Efficient Transportation Methods	0.916				
	GSCM3=Collaboration with Suppliers to Reduce Carbon Emissions	0.934				
	GSCM4=Reduction of Waste Generation through Improved Processes	0.876				
	GSCM5=Integration of Eco-Friendly Materials in Product Design	0.887				
	GSCM6=Implementation of Reverse Logistics for Product Recycling	0.796				
Environmental Costs	ENCO1=Expenditure on Pollution Control Measures	0.814	0.880	0.882	0.909	0.626
	ENCO2=Investment in Waste Management Systems	0.812				
	ENCO3=Compliance with Environmental Regulations	0.810				
	ENCO4=Implementation of Emission Control Technologies	0.716				
	ENCO5=Expenditure on Eco-Friendly Technologies	0.796				
	ENCO6=Costs Associated with Environmental Restoration	0.795				
Sustainable Value Added	SVA1=Resource Optimization and Cost Reduction	0.863	0.933	0.934	0.948	0.751
	SVA2=Positive Environmental Contribution	0.787				
	SVA3=Reputation Enhancement through Sustainable Practices	0.821				
	SVA4=Market Competitiveness through Sustainable Branding	0.905				
	SVA5=Alignment with Eco-Certifications and Standards	0.911				
	SVA6=Expansion into New Markets with Green Demand	0.905				
Sustainable Financial	SUF1=Financial Efficiency through Sustainability Practices	0.875	0.953	0.954	0.961	0.780

Performance	SUF2=Reduction of Regulatory and Legal Risks	0.884
	SUF3=Attraction of Responsible Investment	0.920
	SUF4=Alignment with Sustainable Finance Principles	0.912
	SUF5=Enhanced Financial Performance through Sustainability	0.914
	SUF6=Improved Risk Management through Sustainability	0.873
	SUF7=Contribution to Sustainable Development Goals (SDGs)	0.800

The computation of composite reliability for the variables within this investigation yielded values spanning from 0.909 to 0.962, surpassing the minimum threshold of 0.70. These outcomes suggest that the employed indicators for variable measurement were dependable and coherent. Furthermore, the obtained Cronbach's alpha values ranged from 0.880 to 0.953, confirming the indicators' reliability and indicating their immunity from measurement errors (MacKenzie et al., 2011).

Testing research hypothesis

Testing research hypotheses is a critical phase in the scientific inquiry, whether in natural sciences, social sciences, or other disciplines. It systematically subjects formulated hypotheses to empirical scrutiny and statistical analysis to assess their validity and reliability. This process serves as a litmus test for the research questions or objectives posed at the beginning of a study, helping researchers determine whether their proposed explanations or predictions hold. Through hypothesis testing, researchers aim to establish causal relationships, quantify the strength of associations between variables, and make statistically grounded inferences about populations based on sample data. It also plays a pivotal role in decision-making, guiding choices in various contexts, from business strategies and policy formulation to healthcare interventions. (see Table 2 and figure 2).

Table 2. Path Coefficient

Hypothesis	Construct	Original Sample	STDEV	T Statistics	P Values	Result
H1	CAC -> GSCM	0.671	0.066	10.192	0.000	Accepted
H2	CAC -> ENCO	0.762	0.059	12.911	0.000	Accepted
H3	CAC -> SVA	0.452	0.136	3.328	0.001	Accepted
H4	CAC -> SUF	0.184	0.089	2.074	0.039	Accepted
H5	GSCM -> ENCO	0.141	0.069	2.039	0.042	Accepted
H6	GSCM -> SVA	0.017	0.076	0.222	0.825	Rejected
H7	GSCM -> SUF	0.227	0.081	2.798	0.005	Accepted
H8	ENCO -> SVA	1.088	0.126	8.624	0.000	Accepted
H9	ENCO -> SUF	0.161	0.121	1.333	0.183	Rejected
H10	SVA -> SUF	0.715	0.067	10.637	0.000	Accepted

*): CAC=Carbon Accounting; GSCM=Green Supply Chain Management; ENCO=Environmental Costs; SVA=Sustainable Value Added; SUF=Sustainable Financial Performance

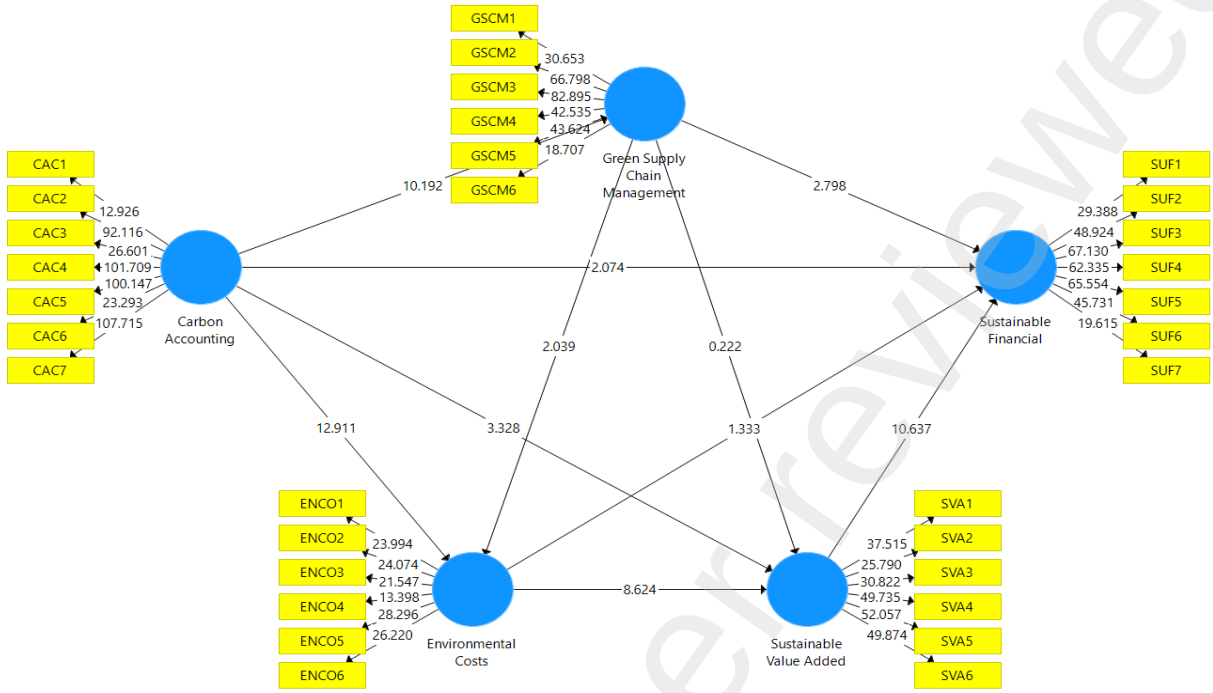

Fig. 2. Bootstrapping Inner Model

The table displays the outcomes of hypothesis testing for various constructs in the study, shedding light on the relationships among these constructs within the Indonesian chemical industry. H1 is affirmed. The analysis reveals a statistically significant association with a T-statistic of 10.192 and a p-value of 0.000, leading to the confirmation of this hypothesis. It suggests a positive and substantial correlation between Carbon Accounting and GSCM in the context of the industry under investigation. H2 is validated. This hypothesis also demonstrates a statistically significant connection with a T-statistic of 12.911 and a p-value of 0.000, resulting in its acceptance. It signifies a robust positive link between Carbon Accounting and Environmental Costs, indicating that improved carbon measurement and management are linked to greater investments in environmental costs. H3 is accepted. The analysis uncovers a statistically significant relationship with a T-statistic of 3.328 and a p-value of 0.001, leading to the affirmation of this hypothesis. It implies a favorable connection between Carbon Accounting and SVA suggesting that companies emphasizing carbon accounting also tend to experience increased sustainable value added. H4 is supported. This hypothesis exhibits a statistically significant relationship with a T-statistic of 2.074 and a p-value of 0.039, resulting in its endorsement. It implies a positive relationship between Carbon Accounting and Sustainable Financial, indicating that companies with more robust carbon accounting practices display enhanced financial sustainability. H5 is acknowledged. This hypothesis uncovers a statistically significant relationship with a T-statistic of 2.039 and a p-value of 0.042, leading to its acceptance. It indicates a favorable link between GSCM and Environmental Costs, underscoring that companies with effective green supply chain management practices tend to allocate more resources to environmental costs. H6 is dismissed. This hypothesis is rejected as the p-value is 0.825, surpassing the significance level of 0.05. It implies the absence of a substantial connection between GSCM and SVA within the study's context. H7 is affirmed. The analysis

demonstrates a statistically significant relationship with a T-statistic of 2.798 and a p-value of 0.005, leading to the validation of this hypothesis. It suggests a positive correlation between GSCM and Sustainable Financial, indicating that companies with more robust green supply chain management practices tend to attain greater financial sustainability. H8 is confirmed. This hypothesis reveals a statistically significant relationship with a T-statistic of 8.624 and a p-value of 0.000, resulting in its confirmation. It indicates a positive association between Environmental Costs and SVA implying that companies allocating more resources to reduce environmental costs are likely to enhance sustainable value added. H9 is rejected. This hypothesis is declined as the p-value is 0.183, exceeding the significance level of 0.05. It implies the absence of a significant relationship between Environmental Costs and Sustainable Financial Performance within the study's context. H10 is ratified. The analysis demonstrates a statistically significant connection with a T-statistic of 10.637 and a p-value of 0.000, leading to the endorsement of this hypothesis. It implies a substantial positive link between SVA and Sustainable Financial. It indicates that companies with higher sustainable value added also tend to exhibit greater financial sustainability. These findings offer valuable insights into the interplay among these constructs and establish a basis for comprehending the dynamics of sustainability and financial performance in the Indonesian chemical industry. Furthermore, the study examines the pathway coefficients to investigate whether GSCM, environmental costs, and SVA can mediate the relationship between carbon accounting on sustainable financial performance (Table 3).

Table 3. Mediation test

Hypothesis	Construct *)	Original Sample	STDEV	T Statistics	P Values	Result
H11	CAC -> GSCM -> SUF	0.152	0.062	2.439	0.015	Accepted
H12	CAC -> ENCO -> SUF	0.122	0.094	1.309	0.191	Rejected
H13	CAC -> SVA -> SUF	0.323	0.101	3.189	0.002	Accepted

*): CAC=Carbon Accounting; GSCM=Green Supply Chain Management; ENCO=Environmental Costs; SVA=Sustainable Value Added; SUF=Sustainable Financial Performance

The provided table in the research study offers a comprehensive view of the results of hypothesis testing, with a particular focus on mediating relationships. Hypothesis H11, the hypothesis suggests a mediating relationship, indicating that the influence of Carbon Accounting on Sustainable Financial Performance is mediated by GSCM. The results support this hypothesis, signifying the presence of a significant mediating relationship. On the other hand, Hypothesis H12 introduces a different mediating relationship, suggesting that the impact of Carbon Accounting on Sustainable Financial Performance is mediated by Environmental Costs. However, the analysis reveals that this hypothesis is rejected, as the p-value exceeds the predefined significance level of 0.05. This outcome implies that there is no substantial mediating relationship between CAC, ENCO, and SUF. Lastly, Hypothesis H13 follows a similar pattern to H11 and suggests a mediating relationship. It posits that the influence of Carbon Accounting on Sustainable Financial is mediated by SVA. The results indicate that this hypothesis is accepted, underscoring the presence of a mediating relationship. In summary, the analysis of these hypotheses reveals the presence of mediating constructs (GSCM and SVA) in connecting Carbon Accounting with Sustainable Financial Performance, although such mediation is not supported in the case of Environmental Costs. These findings offer valuable insights into the interplay between these constructs and contribute to a deeper understanding of sustainability and financial performance within the Indonesian chemical industry.

Discussion

Acceptance of H1 is supported by the statement "carbon accounting has a positive and significant impact on GSCM," which can be interpreted as indicating within the context of the Indonesian chemical industry, the practice of measuring and reporting carbon emissions has a noteworthy and beneficial effect on the implementation of GSCM. It implies that companies employing robust carbon accounting practices tend to exhibit higher levels of GSCM adoption. The finding suggests that environmental awareness of carbon emissions drives companies to embrace more eco-friendly GSCM practices. These findings align with Shen et al. (2023) that companies can identify opportunities to reduce environmental impacts within their supply chains by tracking and reporting carbon emissions. GSCM practices such as employing environmentally friendly packaging materials, sustainable transportation, and collaborative efforts with suppliers for emission reduction become prioritized by companies with a deeper understanding of their carbon impact (Fang et al., 2022). It implicated the Indonesian chemical industry that by recognizing the pivotal role of carbon accounting in driving GSCM practices, companies can proactively position themselves for enhanced operational efficiency, reduced environmental impact, and improved stakeholder perception, thereby fostering a sustainable competitive advantage.

The assertion that "carbon accounting has a positive and significant impact on environmental costs" signifies the acceptance of H2. Within the Indonesian chemical industry, it underscores the pivotal role of effective carbon emissions measurement and reporting in shaping companies incurred environmental costs. It implies that enterprises embracing robust carbon accounting practices are positioned for reduced ecological expenditures. The finding means that heightened awareness of carbon emissions motivates businesses to adopt more sustainable operational approaches, culminating in diminished environmental outlays. By meticulously monitoring and managing carbon emissions, companies are better positioned to identify emission focal points and execute targeted strategies for their mitigation, resulting in tangible cost savings associated with pollution control measures, waste management, and adherence to environmental regulations (Kelly et al., 2019). These findings carry noteworthy managerial implications that underscore the strategic value of carbon accounting. It aids in facilitating environmentally mindful decision-making, abating environmental costs, and advancing overall sustainability within the chemical industry.

The statement "carbon accounting has a positive and significant impact on sustainable value added" can be comprehended as suggesting that H3 accepted, within the context of the Indonesian chemical industry, the effective measurement and reporting of carbon emissions play a pivotal role in enhancing the creation of sustainable value added by companies. It implies that organizations that adopt robust carbon accounting practices tend to exhibit higher levels of sustainable value added. The finding underscores that a heightened awareness of carbon emissions prompts companies to integrate eco-friendly practices into their operations, leading to positive environmental and societal contributions, which translates to increased sustainable value added. Velvizhi et al. (2022) assert that by tracking and managing carbon emissions, companies are better positioned to optimize resource usage, minimize waste generation, and improve overall environmental performance, enhancing their reputation and attracting environmentally conscious stakeholders. These findings carry managerial implications that the integral link between carbon accounting and the creation of sustainable value-added, emphasizing the strategic importance of environmental responsibility in generating enduring value within the chemical industry.

The assertion that "carbon accounting has a positive and significant impact on sustainable financial performance" carries noteworthy managerial implications. It signifies the acceptance of H4, highlighting that within the context of the Indonesian chemical industry, the adept measurement and comprehensive reporting of carbon emissions assume a pivotal role in shaping companies' sustainable financial trajectories. Enterprises that embrace robust carbon accounting practices are poised to experience improved economic sustainability outcomes, establishing a compelling case for their adoption. This finding accentuates that a heightened awareness of carbon emissions propels companies to integrate environmentally responsible practices into their operational fabric seamlessly. This integration manifests as heightened operational efficiency, reasonable cost management, and effective risk mitigation strategies. These contributing factors collectively foster a positive influence on financial performance. Through meticulous monitoring and strategic direction of carbon emissions, corporations strategically position themselves to identify and harness opportunities for resource optimization, waste reduction, and precise emission control (Popescu et al., 2021). This process ensures a coherent alignment between their financial objectives and ecological stewardship. Furthermore, the findings underscore the significance of this harmonious integration, presenting a two-pronged route to success that encompasses financial prosperity and ecological responsibility (He et al., 2022). This holistic approach can enhance both profitability and environmental conscientiousness, effectively positioning companies for a competitive edge within the complex landscape of the chemical industry.

The assertion that "GSCM has a positive and significant impact on environmental costs" can be construed as the acceptance of H4. Within the Indonesian chemical industry sphere, it underscores the pivotal role played by the adoption and execution of GSCM principles in shaping the costs linked to environmental impacts. It implies that companies that give precedence to GSCM practices are poised for reduced environmental expenses. The finding underscores that organizations can efficaciously shorten environmental repercussions by infusing ecologically sound practices throughout the supply chain, encompassing the use of sustainable materials, optimization of transportation methods, and collaborative endeavors with suppliers to curtail emissions (Shao et al., 2021. Consequently, this leads to diminished expenditures associated with waste management, pollution mitigation, and regulatory adherence. Embracing GSCM reflects a proactive commitment to sustainability and translates into tangible financial advantages through the ease of adverse environmental externalities (Knoppen & Knight, 2022). These implications accentuate the managerial significance of prioritizing GSCM as a strategic mechanism for simultaneously advancing environmental objectives and bolstering financial outcomes within the chemical industry.

The observation that GSCM not significantly impact SVA signifies the rejection of H6. Within the confines of the Indonesian chemical industry, this underscores that adopting and implementing GSCM practices might not inherently lead to a direct contribution to the generation of sustainable value added. While GSCM principles center on environmentally responsible practices throughout the supply chain, their immediate correlation with substantial enhancements in the broader sustainable value added by a company might need to be more apparent (Q. Zhang et al., 2022). This finding implies that factors beyond GSCM, such as innovation, product differentiation, and market strategies, could wield significant influence over creating sustainable value added within the

chemical industry. While GSCM remains pivotal for environmental responsibility and operational efficiency, its direct nexus to the broader concept of sustainable value-added may necessitate further clarification within this industry-specific context. This interpretation underscores the importance of incorporating supplementary variables and strategies beyond GSCM to optimize the generation of sustainable value added within the chemical sector. Managers should explore a comprehensive approach encompassing various business aspects to drive sustainable value creation effectively.

The discovery that GSCM significantly and positively affects Sustainable Financial Performance underscores the acceptance of H7. Within the context of the Indonesian chemical industry, the adoption and execution of GSCM practices emerge as pivotal in shaping the financial sustainability of companies. It implies that entities that give precedence to GSCM principles tend to experience enhanced economic outcomes congruent with their sustainability objectives. This outcome accentuates that integrating environmentally conscious practices throughout the supply chain, encompassing resource optimization, waste reduction, and collaboration with ecologically mindful suppliers, contributes to heightened environmental responsibility and translates into augmented financial efficiency and operational efficacy. Jazairy & von Haartman (2020) assert that the adoption of GSCM signifies a proactive dedication to sustainable practices that resonate with investors seeking entities characterized by responsible economic and environmental performance. This implication underscores the managerial significance of prioritizing GSCM as a strategic mechanism for advancing financial and sustainability objectives, effectively harmonizing economic prosperity with ecological responsibility.

The outcome revealing a positive and substantial influence of Environmental Costs on SVA signifies the acceptance of H8. Within the Indonesian chemical industry framework, it becomes apparent that expenses attributed to environmental degradation and pollution exert a noteworthy role in shaping the generation of sustainable value added by corporations. It implies that the financial impact of addressing ecological concerns significantly contributes to the broader value-creation efforts of companies. Entities with higher environmental costs tend to display commendable initiatives in adopting environmentally conscious practices and mitigating their adverse ecological footprint (Dreoni et al., 2022). The finding underscores that augmented expenditures on pollution control measures, waste management, and adherence to environmental standards manifestly enhance the creation of a more positive Sustainable Value Added. It indicates companies' unwavering dedication to sustainability and their role as responsible corporate citizens (de Mello et al., 2020). By actively managing and curbing their environmental costs, corporations can harmonize their financial achievements with broader societal and environmental goals, elevating their standing and appeal among stakeholders who prioritize sustainable practices (Niinimäki et al., 2020). This implication accentuates the managerial importance of optimizing financial performance while advancing ecological stewardship.

The discovery that Environmental Costs have no significant impact on Sustainable Financial Performance signifies the rejection of H9. Specifically, within the framework of the Indonesian chemical industry, the expenditures linked to environmental degradation and pollution may not directly influence the financial sustainability of corporations. It implies that heightened environmental costs sometimes translate into improved economic outcomes that align with sustainability objectives. The result underscores that while addressing environmental costs and mitigating ecological impacts are crucial endeavors, they may not inherently yield substantial financial benefits or lead to enhanced financial performance. Other variables and strategies beyond the direct

reduction of environmental costs, such as innovation, market differentiation, and financial management, might exert a more pronounced influence on determining the sustainable financial performance of companies within this industry. This interpretation underscores the necessity for a comprehensive approach that considers many factors to effectively balance environmental responsibility and financial viability within the chemical sector. This implication highlights the managerial importance of adopting a holistic perspective that acknowledges the complex interplay between ecological and economic considerations.

The outcome highlighting a positive and significant influence of SVA on Sustainable Financial Performance indicates the acceptance of H10. Within the landscape of the Indonesian chemical industry, this suggests that the generation of value that encompasses both environmental and social contributions significantly shape the overall financial sustainability of companies. Entities that manifest a robust commitment to sustainability and responsible business practices, as evidenced by their Sustainable Value Added, tend to achieve enhanced economic outcomes (Drempetic et al., 2020). This finding accentuates that corporations emphasizing generating positive environmental and social impacts alongside financial gains elevate their reputation, foster stakeholder confidence, and draw the attention of conscientious investors who seek alignment with sustainability principles (Kölbel et al., 2020). By purposefully creating meaningful, sustainable value through resource optimization, waste reduction, and eco-friendly initiatives, companies can directly contribute to their long-term financial prosperity while concurrently advancing broader environmental and social aspirations (Chang et al., 2022). This implication underscores the managerial significance of orchestrating value-creation strategies holistically addressing economic and sustainability dimensions, effectively fostering enduring success within the chemical sector.

The discovery that GSCM and SVA mediate the relationship between carbon accounting and Sustainable Financial Performance, while Environmental Costs do not mediate the relationship between carbon accounting and Sustainable Financial Performance, yields insightful managerial implications. Within the Indonesian chemical industry, this underscores the pivotal roles played by GSCM and the creation of sustainable value added in bridging carbon accounting practices with improved financial outcomes. It suggests that effective integration of carbon accounting practices within companies' operations amplifies the positive impact on financial sustainability, synergistically reinforced by their proactive commitment to environmentally responsible practices across the supply chain and their contributions to environmental and societal welfare. However, the absence of a mediating effect by Environmental Costs indicates that while the management of carbon emissions might indirectly influence financial performance through the mechanisms of GSCM and SVA savings (Kelly et al., 2019), the direct relationship between carbon accounting and financial sustainability might not significantly hinge on the immediate reduction of environmental costs. This interpretation underscores the nuanced interplay between ecological practices, the creation of sustainable value, and financial success, highlighting the distinct roles of GSCM, SVA, and environmental costs as mediators within the intricate path toward achieving financial sustainability in the chemical industry. This implication underscores the managerial necessity of adopting a comprehensive perspective that acknowledges the multifaceted dynamics shaping the relationship between ecological responsibility, value creation, and financial prosperity.

Conclusion

The study's comprehensive examination of the Indonesian chemical industry provides valuable insights into the intricate relationships between carbon accounting, GSCM, environmental costs, SVA, and sustainable financial performance. The interpretation of the impact of carbon accounting on GSCM highlights the pivotal role of measuring and reporting carbon emissions in fostering a commitment to environmentally conscious practices throughout the supply chain. The positive correlation between carbon accounting and environmental costs reaffirms the strategic importance of eco-friendly practices in reducing ecological expenses, thus enhancing the industry's environmental footprint and cost efficiency. Moreover, the linkage between carbon accounting and sustainable value-added underscores the potential for companies to create enduring value by incorporating eco-friendly practices into their operations. This finding reinforces the notion that environmental consciousness can be a catalyst for both societal and economic benefits. Furthermore, the significant impact of carbon accounting on sustainable financial performance underscores the potential financial advantages of aligning environmental responsibility with overall business objectives. By effectively measuring and managing carbon emissions, companies can tap into enhanced operational efficiency, cost reduction, and risk mitigation, ultimately contributing to their financial bottom line.

The analysis also reveals the intricate interplay of GSCM with environmental costs, SVA and sustainable financial performance. While the lack of direct influence of GSCM on SVA suggests the need for a more comprehensive approach to value creation in the chemical industry, the positive correlation between GSCM and sustainable financial performance highlights the tangible economic benefits of embracing eco-friendly practices and optimizing supply chain efficiency. Finally, the mediating role of GSCM and SVA in connecting carbon accounting to financial outcomes emphasizes the intricate pathways through which environmental practices influence financial sustainability. These findings collectively provide valuable insights for industry stakeholders, guiding them in navigating the multifaceted landscape of sustainability and financial viability in the context of the Indonesian chemical industry.

Theoretical and practical implications

This study contributes to the theoretical understanding of the relationships between carbon accounting, GSCM environmental costs, SVA, and sustainable financial performance within the Indonesian chemical industry. The findings enrich the existing body of knowledge by highlighting the pivotal role of carbon accounting in influencing various facets of sustainability and financial outcomes. Identifying GSCM and SVA as mediators between carbon accounting and sustainable financial performance adds depth to understanding the complex pathways through which environmental practices impact financial success. Moreover, the observed lack of direct influence of GSCM on sustainable value-added emphasizes the necessity of considering additional factors beyond GSCM for value creation in this industry context. These theoretical insights provide a foundation for future research endeavors that delve deeper into the underlying mechanisms and contextual factors driving the observed relationships.

The practical implications of this study offer valuable guidance for industry practitioners and policymakers in the Indonesian chemical sector. The findings underscore the importance of implementing robust carbon accounting practices for environmental benefits and enhanced GSCM adoption, reduced ecological costs, increased SVA, and improved financial performance. Organizations are encouraged to integrate carbon accounting as a strategic tool for identifying emission hotspots,

optimizing resource usage, and collaborating with suppliers to minimize environmental impacts. By doing so, companies can bolster their commitment to sustainability while reaping the financial benefits of operational efficiency and cost reduction. The study also emphasizes the need to recognize the multifaceted nature of sustainable value-added and consider diverse strategies beyond GSCM to enhance enduring value creation. Policymakers can use these insights to formulate regulations that incentivize the integration of carbon accounting and eco-friendly practices in the chemical industry, fostering a more sustainable and economically resilient sector.

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Limitations and recommendations for future research

It's crucial to acknowledge the rules of this study. The research is confined to the Indonesian chemical industry, potentially limiting its generalizability to other sectors or geographical contexts. Additionally, the reliance on cross-sectional data prevents the establishment of definitive causal relationships. Future research endeavors could extend the scope to encompass diverse industries and regions, employing longitudinal designs to unravel the intricacies of the interplay among carbon accounting, GSCM, SVA, environmental costs, and financial sustainability. Moreover, investigating potential moderating factors and firm-specific attributes could provide deeper insights into the nuances of these relationships. In summary, this study advances our understanding of the intricate interactions between environmental and financial dimensions in the Indonesian chemical industry. The amalgamation of sustainability practices, carbon accounting, GSCM, SVA, and environmental costs underscores the need for integrated strategies that synergize financial prosperity and ecological responsibility.

References

Agrawal, V., Mohanty, R. P., Agarwal, S., Dixit, J. K., & Agrawal, A. M. (2023). Analyzing critical success factors for sustainable green supply chain management. *Environment, Development and Sustainability*, *25*(8), 8233–8258. https://doi.org/10.1007/s10668-022-02396-2

Agustiany, E. A., Rasyidur Ridho, M., Rahmi D. N., M., Madyaratri, E. W., Falah, F., Lubis, M. A. R., Solihat, N. N., Syamani, F. A., Karungamye, P., Sohail, A., Nawawi, D. S., Prianto, A. H., Iswanto, A. H., Ghozali, M., Restu, W. K., Juliana, I., Antov, P., Kristak, L., Fatriasari, W., & Fudholi, A. (2022). Recent developments in lignin modification and its application in lignin-based green composites: A review. *Polymer Composites*, *43*(8), 4848–4865. https://doi.org/https://doi.org/10.1002/pc.26824

Akomea-Frimpong, I., Adeabah, D., Ofosu, D., & Tenakwah, E. J. (2022). A review of studies on green finance of banks, research gaps and future directions. *Journal of Sustainable Finance & Investment*, *12*(4), 1241–1264. https://doi.org/10.1080/20430795.2020.1870202

Alromaizan, M., Afy-Shararah, M., Jagtap, S., Litos, L., & Salonitis, K. (2023). Developing a Carbon Accounting Tool for SMEs in the Agri-Food Sector. *Procedia CIRP*, *116*, 492–497. https://doi.org/https://doi.org/10.1016/j.procir.2023.02.083

Ascione, F., De Masi, R. F., Mastellone, M., & Vanoli, G. P. (2022). Building rating systems: A novel review about capabilities, current limits and open issues. *Sustainable Cities and Society*, *76*, 103498. https://doi.org/https://doi.org/10.1016/j.scs.2021.103498

Balon, V. (2020). Green supply chain management: Pressures, practices, and performance—An integrative literature review. *Business Strategy & Development*, *3*(2), 226–244. https://doi.org/https://doi.org/10.1002/bsd2.91

Barforoush, N., Etebarian, A., Naghsh, A., & Shahin, A. (2021). Green innovation a strategic resource to attain competitive advantage. *International Journal of Innovation Science*, *13*(5), 645–663. https://doi.org/10.1108/IJIS-10-2020-0180

Bhubalan, K., Tamothran, A. M., Kee, S. H., Foong, S. Y., Lam, S. S., Ganeson, K., Vigneswari, S., Amirul, A.-A., & Ramakrishna, S. (2022). Leveraging blockchain concepts as watermarkers of plastics for sustainable waste management in progressing circular economy. *Environmental Research*, *213*, 113631. https://doi.org/https://doi.org/10.1016/j.envres.2022.113631

Broughel, A., & Wüstenhagen, R. (2022). *The Influence of Policy Risk on Swiss Wind Power Investment BT - Swiss Energy Governance: Political, Economic and Legal Challenges and Opportunities in the Energy Transition* (P. Hettich & A. Kachi (eds.); pp. 345–368). Springer International Publishing. https://doi.org/10.1007/978-3-030-80787-0_14

Chang, X., Fu, K., Jin, Y., & Liem, P. F. (2022). Sustainable Finance: ESG/CSR, Firm Value, and Investment Returns*. *Asia-Pacific Journal of Financial Studies*, *51*(3), 325–371. https://doi.org/https://doi.org/10.1111/ajfs.12379

Chen, T.-L., Kim, H., Pan, S.-Y., Tseng, P.-C., Lin, Y.-P., & Chiang, P.-C. (2020). Implementation of green chemistry principles in circular economy system towards sustainable development goals: Challenges and perspectives. *Science of The Total Environment*, *716*, 136998. https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.136998

Chin, W. W. (2010). How to write up and report PLS analyses. In *Handbook of Partial Least Squares* (pp. 188–194). https://doi.org/10.1007/978-3-540-32827-8_29

Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F. N., & Leip, A. (2021). Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*, *2*(3), 198–209. https://doi.org/10.1038/s43016-021-00225-9

Dangelico, R. M., & Vocalelli, D. (2017). "Green Marketing": An analysis of definitions, strategy steps, and tools through a systematic review of the literature. *Journal of Cleaner Production*, *165*, 1263–1279. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.07.184

Danish, Ulucak, R., & Khan, S. U.-D. (2020). Determinants of the ecological footprint: Role of renewable energy, natural resources, and urbanization. *Sustainable Cities and Society*, *54*, 101996. https://doi.org/https://doi.org/10.1016/j.scs.2019.101996

de Mello, N. G. R., Gulinck, H., Van den Broeck, P., & Parra, C. (2020). Social-ecological sustainability of non-timber forest products: A review and theoretical considerations for future research. *Forest Policy and Economics*, *112*, 102109. https://doi.org/https://doi.org/10.1016/j.forpol.2020.102109

Demeter, C., Lin, P.-C., Sun, Y.-Y., & Dolnicar, S. (2022). Assessing the carbon footprint of tourism businesses using environmentally extended input-output analysis. *Journal of Sustainable Tourism*, *30*(1), 128–144. https://doi.org/10.1080/09669582.2021.1924181

Drempetic, S., Klein, C., & Zwergel, B. (2020). The Influence of Firm Size on the ESG Score: Corporate Sustainability Ratings Under Review. *Journal of Business Ethics*, *167*(2), 333–360. https://doi.org/10.1007/s10551-019-04164-1

Dreoni, I., Matthews, Z., & Schaafsma, M. (2022). The impacts of soy production on multi-dimensional well-being and ecosystem services: A systematic review. *Journal of Cleaner Production*, *335*, 130182. https://doi.org/https://doi.org/10.1016/j.jclepro.2021.130182

Faisal, F., Andiningtyas, E. D., Achmad, T., Haryanto, H., & Meiranto, W. (2018). The content and determinants of greenhouse gas emission disclosure: Evidence from

Indonesian companies. *Corporate Social Responsibility and Environmental Management*, *25*(6), 1397–1406. https://doi.org/https://doi.org/10.1002/csr.1660
Fang, K., Li, C., Tang, Y., He, J., & Song, J. (2022). China's pathways to peak carbon emissions: New insights from various industrial sectors. *Applied Energy*, *306*, 118039. https://doi.org/https://doi.org/10.1016/j.apenergy.2021.118039
Farjana, S. H., Huda, N., Mahmud, M. A. P., & Saidur, R. (2018). Solar industrial process heating systems in operation – Current SHIP plants and future prospects in Australia. *Renewable and Sustainable Energy Reviews*, *91*, 409–419. https://doi.org/https://doi.org/10.1016/j.rser.2018.03.105
Fatimah, Y. A., Govindan, K., Murniningsih, R., & Setiawan, A. (2020). Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia. *Journal of Cleaner Production*, *269*, 122263. https://doi.org/https://doi.org/10.1016/j.jclepro.2020.122263
Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50. https://doi.org/10.1177/002224378101800104
Gregory, R. P., Stead, J. G., & Stead, E. (2021). The global pricing of environmental, social, and governance (ESG) criteria. *Journal of Sustainable Finance & Investment*, *11*(4), 310–329. https://doi.org/10.1080/20430795.2020.1731786
Harper, C., & Snowden, M. (2017). *Environment and society: Human perspectives on environmental issues*. Routledge.
He, R., Luo, L., Shamsuddin, A., & Tang, Q. (2022). Corporate carbon accounting: a literature review of carbon accounting research from the Kyoto Protocol to the Paris Agreement. *Accounting & Finance*, *62*(1), 261–298. https://doi.org/https://doi.org/10.1111/acfi.12789
Jazairy, A., & von Haartman, R. (2020). Analysing the institutional pressures on shippers and logistics service providers to implement green supply chain management practices. *International Journal of Logistics Research and Applications*, *23*(1), 44–84. https://doi.org/10.1080/13675567.2019.1584163
Jia, F., Peng, S., Green, J., Koh, L., & Chen, X. (2020). Soybean supply chain management and sustainability: A systematic literature review. *Journal of Cleaner Production*, *255*, 120254. https://doi.org/https://doi.org/10.1016/j.jclepro.2020.120254
Kelly, C., Onat, N. C., & Tatari, O. (2019). Water and carbon footprint reduction potential of renewable energy in the United States: A policy analysis using system dynamics. *Journal of Cleaner Production*, *228*, 910–926. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.04.268
Khalil, M. A., & Nimmanunta, K. (2023). Conventional versus green investments: advancing innovation for better financial and environmental prospects. *Journal of Sustainable Finance & Investment*, *13*(3), 1153–1180. https://doi.org/10.1080/20430795.2021.1952822
Khan, P. A., Johl, S. K., & Johl, S. K. (2021). Does adoption of ISO 56002-2019 and green innovation reporting enhance the firm sustainable development goal performance? An emerging paradigm. *Business Strategy and the Environment*, *30*(7), 2922–2936. https://doi.org/https://doi.org/10.1002/bse.2779
Khan, S. A. R., Yu, Z., & Farooq, K. (2023). Green capabilities, green purchasing, and triple bottom line performance: Leading toward environmental sustainability. *Business Strategy and the Environment*, *32*(4), 2022–2034. https://doi.org/https://doi.org/10.1002/bse.3234

Knoppen, D., & Knight, L. (2022). Pursuing sustainability advantage: The dynamic capabilities of born sustainable firms. *Business Strategy and the Environment*, *31*(4), 1789–1813. https://doi.org/https://doi.org/10.1002/bse.2984

Kölbel, J. F., Heeb, F., Paetzold, F., & Busch, T. (2020). Can Sustainable Investing Save the World? Reviewing the Mechanisms of Investor Impact. *Organization & Environment*, *33*(4), 554–574. https://doi.org/10.1177/1086026620919202

Kotsantonis, S., Pinney, C., & Serafeim, G. (2016). ESG Integration in Investment Management: Myths and Realities. *Journal of Applied Corporate Finance*, *28*(2), 10–16. https://doi.org/https://doi.org/10.1111/jacf.12169

Krevor, S., de Coninck, H., Gasda, S. E., Ghaleigh, N. S., de Gooyert, V., Hajibeygi, H., Juanes, R., Neufeld, J., Roberts, J. J., & Swennenhuis, F. (2023). Subsurface carbon dioxide and hydrogen storage for a sustainable energy future. *Nature Reviews Earth & Environment*, *4*(2), 102–118. https://doi.org/10.1038/s43017-022-00376-8

Laari, S., Töyli, J., & Ojala, L. (2018). The effect of a competitive strategy and green supply chain management on the financial and environmental performance of logistics service providers. *Business Strategy and the Environment*, *27*(7), 872–883. https://doi.org/https://doi.org/10.1002/bse.2038

Li, D., Xin, L., Chen, X., & Ren, S. (2017). Corporate social responsibility, media attention and firm value: empirical research on Chinese manufacturing firms. *Quality & Quantity*, *51*(4), 1563–1577. https://doi.org/10.1007/s11135-016-0352-z

Li, Hepei, Chen, C., & Umair, M. (2023). Green Finance, Enterprise Energy Efficiency, and Green Total Factor Productivity: Evidence from China. In *Sustainability* (Vol. 15, Issue 14). https://doi.org/10.3390/su151411065

Li, Hui, Li, Y., Sarfarz, M., & Ozturk, I. (2023). Enhancing firms' green innovation and sustainable performance through the mediating role of green product innovation and moderating role of employees' green behavior. *Economic Research-Ekonomska Istraživanja*, *36*(2), 2142263. https://doi.org/10.1080/1331677X.2022.2142263

Li, J., Song, G., Cai, M., Bian, J., & Sani Mohammed, B. (2022). Green environment and circular economy: A state-of-the-art analysis. *Sustainable Energy Technologies and Assessments*, *52*, 102106. https://doi.org/https://doi.org/10.1016/j.seta.2022.102106

Luo, W., Zhang, Y., Gao, Y., Liu, Y., Shi, C., & Wang, Y. (2021). Life cycle carbon cost of buildings under carbon trading and carbon tax system in China. *Sustainable Cities and Society*, *66*, 102509. https://doi.org/https://doi.org/10.1016/j.scs.2020.102509

MacKenzie, S. B., Podsakoff, P. M., & Podsakoff, N. . (2011). Construct measurement and validation procedures in MIS and behavioral research: integrating new and existing techniques. *MIS Quarterly*, *35*(2), 293–334.

Maltais, A., & Nykvist, B. (2020). Understanding the role of green bonds in advancing sustainability. *Journal of Sustainable Finance & Investment*, 1–20. https://doi.org/10.1080/20430795.2020.1724864

Mohammad Ebrahimi, S., & Koh, L. (2021). Manufacturing sustainability: Institutional theory and life cycle thinking. *Journal of Cleaner Production*, *298*, 126787. https://doi.org/https://doi.org/10.1016/j.jclepro.2021.126787

Moshood, T. D., Nawanir, G., Mahmud, F., Mohamad, F., Ahmad, M. H., & AbdulGhani, A. (2022). Sustainability of biodegradable plastics: New problem or solution to solve the global plastic pollution? *Current Research in Green and Sustainable Chemistry*, *5*, 100273. https://doi.org/https://doi.org/10.1016/j.crgsc.2022.100273

Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., & Gwilt, A. (2020). The

environmental price of fast fashion. *Nature Reviews Earth & Environment*, *1*(4), 189–200. https://doi.org/10.1038/s43017-020-0039-9

Popescu, I.-S., Hitaj, C., & Benetto, E. (2021). Measuring the sustainability of investment funds: A critical review of methods and frameworks in sustainable finance. *Journal of Cleaner Production*, *314*, 128016. https://doi.org/https://doi.org/10.1016/j.jclepro.2021.128016

Rajesh, R., & Rajendran, C. (2020). Relating Environmental, Social, and Governance scores and sustainability performances of firms: An empirical analysis. *Business Strategy and the Environment*, *29*(3), 1247–1267. https://doi.org/https://doi.org/10.1002/bse.2429

Rezaee, Z. (2016). Business sustainability research: A theoretical and integrated perspective. *Journal of Accounting Literature*, *36*(1), 48–64. https://doi.org/10.1016/j.acclit.2016.05.003

Rupa, R. A., & Saif, A. N. M. (2021). Impact of Green Supply Chain Management (GSCM) on Business Performance and Environmental Sustainability: Case of a Developing Country. *Business Perspectives and Research*, *10*(1), 140–163. https://doi.org/10.1177/2278533720983089

Shad, M. K., Lai, F.-W., Fatt, C. L., Klemeš, J. J., & Bokhari, A. (2019). Integrating sustainability reporting into enterprise risk management and its relationship with business performance: A conceptual framework. *Journal of Cleaner Production*, *208*, 415–425. https://doi.org/https://doi.org/10.1016/j.jclepro.2018.10.120

Shao, X., Zhong, Y., Liu, W., & Li, R. Y. M. (2021). Modeling the effect of green technology innovation and renewable energy on carbon neutrality in N-11 countries? Evidence from advance panel estimations. *Journal of Environmental Management*, *296*, 113189. https://doi.org/https://doi.org/10.1016/j.jenvman.2021.113189

Shekarian, E., Ijadi, B., Zare, A., & Majava, J. (2022). Sustainable Supply Chain Management: A Comprehensive Systematic Review of Industrial Practices. In *Sustainability* (Vol. 14, Issue 13). https://doi.org/10.3390/su14137892

Shen, B., Yang, X., Xu, Y., Ge, W., Liu, G., Su, X., Zhao, S., Dagestani, A. A., & Ran, Q. (2023). Can carbon emission trading pilot policy drive industrial structure low-carbon restructuring: new evidence from China. *Environmental Science and Pollution Research*, *30*(14), 41553–41569. https://doi.org/10.1007/s11356-023-25169-4

Singjai, K., Winata, L., & Kummer, T.-F. (2018). Green initiatives and their competitive advantage for the hotel industry in developing countries. *International Journal of Hospitality Management*, *75*, 131–143. https://doi.org/https://doi.org/10.1016/j.ijhm.2018.03.007

Smol, M., Adam, C., & Preisner, M. (2020). Circular economy model framework in the European water and wastewater sector. *Journal of Material Cycles and Waste Management*, *22*(3), 682–697. https://doi.org/10.1007/s10163-019-00960-z

Tao, R., Umar, M., Naseer, A., & Razi, U. (2021). The dynamic effect of eco-innovation and environmental taxes on carbon neutrality target in emerging seven (E7) economies. *Journal of Environmental Management*, *299*, 113525. https://doi.org/https://doi.org/10.1016/j.jenvman.2021.113525

Velvizhi, G., Goswami, C., Shetti, N. P., Ahmad, E., Kishore Pant, K., & Aminabhavi, T. M. (2022). Valorisation of lignocellulosic biomass to value-added products: Paving the pathway towards low-carbon footprint. *Fuel*, *313*, 122678. https://doi.org/https://doi.org/10.1016/j.fuel.2021.122678

Wong, C. Y., Wong, C. W. Y., & Boon-itt, S. (2020). Effects of green supply chain integration and green innovation on environmental and cost performance. *International Journal*

of Production Research, *58*(15), 4589–4609. https://doi.org/10.1080/00207543.2020.1756510

Wu, J.-Z., Santoso, C. H., & Roan, J. (2017). Key factors for truly sustainable supply chain management. *The International Journal of Logistics Management*, *28*(4), 1196–1217. https://doi.org/10.1108/IJLM-07-2014-0103

Zhang, D., Narbaev, T., Cheng, J., & Aliyeva, A. (2023). How natural resources collaboration affects the pollutants level and economic growth: Novel evidence from China. *Resources Policy*, *85*, 103801. https://doi.org/https://doi.org/10.1016/j.resourpol.2023.103801

Zhang, Q., Gao, B., & Luqman, A. (2022). Linking green supply chain management practices with competitiveness during covid 19: The role of big data analytics. *Technology in Society*, *70*, 102021. https://doi.org/https://doi.org/10.1016/j.techsoc.2022.102021