

A Holistic Approach to Sustainability Reporting: Integrating Social and Governance Dimensions in Life Cycle Assessment

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Due to the growing concern about sustainability issues, business advocacy groups increasingly emphasise the importance of Environmental, Social, and Governance (ESG) analysis and reporting within organisations. ESG performance broadens stakeholders' perspectives, offering insights into how an organisation evaluates its business practices and performance across ESG categories. While sustainability reporting is becoming mainstream, and organisations with high sustainability ratings demonstrate increased competitiveness and greater opportunities, concerns about the trustworthiness and accountability of sustainability reporting persist. Anecdotal evidence suggests that the lack of standardisation—mainly due to the diverse nature of businesses and organisations—and a rise in greenwashing practices have hindered the acceptance of sustainability reporting. Life Cycle Assessment (LCA) is widely recognised for its effectiveness in quantifying environmental impacts by identifying inputs and outputs in various processes. This work introduces the ESG-LCA framework, which evaluates environmental, social, and governance performance throughout the life cycle. The integration of LCA in addressing sustainability reporting based on the respective dimensions of ESG enhances sustainability reporting in terms of credibility, comparability, and practicality. A case study in the palm oil value chain is presented to illustrate the application of the ESG-LCA framework in the context of developing countries. This research contributes to advancing sustainable practices by integrating ESG considerations into the traditional LCA methodology. The proposed framework can facilitate decision-making by promoting higher resource-use efficiency, reducing environmental and social impacts, enhancing governance practices to strengthen stakeholder relationships, and managing risks. The results can serve as a guide for improving credit and investment decisions for financial institutions and investors.

1. Introduction

In the constantly changing world of business and finance, Environmental, Social, and Governance (ESG) have emerged as guiding principles for organisations to achieve a more sustainable future. The adaptation of ESG considerations into an organisation helps transform how businesses operate, improve their decisions, and further influence their impacts on the overall ecosystem (Li et al., 2021). The knowledge and understanding of ESG considerations are becoming increasingly important for stakeholders especially when it comes to sustainability reporting. To bridge the gap between the demand for ESG information by stakeholders and the supply of information by organisations, several countries, including but not limited to the European Union, United States, and Malaysia, have adopted mandatory ESG disclosure legislation to force organisations to adequately disclose information on ESG issues in traditional financial disclosures or specialised standalone reports (i.e., sustainability or CSR reports). However, compared with financial reports, sustainability reports generate less credibility. The comparability of data is less available because sustainability reports deal with non-financial information, and specific measurements may be very subjective and often multidimensional (Tan, 2024). Despite guidelines from ESG forefront organisations such as Global Reporting Initiative (GRI) and Morgan Stanley Capital International (MSCI), sustainability reporting still faces many challenges (i.e. inconsistent reporting framework, variability in metrics, data quality and reliability). Studies show that many

stakeholders consider sustainability reporting as a tool to enhance the organisation's reputation and attract potential investors rather than genuinely committing to sustainable practices (Krueger et al., 2021).

On the other hand, Life Cycle Assessment (LCA) has long been a valuable tool for evaluating the environmental impacts of products, processes, and services. Over the years, LCA has been widely accepted and applied in many industries such as construction, agriculture, manufacturing, as well as oil and gas (Christensen et al., 2020). The effectiveness is evident as LCA has been promoted in various European policy-making initiatives over the past 30 years (Sala et al., 2021). However, more is needed to address the multifaceted sustainability issues of today's world. Sureau et al. (2018) mentioned that for LCA to become a tool for implementing a sustainable supply chain, LCA must consider the socio-economic environment and transgress the traditional quantitative boundaries. With the continual emergence of new technologies, shifting consumer preferences, risk management as well as unpredictable environmental events that constantly redefine sustainability issues, the static nature of LCA seems to limit its ability to adapt to the dynamic environment (van der Giesen et al., 2020). It is essential to realize that LCA is not an interaction tool per se in the entire supply chain, and other approaches or tools are necessary to establish cooperation in and along the supply chain. This study aims to introduce a novel framework integrating social and governance dimensions into LCA to address all three main ESG categories in sustainability reporting comprehensively. Being one of the major palm oil producers in the world, sustainability issues associated with the palm oil industry such as deforestation, habitat loss, pollution and forest fire has been the major concern in the agriculture sector in Malaysia (Lim et al., 2021). Therefore, a case study applying the ESG-LCA framework to Malaysia's palm oil value chain is proposed. The rest of the paper is structured as follows: Section 2 – Contribution of LCA on sustainability reporting; Section 3 – Methodology; Section 4 – Results and Discussion; Section 5 – Conclusion - Prospect, recommendations, and future works.

2. Contribution of LCA on sustainability reporting

In the past, the "Triple Bottom Line" (TBL) approach emphasized that true sustainability is achieved by simultaneously addressing three interdependent dimensions: economic, social, and environmental (Alhaddi, 2015). This approach has broadened stakeholders' awareness, highlighting that sustainability requires not only economic targets but also social and environmental commitments. As organisations adopt the TBL approach to achieve sustainability, critiques such as difficulty addressing conflicting motivations between dimensions and a lack of standardized metrics and methodologies have emerged (Birkel and Müller, 2021). These challenges make performance comparisons across organisations difficult. Moreover, it fails to address governance issues, which are crucial for ensuring accountability and transparency in sustainability efforts (Hussain et al., 2018). Effective sustainable development governance at all levels is key to realizing the goals of sustainable development (Leal Filho et al., 2016). Governance is critical especially when it is capable of acting as the glue that bridges the gap and harmonizes the priorities and actions needed to balance economic growth, environmental protection, and social well-being. Therefore, sustainability reporting has evolved over the years to include governance factors, expanding the scope of traditional sustainability reporting and offering a more holistic view of an organisation's performance.

Sustainability reporting, also known as ESG reporting, is now defined as a form of non-financial reporting that involves disclosing an organisation's environmental, social, and governance (ESG) performance (Li et al., 2021). It communicates how an organisation manages and measures its sustainability impacts, risks, and opportunities with stakeholders, both present and future. Even though the economic dimension seems to have been omitted from sustainability reporting, stakeholders understand that it still plays an essential role in supporting the foundation of sustainability reporting. Based on a study on the European banking sector by Buallay (2019), the findings deduced from the empirical results demonstrate that ESG has a significant positive impact on the organisation's operational, financial, and market performance. Kim and Li (2021) also show that ESG factors can positively impact corporate profitability and credit rating, and the effects may vary across different environmental, social, and governance dimensions. The study's results indicate that the economic dimension remains an important focus when it comes to sustainability reporting. With the global shift from voluntary to mandatory sustainability reporting, more and more stakeholders began to recognise the significance of sustainability towards organisational performance. High ESG ratings provide a competitive edge for an organisation, as research by Buallay (2019) shows that organisations with great ESG performance exhibit lower risk exposure, higher returns on investment, and increased resilience. Having said that, while sustainability reporting is valuable for transparency and accountability, weaknesses such as greenwashing, data accuracy and reliability, and overemphasising metrics while overlooking the real impacts persist.

Life Cycle Assessment (LCA) was first introduced in the 1960s and gained popularity in the 1990s as a systematic and comprehensive methodology to evaluate the environmental performance of a product, process or activity throughout its life cycle. LCA helps to understand the actual environmental footprint of a product,

process or activity from cradle to grave, all the way from the initial stage of raw materials acquisition to the manufacturing or production stage, to use phase and its end-of-life (Guinée et al., 1993). It serves as an integral tool for governments, industries, and academia to enhance the decision-making for sustainable development. Its practicality and broad applicability in various industries led to the development of a common standard published by the International Organisation for Standardization (ISO) for guidance, namely ISO 14040 and ISO 14044. ISO 14040 describes the principles and framework for LCA, while ISO 14044 defines the requirements and guidelines for LCA study (Finkbeiner et al., 2006). ISO 14040 and ISO 14044 consolidate LCA procedures and methods and contribute to its general acceptance by all stakeholders and the international community. LCA methodology has proven effective in providing comprehensive quantitative information on the environmental dimension, a crucial part of sustainability reporting.

Over the years, different assessment tools (e.g., Life Cycle Costing (LCC), Social LCA (sLCA), and Cost-Benefit Analysis (CBA)) have been integrated with LCA elements to provide a more comprehensive overview of sustainability (Hoogmartens et al., 2014). Life Cycle Sustainability Assessment (LCSA) was developed as a comprehensive version of LCA that combines different tools such as LCC and sLCA to consider the economic, environmental, and social dimensions from the life cycle perspective. Even though LCSA have rapidly attracted interest over the years, methodological differences and different weights for environmental, economic and social priorities remain a significant challenge, leading to inconsistent and conflicting assessment outcomes (Costa et al., 2019). The ambiguity of results creates confusion for stakeholders, making it more challenging to identify synergies between different tools. Birkel and Müller (2021) also mention in the article that stakeholders are usually more driven by an economic perspective, and cases in which all three dimensions can be aligned under a win-win paradigm for sustainable development are rare.

3. Methodology - ESG-LCA Framework

Figure 1 illustrates the ESG-LCA framework, which integrates economic, environmental, social, and governance dimensions into Life Cycle Assessment (LCA) to enhance sustainability reporting in terms of credibility, comparability, and practicality. This framework adheres to the ISO (2006) standards and includes the four main components: Goal and Scope Definition, Life Cycle Inventory (LCI), Life Cycle Impact Assessment (LCIA), and Interpretation Phase.



Figure 1: ESG-LCA Framework for sustainability reporting

As the first phase of ESG-LCA, Goal and scope definition stage lays the groundwork for the entire assessment by describing the product system in terms of the system boundaries and functional units (Guinée et al., 1993). It illustrates the extent of the assessment, its coverage in the product life cycle and the purpose of the study. With the rapidly increasing global demand and production of palm oil each year, the urgency of improving sustainability performance in the palm oil industry is high (Klemeš et al., 2021). An important assumption in this study is that economic profits must be guaranteed before organisations are motivated to improve their ESG performance, which is the central pillar in sustainability reporting. This case study will focus on a cradle-to-gate study of the CPO production in Malaysia. LCA analysis will be conducted towards the upstream stage in the palm oil industry (from seedlings to plantation to mill). The system boundary in this study includes the nursery subsystem, plantation subsystem, and palm oil mill subsystem that produces the crude palm oil in a study by Choo et al. (2011), as shown in Figure 2.

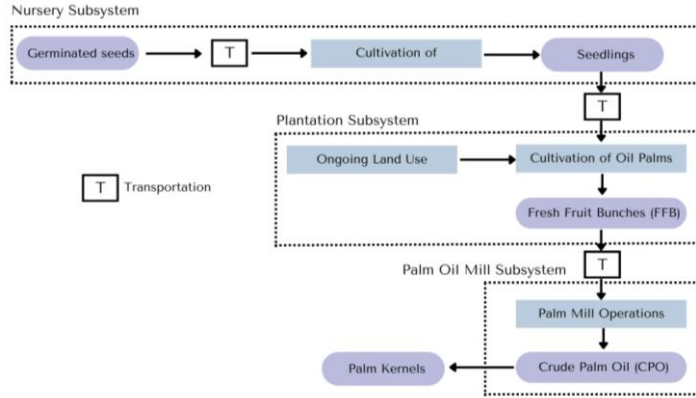


Figure 2: System boundary of the proposed ESG-LCA study (Choo et al., 2011)

The proposed ESG-LCA is performed based on the Eq(1).

$$ESG - LCA = LCA^{En}w^{En} + LCA^{Sc}w^{Sc} + LCA^{Gv}w^{Gv} \quad (1)$$

where $LCA^{En}, LCA^{Sc}, LCA^{Gv}$ is the index score for the environmental, social and governance LCA results respectively while w^{En}, w^{Sc}, w^{Gv} is the priority weightage assigned for the environmental, social and governance indicators with Analytic Network Process (ANP), which is a type of multi-criteria decision analysis. The priority weightage assigned to each ESG dimension varies, reflecting stakeholders' varying priorities and concerns in the palm oil industry value chain. Questionnaires are used to assess the social LCA and governance LCA in the palm oil industry. Key metrics for the social dimension include labor rights and standards, customer satisfaction, community relations, economics and livelihood, trust and power relations, infrastructure and linkage, and quality of life. For the governance dimension, metrics include board composition and structure, audit and internal control, risk management, and transparency and disclosure. Social LCA employed 4-level rubric scale to gather data on palm oil stakeholders' perceptions of the key social dimensions. Reliability was assessed using Cronbach's alpha, with values above 0.7 indicating acceptable internal consistency. Pilot testing and item analysis were conducted to refine the questionnaires, ensuring clarity and stability of responses. Governance LCA is conducted by identification and verification of the enforcement of the respective governance policies in palm-oil related organisations.

The scope of this case study revolves around the environmental consequences of the production of crude palm oil (CPO), utilizing the ESG-LCA framework that quantifies the impacts from the view of environmental, social, and governance dimensions. The objectives will be assessed based on the primary activities and emissions that lead to each scenario's highest environmental burden. Scenario 1 will carry out the LCA analysis, while scenario 2 will build on top of the LCA analysis to include the social and governance considerations. The outcome of both scenarios will be compared to showcase how integrating social and governance dimensions into the LCA framework can ultimately synergize both LCA and ESG and contribute significantly to sustainability reporting. The functional unit will be 1t of crude palm oil produced. LCI is the main data collection phase. The life cycle inventory of this study considered the production of seedlings at a nursery, the production of FFB at oil palm plantations on mineral soil, and the production of 1t of crude palm oil. The data for the production of seedlings and FFB were obtained from the study by Choo et al. (2011). The data on the production of CPO were obtained from a selected oil palm mill in Johor Bahru, Malaysia (Omran et al., 2021). All inventory data were collected and input into Simapro, a powerful LCA software capable of tracking the performance of a product or service's sustainability. It can methodically analyse a complex life cycle and assess the environmental impact of a product or service at each stage. The database libraries selected include Ecoinvent 3.10, Agri-footprint 5.0, and Methods. In the LCIA phase, the inventory data collected in the LCI is transformed into meaningful ESG-centric impact categories (i.e., global warming, marine eutrophication, resource scarcity for the environmental impact categories) to evaluate the potential impacts or implications associated with the product system being studied. In this work, the demonstration of the ESG-LCA is focused on the environmental dimension to help with the general understanding of the framework. The LCIA phase mainly utilises the SimaPro software with ReCiPe 2016 impact assessment method. The primary objective of the ReCiPe method, a key tool in our analysis, is to transform the long list of LCI results into a limited number of indicator scores. These indicator scores express the relative severity of environmental impact category. The results are then paired with the chosen indicators scores for social and governance dimensions that have different weightage of contribution to the palm oil industry value chain (Ngan et al.,

2023). The weightage is obtained based on the pairwise comparison survey results by a total of 17 industry experts. Lastly, the interpretation phase of the ESG–LCA framework is critical for compiling and summarizing the findings from the LCI and LCIA phases accordingly. It includes the identification of significant areas of concern as well as assessing the data quality sensitivity and completeness to ensure the reliability and robustness of the LCA results.

4. Results and Discussion

In this study, the weightage for sustainability reporting is as follows: (environmental 35.5%; social 27.6%; and governance 35.9%). However, this is subject to change with the rapid evolution of ESG policy, which is being updated over time. The LCA results for environmental impacts are shown in Figure 3.

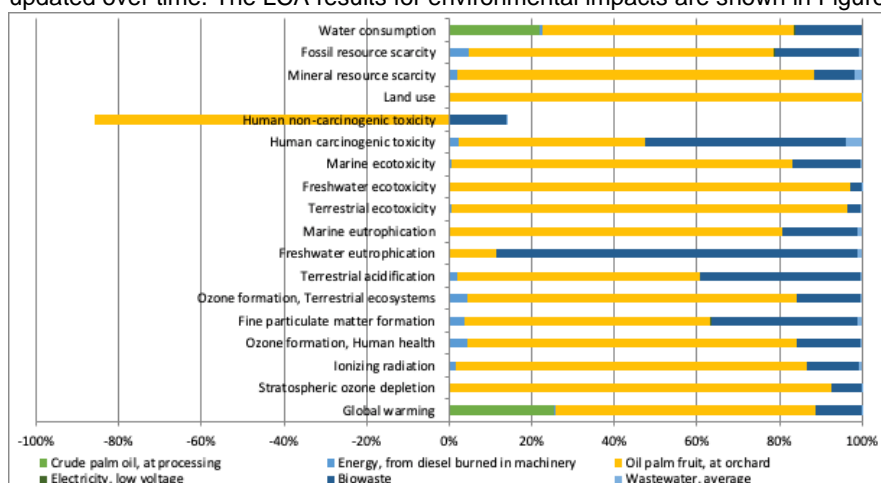


Figure 3: Percentage contribution of 1t of crude palm oil production in Malaysia to environmental impact

The proposed ESG-LCA framework integrates the social and governance dimensions in LCA to offer a comprehensive quantitative result not only in environmental impacts but also in social and governance impacts. By quantifying social and governance metrics, the social and governance impacts are now measurable, and the importance of each metric can be graded accordingly. ESG-LCA also allows analysis of environmental impacts across the entire life cycle from an environmental viewpoint and a social and governance viewpoint in hindsight. With unchanged environmental impacts for 1t of crude palm oil production in Malaysia, organisations in the palm oil industry that implement social policies related to labour standards and rights such as ensuring a safe and healthy working environment, reasonable minimum wages, and fair working hours perform better in sustainability reporting, even though these effects are not reflected in environmental impacts. Ensuring fair labor rights and standards enhances worker well-being and productivity over the long run. On the other hand, risk management has a more significant impact on the governance dimension than transparency and disclosure, followed by audit and internal control. A governance policy such as establishing a risk management committee to oversee potential business risks can lead to more effective risk identification and mitigation, enhancing overall governance and sustainability performance. The integration of social and governance dimension in LCA ultimately strengthens an organisation's reputation and compliance with international standards, leading to more robust and comprehensive sustainability performance. The eco-efficiency analysis of various scenarios can be obtained for benchmarking and performance tracking. The ESG-LCA interpretation phase can provide a comprehensive report that is transparent, reproducible, and understandable for stakeholders, decision-makers, and other interested parties. One of the limitations of this study is that the general progress of ESG adaptation in the palm oil industry in Malaysia is slow, especially among small and medium enterprises (SMEs), causing difficulties in fixing the list of specific social and governance indicators to be included. The following limitation is the scope and boundary issue. As ESG-LCA encompasses a broader scope that focuses on all environmental, social, and governance impacts, more adjustments have to be made to align the scope and system boundaries. Lastly, the framework can be challenged by the dynamic nature of sustainability reporting that change frequently due to regulatory shifts, social movements, and other external reasons.

5. Conclusion - Prospect, recommendations, and future works

This work proposes the ESG-LCA framework to improve the credibility, comparability and practicality of sustainable reporting. The possibility of integrating the social and governance elements into LCA analysis in

the case study demonstrates that there are better approaches than focusing on addressing environmental impacts alone in ensuring sustainability over time. As the scope of sustainability reporting starts to embrace ESG elements, an ESG-compliant organisation will inevitably emerge as a mainstream in future. As LCA has been widely used by organisations to address environmental impacts in the past, integrating social and governance elements into LCA is an easy step forward for organisations in picking up the pace of sustainability reporting while ensuring practicality and transparency at the same time. It is essential to realise that sustainability ratings act as a benchmark for organisations across industries. By accurately identifying metrics tailored to each ESG dimension, the ESG-LCA framework can be applied to other industries. A greater rating in sustainability reporting also indicates a better future outlook with the attraction of more potential investors. The future works will focus on improving the ESG-LCA framework to aid in developing the sustainability efforts of overall palm oil industry in Malaysia.

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